UNIVERSIDADE FEDERAL DE SÃO CARLOS
CENTRO DE CIÊNCIAS EXATAS E TECNOLOGIA
PROGRAMA DE PÓS-GRADUAÇÃO EM ENGENHARIA DE PRODUÇÃO

EMANUELA LEAL CODOGNOTTO

LEAN HEALTHCARE: BARRIERS AND STRATEGIC PATHWAYS TO OVERCOME THEM

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Dissertação apresentada ao Programa de Pós-Graduação em Engenharia de Produção da Universidade Federal de São Carlos (UFSCar), como parte dos requisitos para obtenção do título de Mestre em Engenharia de Produção.

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RESUMO

A busca por eficiência e qualidade na área da saúde tem levado hospitais a adotar práticas de melhoria contínua inspiradas no setor industrial, como o Lean Healthcare (LH). No entanto, as organizações ainda enfrentam diversos desafios que dificultam o sucesso na implantação do LH. Nesse contexto, esta pesquisa tem como objetivo compreender a relação entre as principais barreiras à implementação do LH e os caminhos estratégicos para superá-las. O estudo adota uma abordagem de métodos mistos, combinando Revisão Sistemática da Literatura (SLR) e Análise de Conteúdo, que identificaram 14 meios estratégicos relacionados a dez barreiras principais, com as metodologias *Interpretive Structural Modeling* (ISM) e análise MICMAC, empregadas para mapear as relações de dependência e interdependência entre os fatores. Os resultados possibilitam o desenvolvimento de um framework abrangente, composto por quatro níveis, que representa a progressão lógica desde as condições estruturantes até a obtenção de resultados sustentáveis do LH. O estudo contribui para a teoria ao integrar abordagens qualitativas e quantitativas sob a lente da Teoria da Aprendizagem Organizacional, oferecendo uma visão hierárquica das barreiras e das estratégias de superação. Do ponto de vista prático, fornece um roteiro estruturado que auxilia gestores hospitalares na priorização de ações e no fortalecimento da aprendizagem organizacional em iniciativas Lean. A originalidade da pesquisa reside na integração das metodologias ISM–MICMAC com a teoria da aprendizagem, resultando em um modelo inovador para promover a sustentabilidade do Lean Healthcare.

Palavras-chave: Lean Healthcare; Barreiras; Aprendizagem Organizacional; Framework

ABSTRACT

The pursuit of efficiency and quality in healthcare has led hospitals to adopt continuous improvement practices inspired by the industrial sector, such as Lean Healthcare (LH). However, organizations still face several challenges that hinder its successful implementation. This research aimed to understand the relationship between the main barriers to LH implementation and the strategic pathways to overcome them. The study adopted a mixed-methods approach, combining a Systematic Literature Review (SLR) and Content Analysis, which identified 14 strategic means related to ten main barriers, with Interpretive Structural Modeling (ISM) and MICMAC analysis, employed to map the relationships of dependence and interdependence among the factors. The results enabled the development of a comprehensive four-level framework, representing the logical progression from foundational conditions to sustainable LH outcomes. The study contributes to theory by integrating qualitative and quantitative approaches through the lens of Organizational Learning Theory, offering a hierarchical view of barriers and strategies to overcome them. From a practical perspective, it provides a structured roadmap for hospital managers to prioritize actions and strengthen organizational learning within their Lean initiatives. The originality of the research lies in the integration of ISM–MICMAC methodologies with learning theory, resulting in an innovative model to promote the sustainability of Lean Healthcare.

Keywords: Lean Healthcare; Barriers; Organizational Learning; Framework

LIST OF ABBREVIATIONS AND ACRONYMS

ISM	Interpretive Structural Modeling
LH	Lean Healthcare
LM	Lean Manufacturing
MICMAC	Cross-Impact Matrix Multiplication Applied to Classification
OL	Organizational Learning
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
RQ	Research Question
SLR	Systematic Literature Review

LIST OF TABLES

LIST OF FIGURES

TABLE OF CONTENTS

1 INTRODUCTION

This chapter contextualizes the studied themes, defines the research objectives, and justifies the relevance of this study. It also presents the specific objectives and a brief description of the methods employed, as well as the structure of the dissertation. Finally, it outlines how the dissertation is organized and how the results are presented throughout the text.

1.1 CONTEXT AND MOTIVATION

Lean is a system aimed at eliminating waste to achieve efficiency, based on five principles: defining value, identifying the value stream, creating flow, establishing pull, and pursuing perfection (Womack and Jones, 1996; Lanza-León; Sanchez-Ruiz; Cantarero-Prieto, 2021; Zdeba-Mozola et al., 2023). Due to the great success and dissemination of Lean in industrial environments, the practice has expanded and been adapted to other sectors, including healthcare (Lean Healthcare) (Danese; Manfé; Romano, 2018; Lima et al., 2021; Mansour and Chênevert, 2024). This adaptation has been carefully carried out to address the specific challenges and nuances of healthcare delivery, ensuring that the fundamental principles of Lean are effectively translated to meet the critical demands of patient care and hospital management (Tiso, Crema, Verbano, 2021; Leite et al., 2024; Zdeba-Mozola et al., 2023).

Healthcare services constantly face challenges to improve the quality of care, increase efficiency, and add more value to patients (Tlapa et al., 2020; Freitas, Mendonça e Resende, 2023). In pursuit of excellence, healthcare institutions are increasingly adopting continuous improvement practices (Leite et al., 2024; Costa et al., 2024), among which Lean Healthcare (LH) stands out. Through its wide implementation, it has been observed that Lean is capable of transforming how hospitals conduct their operations, enabling improvements in quality of care, reducing errors and waiting times, and even eliminating interdepartmental barriers (Peimbert-García; Gutíerrez-Mendoza; García-Reyes, 2021; Zdeba-Mozola et al., 2023; Lima et al., 2024).

LH is a relatively recent approach (its first implementation likely took place in the early 2000s), and skepticism regarding its effectiveness persists, posing additional challenges to its acceptance (Chmielarz et al., 2023). Although Lean is a widely acclaimed approach for performance improvement, its implementation in healthcare often fails due to persistent barriers that many institutions struggle to overcome (Almutairi et al., 2021; Leite, Bateman, Radnor, 2020; Pozzan et al., 2025). A significant factor limiting the success of Lean initiatives is the insufficient understanding of these obstacles and of the strategies required to address them effectively (Leite, Radnor, Bateman, 2022; Chmielewska et al., 2023; Nawanir et al., 2025).

This study investigates these barriers, revealing their multifaceted nature and interdependencies across various organizational levels.

The literature calls for an in-depth exploration of the nature and origins of these barriers, their hierarchy, and, most critically, the strategic pathways to overcome them (Almutairi et al., 2021; Chmielewska et al., 2023; Fournier et al., 2021; Noris et al., 2022). Such understanding is essential to sharpen the focus of healthcare leadership, enhance decision-making, and ensure the sustainable success of LH initiatives (Freitas, Mendonça e Resende, 2023; Noris et al., 2022; Rosa, Marolla e McDermott, 2023). Addressing these impediments is not only beneficial but essential to achieving the true objectives of Lean in healthcare environments (Chmielewska et al., 2023; Nawanir et al., 2025).

This scenario highlights a critical research gap: a comprehensive assessment of LH barriers and the formulation of systematic strategies to overcome them are notably lacking. This study aims to bridge this knowledge gap by employing Organizational Learning (OL) Theory as a lens to examine the barriers to LH implementation. OL posits that organizations evolve through the creation, sharing, and application of knowledge, suggesting that overcoming barriers is inherent to the learning process (Secchi; Camuffo, 2021; Zhuge et al., 2023). Moreover, constructing a hierarchical model of LH barriers will enable top management to determine possible causes of implementation failure.

Through expert opinion, the interdependence between barriers and the pathways to overcome them is mapped, allowing for the construction of a framework to guide various stakeholders in overcoming these barriers. This framework is expected to assist managers in addressing the challenges that may affect the pre-implementation and implementation phases, thereby reducing the risk of LH failure (Abu-Salim et al., 2023).

1.2. RESEARCH QUESTION AND OBJECTIVES

Given the above, the main objective of this research is to understand the relationship between the main barriers to Lean Healthcare implementation and the strategic pathways to overcome them, according to both the literature and expert perspectives. To this end, the study seeks to answer the following research questions:

RQ1: What are the main barriers to implementing Lean Healthcare in hospitals, and what are their underlying causes?

RQ2: What strategic pathways to overcome Lean Healthcare barriers in hospitals are identified in the literature?

RQ3: What are the dependency relationships among the strategic pathways for overcoming Lean Healthcare barriers?

This understanding enables the construction of a hierarchical model of pathways and a comprehensive framework that guides Lean Healthcare sustainability. To achieve this overarching goal, five specific objectives were defined (Table 1.1).

This dissertation adopts a structure focused on the production of scientific articles intended for submission to high-impact journals with selective editorial policies. Therefore, despite the effort to avoid redundancies, some repetitions may appear in the text to facilitate comprehension of the two articles independently. Table 1.1 below presents a summary of the methodological procedures employed in the research, as well as the specific objectives.

Table 1.1 - Specific Objectives of the Dissertation

No	Specific objectives	Dissertation Chapter	Method
1	Identify the main barriers to Lean Healthcare implementation in hospitals	2. From Barriers to Strategic Pathways: Organizational Learning Strategies in Lean Healthcare	SLR
2	Identify the strategic pathways described in the literature		
3	Understand how organizational learning is related to LH barriers and pathways		Content Analysis
4	Analyze the dependency relationships between strategic pathways to overcome LH barriers	3. From Barriers to Strategic Pathways: a hierarchical framework for sustainable Lean Healthcare implementation	ISM
5	Propose a framework to establish strategies to enhance the success and sustainability of LH implementation in hospitals		MICMAC Analysis Case study

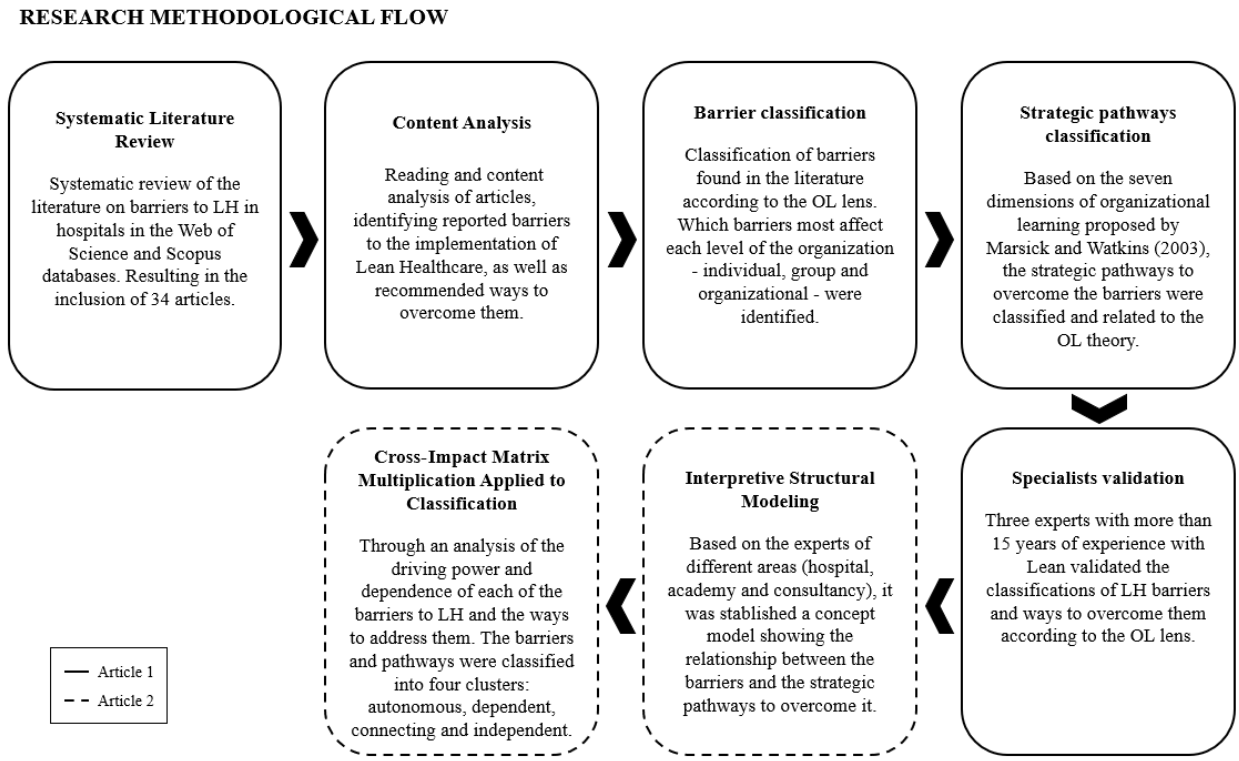
Source: Own authorship

1.3 METHODOLOGICAL APPROACH

This study can be classified as a mixed methods research approach, which, according to Bryman (2012), has become increasingly popular among researchers in the field of social sciences since 2001. The term is used to represent studies that integrate quantitative and qualitative strategies within a single research project (Creswell; Clark, 2017). The choice of research methods used in this dissertation was associated with the process of developing the scientific investigation, and the details of each selected method are presented throughout the following chapters, which are organized in the form of academic articles (with one article presented in Chapter 2 and the other in Chapter 3).

This section presents the methodological framework through which the general and specific objectives will be achieved. As the dissertation is structured in an article-based format, it is appropriate to define a specific research method for each article, as illustrated in Figure 1.1.

Figure 1.1 - Summary of the methodological flow of the research



Source: Own authorship

The first stage of this dissertation was conducted using the Systematic Literature Review (SLR) and Content Analysis methods, presented in detail in Chapter 2 of this dissertation, as they comprise the methods used in the first article produced. To conduct the SLR, the stages proposed by Tranfield, Denyer and Smart (2003) were followed. To support the development of the SLR planning stage, the PRISMA 2020 model (Page et al., 2021) was applied. The systematic review contributed to achieving specific objectives 1 and 2, which involved identifying the barriers to Lean Healthcare and the pathways to overcome them described in the literature.

Content analysis allows researchers to analyze relatively unstructured data by considering their meanings, symbolic qualities, expressive content, and communicative roles within the data sources (Krippendorff, 2018). Therefore, this technique was applied to compile the information identified in the SLR and relate it to the characteristics of Organizational Learning (specific objective 3).

The quantitative research of this dissertation was carried out using the Interpretive Structural Modeling (ISM) approach and MICMAC analysis (Cross-Impact Matrix

Multiplication Applied to Classification), which are described in detail in Chapter 3, corresponding to the second article of the dissertation. These methods were applied to analyze the dependency relationships among the pathways to overcome LH barriers, with the goal of establishing strategies to enhance the success and sustainability of LH implementation in hospitals (specific objectives 4 and 5).

ISM is a well-established methodology for constructing and analyzing the underlying interrelationships among elements in complex systems. It helps impose order and direction on the complexity of these relationships, enabling a more systematic analysis of their influences (Mandal; Deshmukh, 1994; Samantra et al., 2016). However, ISM does not indicate the strength or importance of a parameter in terms of its driving and dependence powers; thus, the MICMAC approach was employed to overcome this limitation (Attri; Dev; Sharma, 2013). Consequently, MICMAC was used in combination with ISM to categorize the parameters into four clusters: autonomous, dependent, linkage, and independent (Abu-Salim et al., 2023).

1.4 STRUCTURE OF THE DISSERTATION

Chapter 1 presents the introduction, outlining the context and relevance of the research, its objectives, and a brief description of the methods employed. Chapter 2 contains the first article of the dissertation, which presents a systematic literature review on the barriers to Lean Healthcare implementation in hospitals, along with a content analysis that relates these barriers to characteristics of organizational learning. The second article, presented in Chapter 3, incorporates expert opinions to identify the dependency relationships between the pathways to overcome LH barriers found in the literature, validated by specialists through the ISM–MICMAC methodology. Finally, Chapter 4 presents the overall discussion and the concluding remarks of this research.

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2 FROM BARRIERS TO BREAKTHROUGHTS: ORGANIZATIONAL LEARNING AS A CATALYST FOR LEAN HEALTHCARE EXCELLENCE

This chapter presents the first article that composes this dissertation. This article introduces the Systematic Literature Review (SLR), which addresses the barriers to Lean Healthcare implementation and the pathways proposed in the literature to overcome them, analyzed through the lens of Organizational Learning (OL). This article was published in the *International Journal of Lean Six Sigma*, with the following DOI: 10.1108/IJLSS-05-2025-0141

2.1 INTRODUCTION

Health services face constant challenges to improve the quality of care, increase efficiency, and add more value for patients (Tlapa et al., 2020; Freitas, Mendonça, and Resende, 2023). Striving for excellence, healthcare institutions increasingly adopt continuous improvement practices initially designed for the industrial sector and tailor them to their unique context (Leite et al., 2024; Costa et al., 2024). Among these practices, Lean Manufacturing (LM) has been one of the most extensively adapted methodologies, known within the healthcare sector as Lean Healthcare (LH) (Mansour and Chênevert, 2024). This adaptation has been carefully undertaken to address the specific challenges and nuances of healthcare delivery, ensuring that the core principles of Lean—efficiency, waste reduction, and value maximization—are effectively translated to meet the critical demands of patient care and hospital management (Tiso, Crema, Verbano, 2021; Zdeba-Mozola et al., 2023). The evolution of LM into LH reflects a dedicated effort to bridge industry wisdom with the mission of health services, aiming to enhance outcomes and streamline care processes (Leite et al., 2024; Rosa, Marolla, McDermott, 2023).

The implementation of LH offers a promising avenue for enhancing patient value and operational efficiency in hospital institutions (Lima et al., 2024). However, skepticism about LH efficacy persists (Chmielarz et al., 2023), and the assimilation of LH principles in hospitals continues to encounter obstacles that hinder full-scale adoption and sustainability (Freitas, Mendonça, and Resende, 2023). Although Lean is widely acclaimed for performance improvement, its implementation in healthcare often falters because many hospitals struggle to overcome recurrent barriers (Almutairi et al., 2021; Leite, Bateman, and Radnor, 2020); a key factor is the insufficient understanding of these obstacles and of the strategies needed to address them effectively (Leite, Radnor, and Bateman, 2022; Chmielewska et al., 2023). Building on

this evidence, our research examines these barriers, their complex nature and interdependencies across organizational levels.

The literature calls for an in-depth exploration of the nature and origins of these barriers, their hierarchy, and, most critically, the strategies to surmount them (Almutairi et al., 2021; Chmielewska et al., 2023; Fournier et al., 2021; Noris et al., 2022). Such insights are imperative for sharpening the focus of healthcare leadership, enhancing decision-making, and ensuring the sustainable success of LH initiatives (Freitas, Mendonça and Resende, 2023; Noris et al., 2022; Rosa, Marolla and McDermott, 2023). Therefore, despite the recognized potential of Lean in healthcare, a comprehensive understanding of how to effectively navigate and eliminate these barriers remains elusive (Almutairi et al., 2021; Chmielewska et al., 2023; Noris et al., 2022). A comprehensive evaluation of the barriers to LH in the hospital settings and the formulation of systematic strategies to overcome them is notably absent (Almutairi et al., 2021; Leite, 2024). Addressing these impediments is not merely beneficial but essential for realizing the true objectives of Lean in healthcare settings (Leite et al., 2024).

This study aims to bridge this knowledge gap by employing Organizational Learning (OL) Theory as a lens to scrutinize LH implementation barriers. OL posits that organizations can advance through the creation, sharing, and application of knowledge, suggesting that overcoming barriers is inherently a learning process (Secchi; Camuffo, 2021; Zhuge et al., 2023). Previous research has highlighted the synergy between OL and barrier mitigation, demonstrating OL's capacity to facilitate sustainability, enhance error management, foster collaboration, and break through systemic resistance (Jackson, O'Callaghan, & Leon, 2014; Scipioni et al., 2021). Therefore, this study aims to fill this gap by cataloguing the barriers to LH implementation in hospitals and exploring effective solutions to navigate these challenges, thereby enhancing LH practices and providing a more nuanced understanding of Lean transformation within the healthcare sector.

By conducting a Systematic Literature Review (SLR) and a rigorous content analysis, this study delves into the evolution of LH barrier research, aiming to identify, categorize, and understand these barriers and their solutions through the prism of OL. This approach elucidates the challenges of LH implementation in hospitals and also offers a novel perspective on leveraging OL to transcend these obstacles, contributing significantly to the fields of LH and OL Theory.

Our study transcends mere identification by integrating the barriers within the framework of OL Theory. By doing so, we categorize and analyze the hurdles to LH and also propose a theoretically grounded and practically viable pathway to surmount them. This

integration facilitates a deeper understanding of how learning processes within organizations can be harnessed to navigate and eliminate the barriers to Lean implementation effectively.

The theoretical contribution of our research lies in its innovative use of OL Theory as a lens to examine and resolve the barriers of LH implementation. This approach sheds light on the practical application of the theory within the healthcare context, extending its conceptual boundaries by providing a structured methodology to address and overcome organizational inertia. Practically, our research equips hospital managers with a strategic toolkit based on OL dimensions to prepare for and enhance the success rates of LH initiatives. In doing so, it moves beyond theoretical discourse, offering actionable insights that can be directly applied in hospital operations to achieve a Lean transformation that is both efficient and enduring.

This study is structured as follows. Section 2 presents the concepts of Lean and OL and the relationship between them proposed in the literature. Section 3 exhibits the research method applied. Section 4 presents and discusses the results of the research. Section 5 presents the conclusions, limitations, and opportunities for future research.

2.2 THEORETICAL BACKGROUND

2.2.1 Lean Healthcare

The history of the term Lean is relatively recent, originating in the Toyota Production System in the 1950s. Lean is a system based on five principles: It is based on five guiding principles: define value; identify the value stream; create flow; establish pull and seeking perfection; and it is focused on the elimination of all types of waste to achieve efficiency (Womack and Jones, 1996; Lanza-León, Sanchez-Ruiz and Cantarero-Prieto, 2021; Zdeba-Mozola et al., 2023). Due to the great success and dissemination of Lean in industrial environments, the practice expanded and was adapted to other sectors, including healthcare (Danese, Manfé and Romano; 2018; Lima et al., 2024). However, in healthcare, given organizational complexity and limited Lean tenure, the literature essentially treats Lean as a process-improvement toolkit focused on waste elimination and value rather than a whole-system management philosophy (Al-Balushi et al., 2014).

Although the precise date of the first application of Lean in healthcare is uncertain (probably in the early 2000s), authors found that over the last few decades, international interest in LH has grown, driven by the recognition of its numerous advantages (Rosa, Marolla and McDermott, 2023). Lean has been found to be capable of changing how hospitals conduct their operations, allowing the quality of care to be improved, reducing errors and waiting times, and even eliminating interdepartmental barriers (Zdeba-Mozola et al., 2023). Recently, the LH

scope has evolved from a waste reduction focus to include broader goals like process optimization and improved working conditions (Parkhi, 2019; Rosa, Marolla and McDermott, 2023).

While there is a wealth of literature celebrating the successes of LH in transforming hospital environments (e.g., Fillingham, 2007; Holden, 2011; Costa et al., 2017; Rosa, Marolla and McDermott, 2023; Zdeba-Mozola et al., 2023), there remains a persistent exploration of its limitations and the unique challenges it encounters within the healthcare sector. The relative novelty of LH, especially when contrasted with its industrial origins in LM, necessitates a deeper investigation into the barriers that obstruct its implementation (Chmielewska et al., 2023; Leite et al., 2024). These barriers, identified as hurdles or obstacles, range from cultural and technical aspects to a scarcity of qualified personnel equipped to guide the Lean transition in healthcare settings, as highlighted by Leite, Bateman, and Radnor (2016) and Amran et al. (2020).

Despite recognizing these barriers, the literature reveals a significant gap in addressing and overcoming them. Leite, Bateman and Radnor (2020) emphasize the importance of understanding the root causes of these barriers to facilitate LH's implementation and sustainability.

There is relatively limited scientific information in this respect, as most studies focus on the benefits of Lean itself (Chmielewska et al., 2023). While a few studies have proposed solutions to overcome LH implementation obstacles (e.g., Almutairi et al., 2021), a comprehensive framework for addressing LH implementation challenges remains elusive. Chmielewska et al. (2023) found that the awareness of these challenging factors and the ability to manage them are the preconditions for effective use of the Lean principles in healthcare. Leite, Bateman and Radnor (2016) underscore the need for research focused on surmounting barriers related to patient behavior and the complexities of public healthcare systems.

2.2.2 Organizational Learning

Since the influential study of Crossan et al. (1999), research has begun to recognize OL as a multilevel phenomenon, providing a more complete picture of how learning occurs and flows within and between organizations (e.g. Alerasoul et al., 2022; Hueske; Guenther, 2015; Stelmaszczyk, 2016). According Freitas et al. (2018), OL is a process that develops over time, comprising three core sub-processes: creation of knowledge from the experience in the workplace; knowledge transfer from external experiences; knowledge retention through the establishment of knowledge flows in the context of the organization. Within organizations, the

OL theory focuses on the understanding of the learning phenomenon, moving across the individual, group, and organizational levels (Crossan et al. 2023).

At the Individual level, learning encompasses the personal acquisition and application of knowledge, shaped by one's exposure to information, memory capabilities, ability to retrieve information, incentives for learning, and underlying belief systems (Crossan, Lane, White, Djurfeldt, 1995; Hueske; Guenther, 2015). This dimension highlights the importance of individual cognitive processes in the broader learning landscape.

In a Group or Team context, learning transcends individual contributions, embodying a collective process where knowledge, though generated individually, gains value and meaning through sharing and collaboration (Crossan, Lane, White, Djurfeldt, 1995). Hueske and Guenther (2015) delineate this level through the lens of team dynamics, including team structure, climate, processes, member characteristics, and leadership style, emphasizing the synergistic nature of group learning.

At the Organizational level, learning manifests through the collective and systemic integration of individual insights and experiences, solidified within the organization's memory as established behaviors, mental frameworks, norms, and values that endure over time (Crossan, Lane, White, Djurfeldt, 1995). This level is characterized by the organization's dynamic capabilities, including its mission, objectives, strategy, structural and systemic arrangements, resource allocation, learning and knowledge management approaches, and the prevailing organizational culture (Hueske; Guenther, 2015). These elements collectively forge the environment in which OL unfolds, influenced by the organization's inherent systems, structures, and procedures.

It is essential to understand that the learning levels are related and influence each other since individual learning and mental models are the basis for those of teams, and these provide information for the organization's mental models and learning (Canbaloglu, Treur and Roelofsma, 2022). The use of learning phenomenon levels (individual, group, and organizational) has been applied to deeper understand barriers in different contexts of organizational management (e.g., Schilling and Kugle, 2009—learning barriers; Hueske and Guenther, 2015—innovation barriers; Scipioni et al., 2021—circular economy barriers). However, research using OL theory to explore LH barriers in greater detail is currently absent. This classification of learning levels can help to understand the LH barriers and how to overcome them through learning.

Marsick and Watkins (2003) present seven dimensions of the learning organization. They encompass perspectives on the organization’s climate, culture, systems, and structures that influence whether individuals learn (Marsick and Watkins, 2003). Furthermore, the

dimensions are built on the idea that learning must occur at every level - from individual to group to organizational - and that these changes must become new practices and routines that enable and support the ability to use learning to improve performance (Marsick and Watkins, 2003; Marsick, 2013). The seven dimensions of the learning organization are: Create continuous learning opportunities, Promote inquiry and dialogue, Encourage collaboration and team learning, Create systems to capture and share learning, Empower people toward a collective vision, Connect the organization to its environment, and Provide strategic leadership for learning.

2.2.3 Organizational Learning and Lean

Several studies connect the OL perspective to Lean implementation (Danese, Manfe and Romano, 2018; Ballé, Chaize, Jones, 2019; Al-Baik and Miller, 2018). An important part of Lean is learning at different organizational levels (Backstrand and Powell, 2021; Ballé, Chaize, Jones, 2019). Backstrand and Powell (2021) highlight that OL has recently emerged as the missing link to a successful Lean transformation. The Lean system is closely related to OL, as it fosters change through iterative learning (Zhuge et al., 2023).

Lean aligns with the dynamic capabilities approach to continuous improvement, highlighting that process enhancement requires OL to effectively adapt operational routines (Backstrand and Powell, 2021; Marathe et al., 2021). Backstrand and Powell (2021) argue that continuous improvement without learning is not Lean.

Al-Baik and Miller (2018) and Marathe et al. (2021) emphasize that Lean promotes OL, increasing team members' knowledge, learning ability, and experience, thereby enhancing learning at the individual and group levels. Thus, it allows the development of OL capability, promoting double-cycle learning, which is essential for developing dynamic capabilities in the organization (Ballé, Chaize, Jones, 2019; Marathe et al., 2021).

The learning phenomenon levels (individual, group, and organizational) and the OL dimensions model proposed by Marsick and Watkins (2003) have been used to analyze and understand the Lean approach. Alagaraja and Herd (2022) examine the key elements of Learning Organization (LO) and Lean literature to compare and contrast the two approaches, and for this, they used the OL dimensions model proposed by Marsick and Watkins (2003) as a basis for comparison. The model emphasizes supportive learning opportunities for individual employees, identifies concrete learning processes for team learning, and strategic leadership and the promotion of inquiry and dialogue in organizational level, which the research identified as compatible with the Lean system (Alagaraja and Herd, 2022). Tortorella et al. (2019) also relate pairwise relationships between specific sets of Lean Production practices and LO

dimensions using the same OL dimensions proposed by Marsick and Watkins (2003). The same occurs with the study by Lim, Sabil and Othman (2022), which uses the OL dimensions to study the mediating role of continuous improvement on the relationship between workplace learning and LM. Saabye and Powell (2022) study the link between LM and I4.0 from a LO perspective and highlight the importance of the dimensions of Marsick and Watkins (2003) in which learning must be an integrated part of the operator's daily work and highlights the importance of leaders and their behaviors for the OL.

The dimensions were also used as a proxy to measure soft skills in Lean Management implementation. Tortorella and Fogliatto (2014) created a method to assess the dimensions of OL and human resources management practices in a company under LM implementation. In the healthcare sector, Alonazi (2021) applied the Dimensions of Learning Organizations Questionnaire (DLOQ) developed by Marsick and Watkins (2003) to study LO during COVID-19 outbreak.

Given the complementary relationship between Lean and OL, the perspective of learning levels and OL dimensions can enhance the understanding of the Lean barriers faced and the pathways to overcome them. The OL dimensions proposed by Marsick and Watkins (2003) are related to Lean and healthcare and can help analyse how to overcome LH barriers through OL. Since, understanding Lean from the OL perspective enables organizations to achieve better results, as Lean evolves beyond a mere set of tools and, through learning, helps develop enhanced capabilities (Backstrand; Powell, 2021; Al-Baik; Miller, 2018).

2.3 STUDY DESIGN AND METHODS

A Systematic Literature Review (SLR) aims to find empirical evidence that answers specific research questions and fits pre-specified inclusion criteria (Webster and Watson, 2002; Snyder, 2019). SLRs synthesize research results in a structured, transparent, and repeatable manner (Tranfield, Denyer, Smart, 2003; Nunez-Merino et al., 2020; Hiebl, 2023).

This study uses the guidelines of Tranfield, Denyer, and Smart (2003) and Gupta, Altay and Luo (2019) to conduct the SLR, which includes planning (definition of the research question, establishment of the research protocol, definition of search bases and inclusion and exclusion criteria), conduction (selection and compilation of information obtained) and presentation of the results obtained.

2.3.1 Planning phase

The planning phase should identify the need for a review, specify the research questions, and develop a review protocol with methods for conducting the review, all to provide effective answers (Brereton et al., 2007; Maia, Lizarelli, and Gambi, 2023; Rossini et al., 2022).

This study applied the updated version of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) research protocol (Page et al., 2021) to support the planning stage. PRISMA became widely accepted as a gold standard for both meta-synthesis and meta-analysis, not bounded by specific research designs (Hiebl, 2023; Maia, Lizarelli and Gambi, 2023).

The planning protocol's first stage was defining the RSL research questions. To this end, exploratory research was carried out, and two research questions were defined:

RQ1 – What are the main barriers to implementing LH in hospitals and what are their causes?

RQ2 – What are the strategic pathways to overcome LH barriers in hospitals presented in the literature?

After defining the research questions, the research protocol contains the information to guide the steps in the review conduction phase (Brereton et al., 2007; Rossini et al., 2022), including the search string, the databases and search strategy, the selection criteria (inclusion and exclusion) and quality assessment (Brereton et al., 2007; Rossini et al., 2022) (Table 2.1). The search string was based on other authors who carried out systematic reviews on the topic of LH in hospitals (e.g., Lima et al., 2024; Tiso et al., 2022).

Table 2.1 - SLR protocol details

Topics	Details	
Search String	("Lean Healthcare") OR ("Lean" AND "Healthcare" AND "Barriers" AND "Hospitals")	
Databases	Web of Science and Scopus	
Search strategy	Terms of the string were searched for in the title, abstract, and keywords	
Exclusion Criteria	**Code**	**Exclusion Criteria**
	C1	Does not deal with hospitals
	C2	Focuses on methodologies other than Lean Healthcare
	C3	Full article not available
	C4	The article does not address the implementation or review of the literature on Lean
	C5	Articles in other languages
	C6	Books and book chapters
	C7	Does not answer any of the research questions
Inclusion Criteria	**Code**	**Inclusion Criteria**
	C8	The focus is on Lean applied in hospitals
	C9	Study about Lean Healthcare
	C10	Full article is available
	C11	The article presents an implementation or review of the literature on Lean
	C12	Article in English, Portuguese or Spanish
	C13	Journal articles or reviews
	C14	Answer at least one of the research questions
Quality Assessment	Peer review source and and presence of the applied method and its steps	

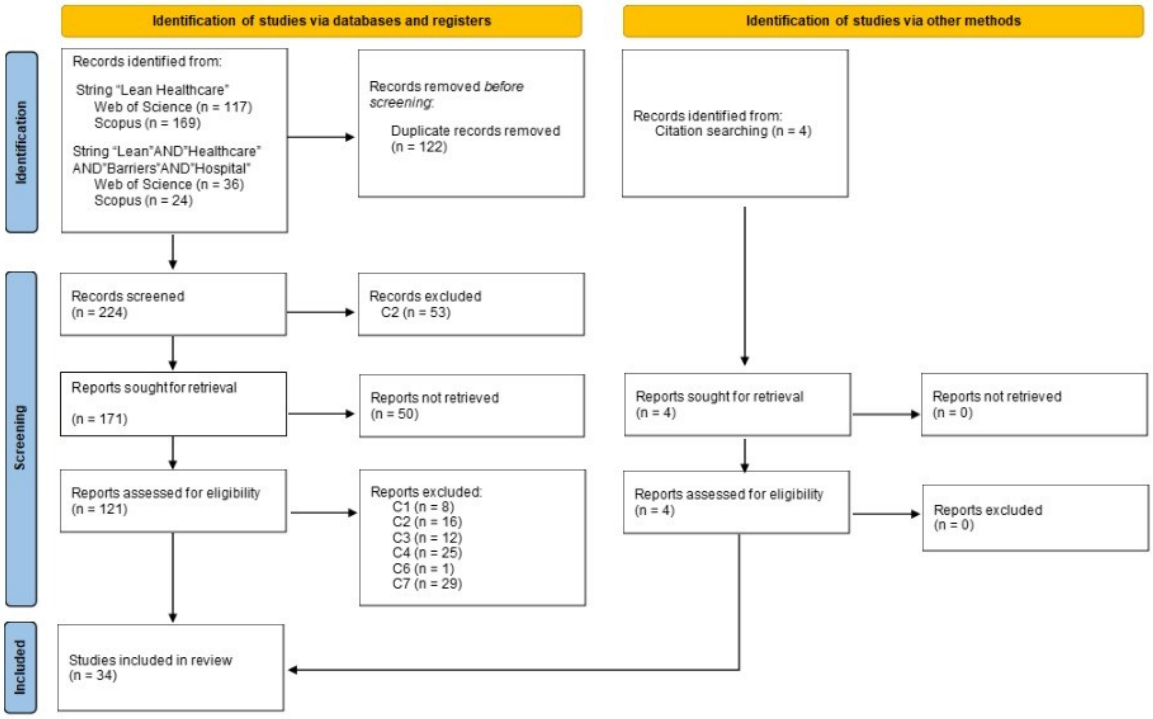
Source: Own authorship

The search was carried out on the Web of Science and Scopus databases. Two of the largest multidisciplinary databases with selective journal-based inclusion policies (Gupta et al. 2020; Buer et al., 2018). These databases serve as data sources for systematic reviews in the management and operations management literature (e.g., Nunez-Merino et al. 2020; Maia, Lizarelli and Gambi, 2023), underscoring their relevance to the field.

The search strategy used string terms in the titles, abstracts, and keywords (Table 2.1), resulting in the identification of documents in both databases. No time frame was made to obtain greater coverage, and because it is a relatively recent topic in the literature (articles found since 2008), selecting everyone until February 2024, when the step was carried out. No subject-area restrictions were applied in Web of Science or Scopus; searches were run across all subject areas to maximize coverage. In the screening stage, a two-stage process was applied. First, two independent researchers applied the inclusion/exclusion criteria to a partial reading (title, abstract, keywords) of all 224 records, of which 53 were excluded for not focusing on Lean (Figure 2.1). Second, we conducted full-text eligibility assessments for 125 reports (121 from databases and 4 from other sources), retaining 34 studies for the included stage. Each record was screened independently by both researchers; when initial judgments diverged, the record advanced to full-text review, following Maia, Lizarelli, and Gambi (2023). No inconsistent

judgments remained at the full-text stage. The inclusion/exclusion criteria (Table 2.1) ensured that studies addressing at least one research question were included. The PRISMA 2020 flow was used to represent the steps of the SLR (Figure 2.1).

Figure 2.1 – PRISMA 2020 flow diagram



Source: Own authorship

2.3.2 Conduction phase

The second SLR phase encompasses the conduction of the SLR, which involves the selection and compilation of information obtained (Tranfield, Denyer, and Smart, 2003). The documents were analyzed to identify the main characteristics for quantitative analysis (e.g., published source, authors, and publication date), and the coding of variables was used to answer the research questions (e.g., barriers, pathways of overcoming them) in the thematic analysis (Brereton et al., 2007; Rossini et al., 2022). The compilation of information was supported by content analysis, recommended to facilitate the exploration of complex issues in the field of management and allow the synthesis of qualitative results (Krippendorff, 2013).

Krippendorff (2018) defined content analysis as a research technique for making replicable and valid inferences from texts (or other significant subjects) to the contexts of their use. According to the author, the technique allows researchers to analyze relatively unstructured data by considering the meanings, symbolic qualities, and expressive content they possess, as

well as the communicative roles they play in the lives of the data. Content analysis has a long history in the management and business fields and its applications are continually expanding sources (Neuendorf, 2016; Krippendorff, 2018).

According to Neuendorf (2016), content analysis is a systematic technique. The technique is based on the systematic reading of potentially available texts and other data that could provide answers to research questions (Krippendorff, 2018). The content analysis was conducted following Krippendorff's (2018) steps, in which, after formulating the research questions, relevant documents were located and collected, analysis units were defined and sampled, categories and coding instructions were developed, as well as appropriate analytical procedures. These steps were applied to identify barriers and strategic pathways to overcome them in the 34 documents identified.

2.3.3 Reporting phase

Finally, the reporting phase is mainly related to the analysis, the presentation, and the interpretation of the results (Tranfield, Denyer and Smart, 2003; Rossini et al., 2022; Maia, Lizarelli and Gambi, 2023). Quantitative analysis used graphs and tables (quantitative descriptions) to present the results and compile the main characteristics of the selected studies according to the research questions.

For the thematic analysis proposed by Tranfield, Denyer and Smart (2003), the content analysis technique was applied to code and identify barriers and strategic pathways to overcome them. The analysis consisted of 6 steps (Figure 2.1), in which the first Step encompassed the eligibility of relevant documents produced by SLR, and Step 2 included content analysis to identify barriers. For content analysis, two independent coders screened and coded each study using a structured codebook piloted and refined through calibration rounds. All included records were double-coded. Discrepancies were resolved by discussion between them and revision of the definitions, with a third reviewer arbitrating unresolved cases (Burla et al., 2008).

In Step 3 the barriers were classified according to the perspective of learning levels (individual, group/team, and organizational), as already done in other studies (e.g., Schilling and Kugle, 2009; Hueske and Guenther, 2015; Scipioni et al., 2021) for a better understanding of the barrier and its action. The classification of barriers into levels was validated by four Lean experts with established knowledge of OL theory. The experts were identified through purposive sampling targeting individuals who combined academic experience (to facilitate rapid comprehension of the methodological protocol) and practical Lean expertise in healthcare setting. Candidates were screened via curriculum analysis and peer nominations provided by the

research team. Inclusion criteria comprised: (a) ≥10 years of experience with Lean; (b) experience in LH; and (c) roles in practice, training, or consulting, and being an academic/researcher in the field. Four experts met all criteria and agreed to participate.

The first expert has more than 20 years of Lean experience spanning consultancy (including healthcare) and academic research. The second and third experts each have over 20 years of Lean practice across service (including healthcare) and manufacturing organizations and are active researchers in the field. The fourth expert has more than 15 years of research experience on Lean in manufacturing and healthcare contexts and is an academic research in the field (Table 2.2).

Table 2.2 - Experts profile

Expert ID	Sector background	Experience	Years of experience
E1	Consulting	Research; Consulting	> 20 years
E2	Service (Healthcare) and Industry	Research; Practice	> 20 years
E3	Service (Healthcare) and Industry	Research; Practice	> 20 years
E4	Academia and projects in LH training	Research	> 15 years

The proposed classification was subjected to expert review, with the task of verifying its adequacy and identifying potential alternative levels. An initial classification was prepared by two researchers using blind analysis. When there was a classification conflict, the researchers talked and reanalyzed together, reaching a consensus. After that, the classification was independently validated by each expert. Points of divergence were documented and discussed in joint sessions until a consensus classification was achieved, following three rounds of review.

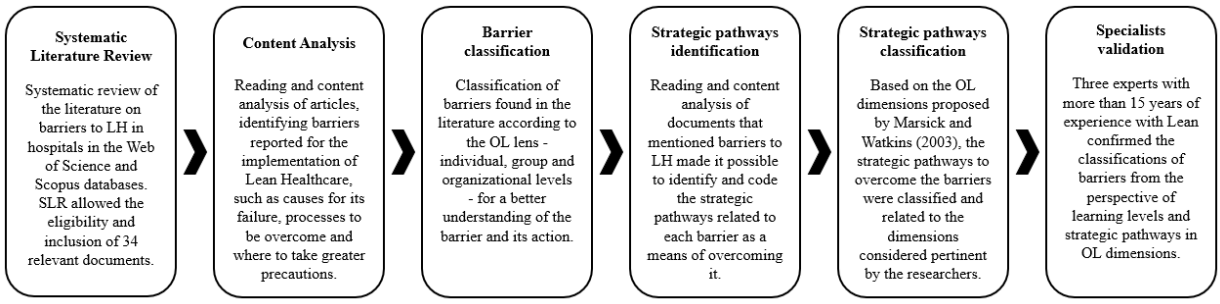
Therefore, in Step 4, the strategic pathways are identified and related to the corresponding barriers. In Step 5, the strategic pathways for overcoming were analyzed according to the OL dimensions proposed by Marsick and Watkins (2003). The classification was carried out in the dimensions considered pertinent, that is, a strategic pathway could be classified in more than one dimension. The same classification and validation procedure by the experts was carried out in steps 3 and 6. In step 6 the experts' consensus was obtained after two rounds of interaction.

To connect the relationships between barriers, strategic pathways, and OL dimensions, a Sankey diagram was created. This type of diagram is a visualization tool that represents flows between different sets of values, enabling the proportional display of each stream (Fang et al., 2020). The width of the lines denotes the magnitude of the flows, with thicker lines indicating larger volumes of transfer (Ma et al., 2018; Chong et al., 2021). In addition, arrows specify the direction of the flows, while the use of distinct colors allows for the categorization of elements or the indication of transitions between states (McLoughlin et al., 2010).

The Sankey diagram is particularly suitable for illustrating many-to-many relationships, as it visually emphasizes the most significant transfers or flows within a system (Fang et al., 2020). In essence, the capacity of the Sankey diagram to simultaneously represent both quantitative and directional aspects of flows renders it a powerful analytical tool for understanding complex systems and for examining the relationships and interconnections within them across diverse fields (Fang et al., 2020; Chong et al., 2021). The diagram has been used in Lean studies to present complex interactions between elements (e.g., Kassam et al., 2024).

Based on the classification of each barrier as individual, group, or organizational, it was possible to identify the strategic pathways for overcoming barriers at each level of OL. Similarly, these pathways were previously categorized according to the dimensions of OL, enabling the identification of which dimensions to prioritize in order to minimize the development of barriers at the specific level being addressed.

Figure 2.2 – Research planning



Source: Own authorship

2.4 RESULTS AND DISCUSSION

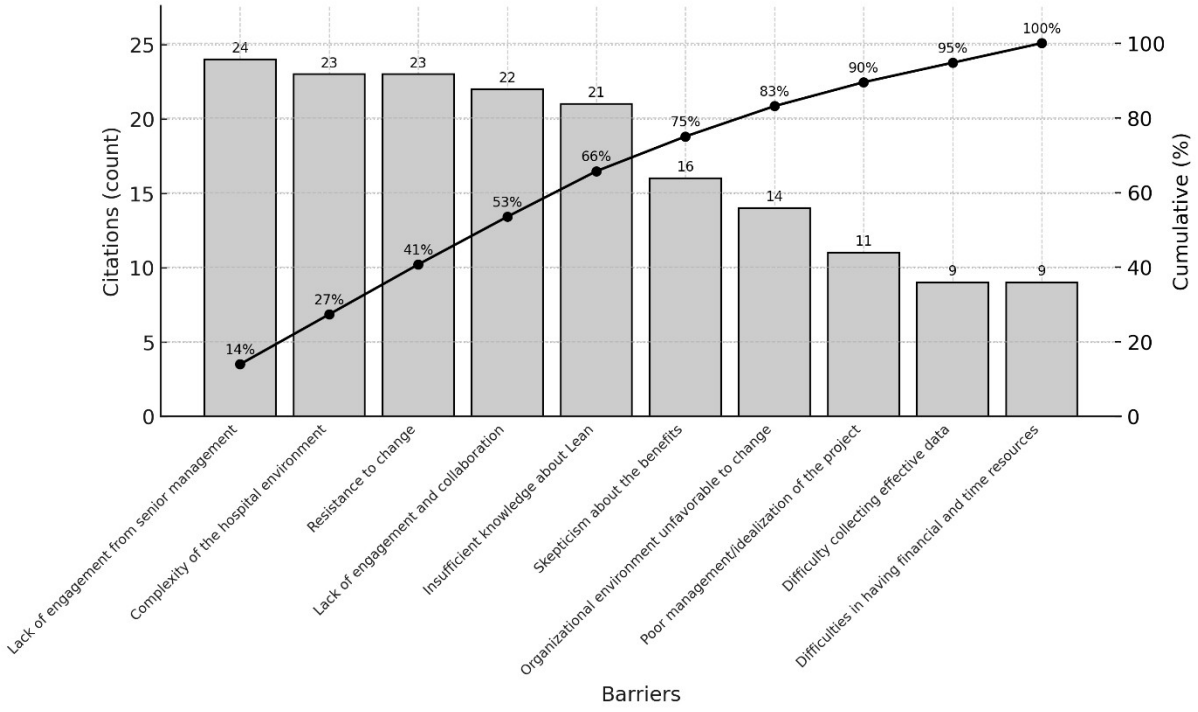
This section analyses the articles selected in the SLR to answer the research questions (RQ1 and RQ2). It also presents the analysis of these results through the lens of OL theory.

2.4.1 Main Barriers to implement Lean Healthcare through the perspective of learning levels

The SLR allowed the identification of 10 barriers to the implementation of LH: “Complexity of the hospital environment”, “Difficulties in having financial and time resources”, “Difficulty collecting effective data”, “Insufficient knowledge about Lean”, “Lack of engagement and collaboration”, “Lack of engagement from senior management”, “Organizational environment unfavorable to change”, “Poor management/idealization of the project”, ‘Resistance to change”, and “Skepticism about the benefits”. Table A1 (Appendix A) lists these barriers and the authors who identified them. Figures 2.3 and 2.4 present Pareto charts

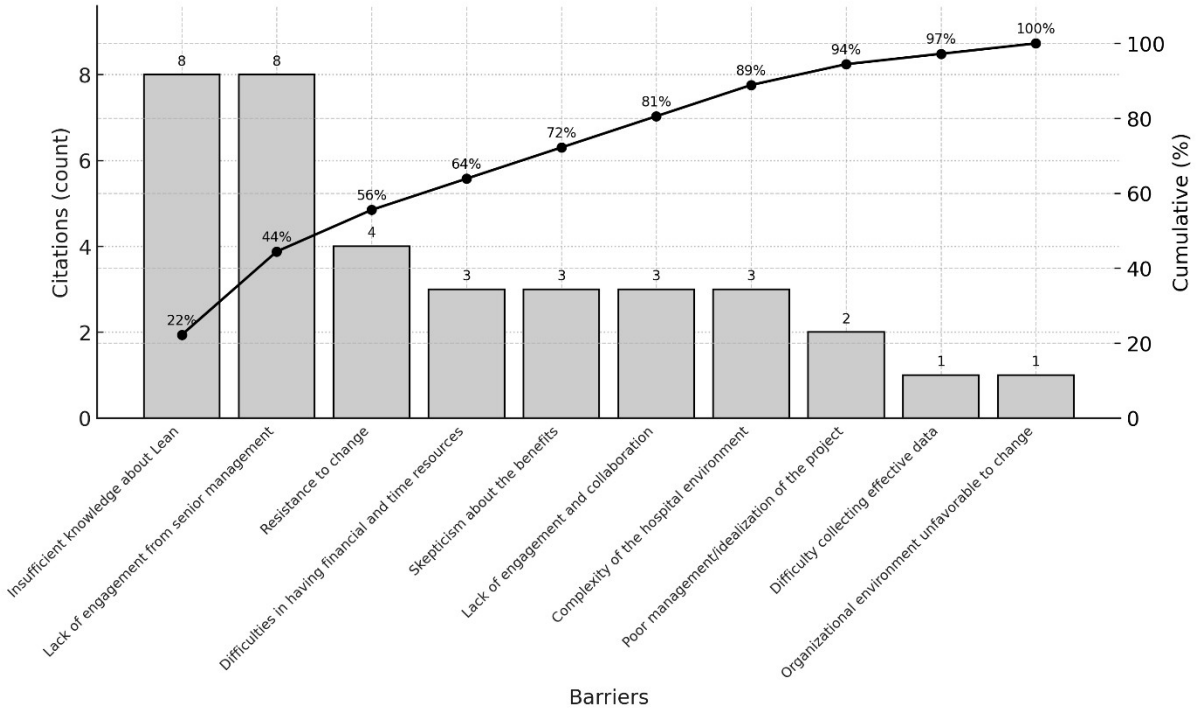
of the barriers, ordered respectively by the number of times a barrier was mentioned by different authors and by the number of times it was identified as the main barrier by different authors.

Figure 2.3 – Number of citations of the identified barriers in the literature



Source: Own authorship

Figure 2.4 – Number of prioritizations of the identified barriers in the literature

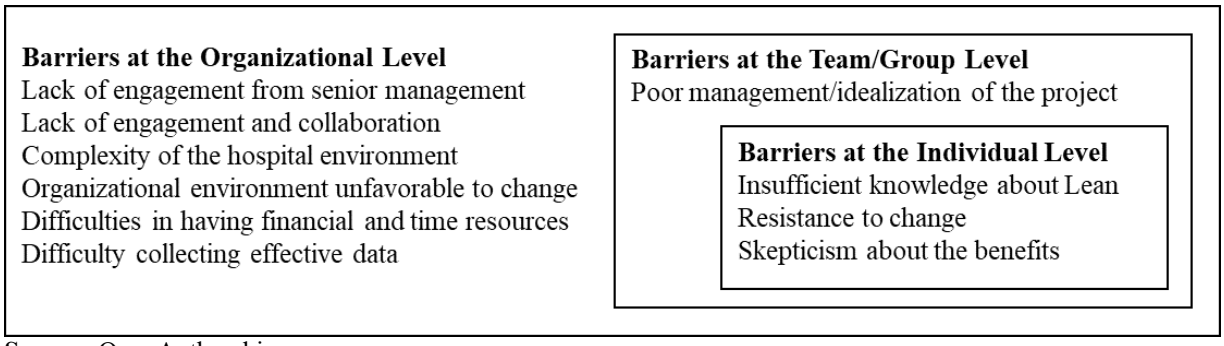


Source: Own authorship

The “Lack of engagement from senior management” was the principal barrier mentioned - 24 of the 34 articles (71% of the documents analyzed), being considered a priority to 24% of the authors. Followed by “Resistance to change” among employees (68%) and “Complexity of the hospital environment” (68%). Another highlight was “Insufficient knowledge about Lean,” which, although cited in 21 articles (67%), being the fifth barrier in the citation, was prioritized in 24% of articles, the highest value in this regard tied with "resistance to change."

The identified barriers were classified into learning levels: organizational, group/team, and individual (Figure 2.5). The separation into levels allowed a more in-depth analysis of the level at which this barrier occurs, and the impacts generated.

Figure 2.5 – Barriers to Lean Healthcare at different Organizational Learning’s Levels



Source: Own Authorship

2.4.1.1 Barriers at the Organizational Level

The organizational barriers are related to the following aspects: mission, goals and strategy; structure and systems; resource allocation; OL and knowledge management; and organizational culture (Hueske and Guenther, 2015). **The lack of engagement from senior management** and leaders is one of the main barriers to Lean implementation (Abdallah, 2020; Chmielewska et al., 2023; Patri; Suresh, 2018; Rosa, Marolla and McDermott, 2023). In hospitals, the training of managers is often more focused on health than on the areas of management, and it is common for them to not have the necessary knowledge about Lean (Abdallah, 2020; Amran et al., 2020; Lanza-León; Sanchez-Ruiz; Cantarero-Prieto, 2021; Vitásková, 2015). Managers may not be prepared to provide their employees with the learning, knowledge and experience necessary to develop a Lean culture and mindset (Vitásková, 2015). This structure makes it common to have leaders who do not understand the importance of implementing Lean and even their role in this type of change, which are a frequent cause of failure (Patri; Suresh; Prasad, 2021; Rosa, Marolla and McDermott, 2023) Without top management engagement, there is also a lack of allocation of resources for Lean and people development (e.g., mentoring and necessary training), making it difficult to disseminate Lean culture (Abdallah, 2020), which hinder the necessary adaptation to implementing Lean (Chmielewska et al., 2023; Vitásková, 2015).

The hospital organizational structure and systems make it is easy to create an organizational culture that does not **encourage engagement and collaboration from the employees** (Freitas, Mendonça and Resende, 2023). The structure is generally designed to maintain independence between departments and even professionals, who often have great autonomy, which leads to the presence of organizational silos that represent barriers to Lean (D'Andreamatteo et al., 2015; De Souza and Pidd, 2011; Drotz and Poksinska, 2014; Noris et al.; 2022; Parkhi, 2019). The professionals work in silos hindering communication and cooperation (Patri and Suresh, 2018). Therefore, it is challenging to adopt a structure that emphasizes process over function and that requires interdepartmental and interpersonal

collaboration for success (Bruno, 2017; Patri and Suresh, 2018). A point of attention presented in the literature is the engagement and collaboration of physicians (Abdallah, 2020; Almutairi et al., 2021; Amran et al., 2020; Reijula and Tommlein, 2012). Additionally, cultural issues based on the hierarchy of professionals in hospitals limit collaboration (Amran et al., 2020).

The hospital sector faces great competition and regulation (Amran et al., 2020; Freitas, Mendonça and Resende, 2023), making it especially difficult to implement changes due to the complexity of care processes and to the need to focus on the patient (Abdallah, 2020; Drotz and Poksinska, 2014; Leite, Bateman and Radnor, 2016). Additionally, there is difficulty in predicting demand (Almutairi et al., 2021; Aguilar-Escobar and Garrido-Vega, 2013; Freitas, Mendonça and Resende, 2023; Leite, Bateman and Radnor, 2016), high process variability (Amran et al., 2020) and difficulty in aligning Lean with the hospital strategy (Amran et al., 2020; Leite, Bateman and Radnor, 2020). This barrier of **complexity in the hospital environment** is a proven result of the hospital structure and systems.

The hospital environment has a greater complexity of cultural aspects to be faced to implement a new form of management and the cultural changes necessary for LH (Chmielewska et al., 2023; Patri and Suresh, 2017). This makes an **environment unfavorable to change**. Among the factors that aggravate the difficulty of change are the cultural difference between medical and Lean professionals (Almutairi et al., 2021; Bruno, 2017; Leite, Bateman and Radnor, 2016; Mannon, 2014), since healthcare professionals have a firefighting mentality (De Souza and Pidd, 2011; Amran et al., 2020) and and the lack of communication between departments when there are projects that require everyone's involvement (Amran et al., 2020; Chmielewska et al., 2023; De Souza and Pidd, 2011; Leite, Bateman and Radnor, 2016; Noris et al., 2022).

Among the organizational barriers, there is a **lack of financial and time resources**. Especially in the case of public hospitals, but also in other management models, there is a lack of financial resources for all actions necessary for patient care, becoming difficult to obtain the financial resources necessary to implement Lean (De Souza and Pidd, 2011; Chmielewska et al., 2023; Lanza-León, Sanchez-Ruiz and Cantarero-Prieto, 2021), which is aggravated when value generation is difficult to visualize (Leite, Bateman and Radnor, 2020). Furthermore, the hospital routine is complex, and time barriers are faced in carrying out training and activities outside of what is considered central (Amran et al., 2020; Leite, Bateman and Radnor, 2020; Portioli-Staudacher, 2008; Santos et al., 2020), that is, to invest in Lean projects (Amran et al., 2020).

When researching hospitals, authors report that there may be a lot of data available, but the hospitals structure are not prepared for data collection, performance measurement and management, and data analysis (Bruno, 2017; Amran et al., 2020; Guarilha et al., 2023), which

can be summarized in **difficulties in data collection** (Bruno, 2017 ; De souza and Pidd, 2011; Lanza-León, Sanchez-Ruiz and Cantarero-Prieto, 2021), which is very important for the best implementation of Lean and the measurement of its success (Amran et al., 2020; Bruno, 2017; De Souza and Pidd, 2011).

Barriers at the OL level are related to hospital structure and systems, in addition to problems of OL and knowledge management and also cultural issues, which hinder the implementation of LH (Noris et al., 2022).

2.4.1.2 Barriers at the Group/Team Level

Barriers at the Group/Team Level are related to team structure, climate, processes, member characteristics, and leadership style (Hueske and Guenther, 2015).

One of the barriers to Lean implementation in hospitals is **poor project management** (Rosa, Marolla, and McDermott, 2023), with slow adoption of Lean projects and delays in implementing changes (Zepeda-Lugo et al., 2020). There is difficulty in identifying waste in hospital supply chain management processes and implementing a performance measurement system (Almutairi et al., 2021), difficulty in standardization (Amran et al., 2020; D'Andreametteo et al., 2015; Zepeda-Lugo et al., 2020), demonstrating several problems in the way that the project team leads the implementation processes. One of the reasons for this poor management of the Lean project is the lack of professionals who have knowledge of Lean in the hospital context, considering the culture of healthcare (Almutairi et al., 2021; Amran et al., 2020; Drotz and Poskinska, 2014; Leite, Bateman and Radnor, 2016), directly related to the team structure and members characteristics.

2.4.1.3 Barriers at the Individual Level

The barriers at the individual level are related to the individual's ability and the attitude of individuals (Hueske and Guenther, 2015).

Several authors point out the **difficulty in training those involved in the project to use Lean** (Almutairi et al., 2021; Chmielewska et al., 2023; Lanza-León, Sanchez-Ruiz and Cantarero-Prieto, 2021; Santos et al., 2020), primarily due to the difficulty in adapting the methodology and its terms originating from manufacturing for the hospital environment (Chmielarz et al., 2023; Costa et al., 2017; Santos et al., 2020; Vitáskova, 2015). There is difficulty in individuals absorbing new skills related to Lean because of the lack of theoretical or applied knowledge about Lean and the absence/deficiency of training offered (Santos et al., 2020). The lack of well-trained people in implementation is seen as the cause of several barriers, such as resistance and lack of engagement from leaders and employees (Amran et al., 2020;

Costa et al., 2017), which emphasizes its prioritization in literature, representing the main barrier related to individual's ability.

Looking at individuals' attitudes, there are two barriers: resistance to change and Skepticism about the benefits of implementing LH. The **resistance to change** are recurring attitudes in the hospital environment when implementing Lean (Almutairi et al., 2021; Fournier et al., 2021; Mannon, 2014; Waring and Bishop, 2010; Zdeba-Mozola et al., 2023) as LH is associated with reduced autonomy, loss of value in their work and fear of losing job (Leite, Bateman and Radnor, 2020; Noris et al., 2022). Other causes are due to the implantation of LH being seen as a very high effort necessary to learn and change the previous routine (Al-Balushi et al., 2014; Lanza-León, Sanchez-Ruiz and Cantarero-Prieto, 2021; Reijula and Tommlein, 2012) and even if lesser or different educational or professional designation will make suggestions that change the work of health professionals (Al-Balushi et al., 2014). Another important cause of resistance is the origin of Lean in manufacturing (Amran et al., 2020; Drotz and Poskinska, 2014; Parkhi, 2019; Patri and Suresh, 2017) and placing cost reduction and greater efficiency (Costa et al., 2017; Fournier and Jobin, 2018).

The resistance to believe in Lean (**skepticism**) and in the benefits that Lean will bring to the hospital is a central barrier (De Souza and Pidd, 2011; Drotz and Poskinska, 2014; Leite, Bateman, and Radnor, 2020; Waring and Bishop, 2010). Skepticism may be due to the lack of correct knowledge about Lean, biased perceptions, and fear of the unknown (Reijula and Tommlein, 2012; Parkhi, 2019), fear that it will generate negative consequences for patients of changes in working practices (Waring and Bishop, 2010) and due to previous occurrences of failure in implementing similar changes or Lean itself (Leite, Bateman and Radnor, 2020; Rosa, Marolla and McDermott, 2023).

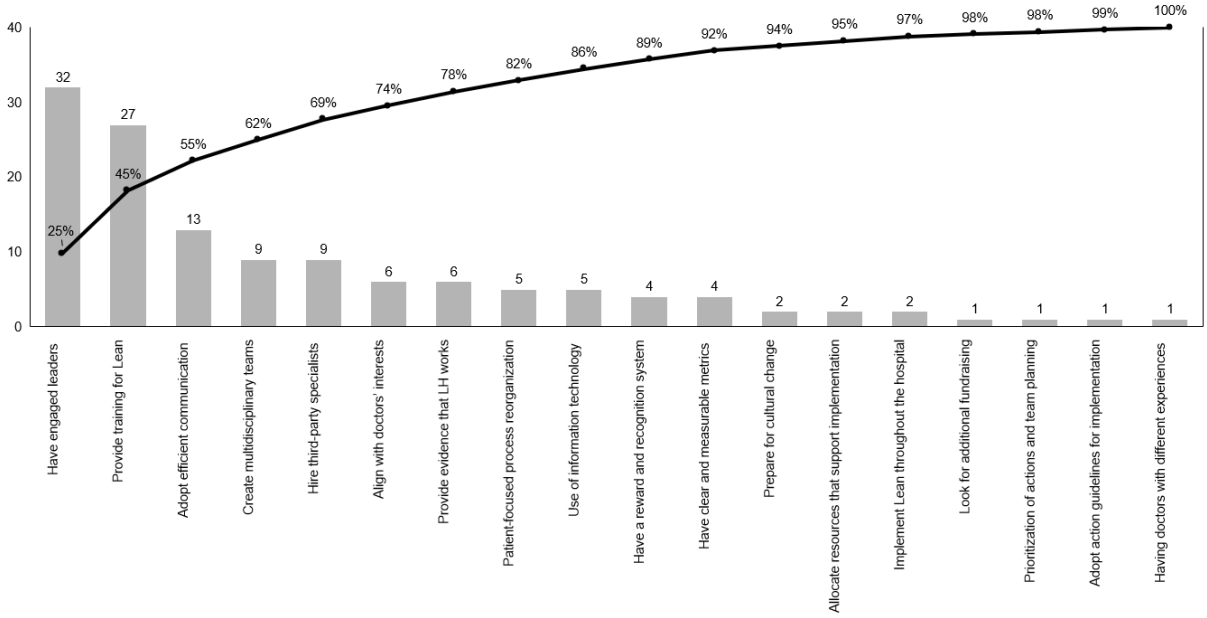
Barriers at the individual level are related to the attitude and perception towards adopting Lean, which also depends on the level of knowledge that the individual has about the approach. Classification allows the identification of barriers belonging to the same level and allows the discussion of how the levels are related and influence each other (Canbaloglu, Treur, and Roelofsma, 2022), facilitating the overcoming of barriers.

2.4.2 Navigating Beyond Barriers: Strategic Pathways for Lean Healthcare Advancement

To answer the second research question, strategic pathways to overcome barriers were identified through the content analysis, compiled, and analyzed in order to associate potential solutions (strategic pathways) with each of the barriers encountered. Table 2.3 presents all 18 distinct strategic pathways identified, along with their corresponding barriers, ordered by the frequency with which different authors mentioned each pathway. Table 2.3 also shows

examples of implementation strategies for each pathway to support practical application. To enhance clarity, a ‘How it helps to overcome barriers’ column, based on cited literature, defines each pathway’s role, specifies its link to particular barriers, and explains how it can help overcome them. Figure 2.6 presents Pareto chart of the strategic pathways to overcome the LH barriers, ordered by the number of times it was mentioned by different authors.

Figure 2.6 – Number of citations of the strategic pathways in the literature



Source: Own Authorship

Table 2.3 – Strategic Pathways to overcome barriers to LH implementation ordered by frequency of mention (1/5)

Strategic Pathways	How it helps to overcome barriers	Implementation strategies (examples)	# Mentions	# Barriers	Barriers
Have engaged leaders (e.g. providing material resources, data availability)	Leaders must demonstrate support, commitment, and understanding of Lean principles, acting as role models to foster a continuous improvement philosophy among employees (Parkhi, 2019). They should provide resources, such as time for employee training and involvement in Lean activities (Al-Balushi et al., 2014; Parkhi, 2019). Lean projects initiated and engaged by top management tend to be significantly more successful than those started by a single department (Tiso, Crema, Verbano, 2021). In practice, visible sponsorship and resource provision help address complexity of the hospital environment, insufficient knowledge about Lean, lack of engagement and collaboration, an organizational environment unfavorable to change, poor project management/idealization, resistance to change, skepticism about the benefits, and difficulty collecting effective data.	Provide training in Lean to hospital Leaders to understand its principles, tools and how it can be implemented; state and model Lean priorities (e.g., attend kick-offs and project updates); protect time for hospital staff training and participation in Lean projects; ensure the availability of hospital process data (often hard to access) for improvement work; and launch projects to be monitored by senior management, with a defined interdepartmental scope and regular oversight.	32	8	Complexity of the hospital environment (O) Insufficient knowledge about Lean (I) Lack of engagement and collaboration (O) Organizational environment unfavorable to change (O) Poor management/idealization of the project (T) Resistance to change (I) Skepticism about the benefits (I) Difficulty collecting effective data (O)
Provide training for Lean	Providing comprehensive Lean training is crucial for equipping healthcare staff with the knowledge and skills needed for successful implementation (Tiso, Crema, & Verbano, 2021), thereby addressing insufficient knowledge about Lean and skepticism about the benefits. Staff members—including internal medicine residents and frontline workers—also require protected time and specialized training to adopt process improvements and avoid a return to previous practices (Garcia, Mendonza, & Reys, 2021), which mitigates resistance to change, promotes engagement and collaboration, and helps shift an organizational environment unfavorable to change. Incorporating basic measurement content and simple data-collection routines within training further improves data readiness, reducing difficulty collecting effective data.	Provide time for short, focused Lean training; offer role-based modules for residents, nurses, and frontline staff with hospital-specific cases; create interdepartmental cohorts to build a shared language and collaboration; link training to real improvement projects; include basic measurement content and simple data-collection routines during the course; assign a Lean coach to support the first two improvement projects; schedule feedback sessions for early projects; ensure shift coverage so staff can attend without disrupting patient care.	27	7	Insufficient knowledge about Lean (I) Lack of engagement and collaboration (O) Organizational environment unfavorable to change (O) Poor management/idealization of the project (T) Resistance to change (I) Skepticism about the benefits (I) Difficulty collecting effective data (O)
Adopt efficient communication (Share information openly with a common goal for the project)	Adopting efficient communication involves openly sharing information and clearly articulating project goals and benefits to all stakeholders, including staff and patients (Erthal, Frangeskou, & Marques, 2021; Ngee-Wen et al., 2000). While such communication can prompt initial compliance, it is often insufficient on its own to overcome deeply entrenched resistance—particularly when changes are perceived as threats to medical professionalism (Fournier et al., 2021). In practice, transparent messages and a shared aim help navigate the complexity of the hospital environment, build basic understanding of Lean, foster engagement and collaboration, shift an organizational environment unfavorable to change, and reduce resistance to change.	Define clear project's objective and communicate it to everyone involved and across departments (recognizing the diversity of professional backgrounds in hospitals); establish routines to update stakeholders on project progress; clinical champions must be appointed to communicate changes in clinical forums; and simple visual charts must be used to display the current status, next steps, and team performance indicators.	13	5	Complexity of the hospital environment (O) Insufficient knowledge about Lean (I) Lack of engagement and collaboration (O) Organizational environment unfavorable to change (O) Resistance to change (I)
(O) Barriers at the Organizational Level; (T) Barriers at the Group/Team Level; (I) Barriers at the Individual Level					

Source: Own authorship

Table 2.3 – Strategic Pathways to overcome barriers to LH implementation ordered by frequency of mention (2/5)

Strategic Pathways	How it helps to overcome barriers	Implementation strategies (examples)	# Mentions	# Barriers	Barriers
Create multidisciplinary teams	Comprising professionals from diverse departments and hierarchical levels, including medical managers, physicians, nurses, and administrative staff—promotes horizontal integration and a shared sense of purpose (Erthal, Frangeskou, & Marques, 2021; Tiso, Crema, & Verbano, 2021). Integrating physicians into team-based quality improvement programs is also a strategic way to engage them in Lean initiatives (Garcia, Mendonza, & Reys, 2021). In practice, such cross-functional composition helps navigate the complexity of the hospital environment, builds basic Lean understanding through peer learning, and strengthens engagement and collaboration via joint ownership of goals and routines.	Define the improvement team composition, appointing a multidisciplinary core (e.g., medical manager, physician(s), nurse, administrative, physiotherapists and others) with explicit roles and decision rights, ensuring physician participation and shift coverage so all disciplines can attend without disrupting care; and establish operating routines, including a fixed cadence, execution of at least one project per team, and rules between departments to sustain collaboration.	9	3	Complexity of the hospital environment (O) Insufficient knowledge about Lean (I) Lack of engagement and collaboration (O)
Hire third-party specialists (e.g. consultancies)	Engaging third-party specialists, such as consultancies, can provide essential technical knowledge and external support for Lean implementation in healthcare organizations (Fournier et al., 2021). These experts help guide organizations through process-improvement complexities, particularly when internal staff have limited experience with Lean methods (Tiso, Crema, & Verbano, 2021). In practice, external facilitation and targeted expertise help navigate the complexity of the hospital environment, address insufficient knowledge about Lean, catalyze engagement from senior management through structured governance and credible guidance, and reduce resistance to change by supporting early, visible wins and neutral mediation.	Define the scope of outsourced expertise and explicit knowledge transfer and training requirements to avoid dependency. Outsourced professionals should be encouraged to initiate a time-bound pilot in a high-impact value stream for patients or hospital staff, co-led by a clinical champion and an internal improvement leader, with deliverables based on clear objectives and sustainability.	9	4	Complexity of the hospital environment (O) Insufficient knowledge about Lean (I) Lack of engagement from senior management (O) Resistance to change (I)
Align with doctors' interests	Aligning with doctors' interests is essential when Lean is perceived as purely efficiency-driven or as a threat to medical professionalism—often due to emphases on cost reduction or changes to established clinical routines (Fournier & Jobin, 2018). To counter this, organizations should highlight how Lean improves quality of care and patient experience, fostering greater physician engagement (Fournier et al., 2021). Recognizing that younger, less experienced physicians may be more receptive—while highly experienced physicians may resist due to perceived threats to professional autonomy and power relations—underscores the need for tailored engagement strategies by career stage and specialty. In practice, this framing directly addresses resistance to change by linking Lean to clinical value rather than administrative efficiency.	Frame Lean around clinical value and co-leadership, presenting problem statements and outcomes in terms of patient safety, quality, and experience; appoint physician co-leads for projects; and define patient-centred KPIs (e.g., complications, delays, handoff defects) to make benefits salient.	6	1	Resistance to change (I)
Provide evidence that LH works (e.g. successful benchmarks)	Benchmarking successful implementations—particularly in emergency care and surgical optimization—offers actionable insights and a roadmap for continuous improvement; documented cases report gains in patient flow and efficiency, with reductions in waiting times, waste, and length of stay in emergency departments and general hospital units (Santandreu, Mascarell, & Sabater, 2021). In practice, making these results visible helps secure engagement from senior management, reduces resistance to change by demonstrating clinical value, and addresses skepticism about the benefits through concrete, hospital-based evidence.	Build systematic reports with results from peer benchmarks, selecting comparable hospitals/services, extracting before–after results (flow, waiting time, length of stay, waste), context and methods, and mapping lessons to local value streams; and make them visible to clinical teams. Pilot projects with a set timeframe should also be encouraged to disseminate results transparently and allow for standardization and expansion (changes to standard operating procedures, monitoring plan).	6	3	Lack of engagement from senior management (O) Resistance to change (I) Skepticism about the benefits (I)
(O) Barriers at the Organizational Level; (T) Barriers at the Group/Team Level; (I) Barriers at the Individual Level					

Source: Own authorship

Table 2.3 – Strategic Pathways to overcome barriers to LH implementation ordered by frequency of mention (Continuation 3/5)

Strategic Pathways	How it helps to overcome barriers	Implementation strategies (examples)	# Mentions	# Barriers	Barriers
Reorganize processes	Reorganizing processes with a strong patient-focused approach involves	Define patient-value criteria for the target service	5	4	Complexity of the hospital environment (O)

with patient-focused quality practices and programs	redesigning care processes to eliminate waste and enhance efficiency, using tools such as value chain mapping, process diagrams, and Ishikawa diagrams to visualize and analyze workflows (Santandreu, Mascarell, & Sabater, 2021). Moving beyond traditional approaches that prioritize clinical staff needs or financial stakeholders, Lean advocates structuring healthcare operations around what is valuable to the patient, thereby improving overall quality and safety (Al-Balushi et al., 2014; Tiso, Crema, & Verbano, 2021). In practice, this patient-centred redesign helps navigate the complexity of the hospital environment, builds basic understanding of Lean through shared visual tools, shifts an organizational environment unfavorable to change by making patient value explicit, and reduces resistance to change by tying modifications to observable quality and safety gains.	(e.g., safety, wait time, handoff quality) and select a key patient value stream to pilot; involve physicians and, when feasible, patient representatives to analyze and improve current and future states; execute improvement projects anchored in patient-centered KPIs (e.g., door-to-doctor time, length of stay, readmissions, handoff defects); and implement standard work, visual management, and error prevention at critical steps (triage, medication administration, discharge).			Insufficient knowledge about Lean (I) Organizational environment unfavorable to change (O) Resistance to change (I)
Use of information technology (control sheet/electronic system)	Using information technology (e.g., control sheets/electronic systems) to continuously monitor KPIs has been associated with improved organizational performance (Ngee-Wen et al., 2000; Tiso, Crema, & Verbano, 2021). Although there may be initial resistance from medical professionals to transitioning to digital information, these tools are essential for transparency, data-driven decision-making, and identifying opportunities for continuous improvement (Erthal, Frangeskou, & Marques, 2021), thereby reducing difficulty collecting effective data and helping navigate the complexity of the hospital environment.	Define a minimum KPI set with clear operational definitions and dashboards with near-real-time data; implement visual management using trend charts and explicit targets; establish a review routine aligned with multifunctional teams or hospital departments, and maintain a problem log linked to monitoring and improvement projects; provide role-based training on data entry, interpretation, and basic analysis.	5	2	Difficulty collecting effective data (O) Complexity of the hospital environment (O)
Have a reward and recognition system	Implementing a robust reward and recognition system is vital for motivating staff and sustaining Lean initiatives in healthcare (Erthal, Frangeskou and Marques, 2021; Parkhi, 2019). The focus should extend beyond direct payments to encompass a broader strategy of recognition that reinforces engagement and celebrates small successes (Erthal, Frangeskou and Marques, 2021; Tiso, Crema, Verbano, 2021). In practice, consistent recognition mechanisms help strengthen engagement and collaboration by valuing contributions across roles and shifts, and reduce resistance to change by signaling organizational support for new routines and acknowledging early wins.	Establish focused, patient-centred recognition criteria linked to improvement KPIs, participation in improvement projects, and documented individual contributions; adopt a diverse mix of methods (e.g., public acknowledgement, certificates/awards); and tie recognition to project sustainability (evidence of maintained results), incorporating patient-feedback insights alongside leadership assessment whenever possible.	4	2	Lack of engagement and collaboration (O) Resistance to change (I)
Have clear and measurable metrics for project evaluation	Key performance indicators (KPIs), such as waiting times, length of stay (LOS), patient throughput, and cost reductions, are critical for defining project goals and assessing outcomes (Garcia, Mendonza, and Reys, 2021; Ngee-Wen et al., 2000; Tiso, Crema, Verbano, 2021).The use of an evidence-based approach, supported by KPIs and root-cause analysis, provides robust arguments for necessary changes and facilitates problem identification (Erthal, Frangeskou and Marques, 2021). In practice, explicit KPIs and cause-analysis routines help navigate the complexity of the hospital environment by creating a shared factual basis across services, and reduce poor project management/idealization by clarifying scope, targets, accountability, and decision rules from the outset.	Define a minimum set of patient-centred KPIs with clear operational definitions (formula, data source, measurement frequency) and explicit targets; assign ownership for data collection, analysis, and reporting; and implement unit-level visual dashboards showing trends and targets by team/department, supported by a shift-aligned review cadence and periodic analyses to inform actions.	4	2	Complexity of the hospital environment (O) Poor management/idealization of the project (T)
(O) Barriers at the Organizational Level; (T) Barriers at the Group/Team Level; (I) Barriers at the Individual Level					

Source: Own authorship

Table 2.3 – Strategic Pathways to overcome barriers to LH implementation ordered by frequency of mention (Continuation 4/5)

Strategic Pathways	**How it helps to overcome barriers**	**Implementation strategies (examples)**	# Mentions	# Barriers	Barriers
Prepare for cultural change	Cultivating a culture of continuous improvement, structured problem-solving, and shared Lean thinking among all members is crucial for long-term sustainability, moving beyond isolated improvements to an organization-wide transformation (Al-Balushi et al., 2014; Parkhi,	Establish pilot projects to disseminate a culture of improvement and showcase results that matter to the hospital—e.g., patient-centred projects with clear before-and-after examples to make cultural change	2	2	Organizational environment unfavorable to change (O) Resistance to change (I)

	2019). Leaders must address this by actively supporting and demonstrating commitment to Lean principles, thereby facilitating the shift from a hierarchical environment to one that fosters flexibility and individual initiative (Al-Balushi et al., 2014). In practice, this orientation helps transform an organizational environment unfavorable to change and reduces resistance to change by aligning behaviors, symbols, and routines with continuous improvement.	visible; hold periodic area meetings to generate and track simple improvement actions; and introduce Gemba-focused training to build problem-solving capability and drive improvements.			
Allocate resources that support implementation	Effective allocation of resources is critical for supporting Lean implementation in healthcare, particularly given the sector's challenges with budget reductions and the need to control high costs (Santandreu, Mascarell and Sabater, 2021; Tiso, Crema, Verbano, 2021). While Lean inherently aims to achieve efficiency and cost reduction, sometimes leading to significant gains without additional investment, strategic resource deployment is essential for sustained success (Garcia, Mendonza, and Reys, 2021). Moreover, reallocating resources, including personnel, equipment, materials, and medicines, can optimize internal logistics and patient care, addressing issues such as inadequate services and coordination (Tiso, Crema, Verbano, 2021). In practice, dedicating protected time, staffing, and basic tooling (e.g., access to data and improvement support) helps overcome difficulties in having financial and time resources, and targeted funding for training/coaching strengthens capability, mitigating insufficient knowledge about Lean.	Define and provide the resources needed for implementation (e.g., protected staff time for improvement work, shift coverage to enable participation, training, and access to basic tools and data); establish a dedicated budget for training, project management, and required system/process changes, with a clear approval workflow.	2	2	Difficulties in having financial and time resources (O) Insufficient knowledge about Lean (I)
Implement Lean throughout the hospital	Lean applications in healthcare have often been fragmented, focusing on isolated processes or departments, which can limit long-term organizational benefits and create pockets of best practices (Augusto and Tortorella, 2019; Parkhi, 2019). A holistic view, however, ensures that the effects of improvement projects on the entire value stream are considered, acting synergistically across upstream and downstream processes and breaking down departmental barriers (Tiso, Crema, Verbano, 2021). In practice, this end-to-end orientation helps mitigate poor management/idealization of the project by clarifying scope and governance across services, aligning objectives, and preventing local optimizations that degrade overall performance.	The hospital should select pilot projects that span end-to-end value streams and are suitable for scale-up; establish a hospital-wide Lean roadmap and governance (executive sponsor, cross-department steering group, defined scope and decision rights); and specify a clear scale-up sequence.	2	1	Poor management/idealization of the project (T)
(O) Barriers at the Organizational Level; (T) Barriers at the Group/Team Level; (I) Barriers at the Individual Level					

Source: Own authorship

Table 2.3 – Strategic Pathways to overcome barriers to LH implementation ordered by frequency of mention (Continuation 5/5)

Strategic Pathways	**How it helps to overcome barriers**	**Implementation strategies (examples)**	# Mentions	# Barriers	Barriers
Look for additional fundraising	Securing additional funding or optimizing existing financial resources is often a critical consideration for healthcare organizations facing pressures from rising costs and budget constraints (Santandreu, Mascarell and Sabater, 2021; Tiso, Crema, Verbano, 2021). For example, governmental programs have provided substantial funding to support Lean implementation in hospitals (Fournier and Jobin,	Define a funding plan that maps external sources (e.g., government programs, innovation/quality grants, philanthropy) and outlines eligibility, timelines, and reporting requirements; establish co-funding arrangements with academic and industry partners.	1	1	Difficulties in having financial and time resources(O)

	2018; Fournier et al., 2021). In practice, accessing external funds and better aligning internal budgets directly addresses difficulties in having financial and time resources, enabling protected time, training, and basic tooling necessary to initiate and sustain improvement work.				
Prioritization of actions and adequate team planning	Strategic prioritization of actions and meticulous team planning are essential for successful Lean implementation, particularly in complex healthcare environments (Garcia, Mendonza, and Reys, 2021). This involves identifying problems, defining clear project goals, and selecting actionable priorities through thorough process analysis (De Barros et al., 2021). Techniques such as the Pareto principle can be utilized to focus improvement efforts on areas with the most significant or recurring delays (De Barros et al., 2021). In practice, this disciplined focus helps address difficulties in having financial and time resources by directing limited staff time and budget to high-impact opportunities and sequencing work to avoid dispersion.	Use prioritization routines with clear criteria for project selection and resource allocation; plan with explicit, time-bound sprints and clearly stated goals; and hold regular status meetings, adjusting the schedule as necessary.	1	1	Difficulties in having financial and time resources(O)
Adopt action guidelines for implementation	While heterogeneity in experience can hinder a standardized approach, frameworks exist that outline phases, activities, tools, techniques, and enablers for Lean projects (Tiso, Crema, Verbano, 2021). These guidelines can facilitate continuous improvement processes and are replicable in various healthcare settings (Santandreu, Mascarell and Sabater, 2021). In practice, a clear, stepwise roadmap—shared with teams—improves transparency about what to do next and what results to expect, thereby reducing skepticism about the benefits.	Define guidelines and a core framework for implementing Lean in hospitals—covering phases, activities, deliverables, and tools—with standard templates; train teams on how to use these guidelines; and conduct periodic reviews to assess results and milestones achieved.	1	1	Skepticism about the benefits (I)
Having doctors with different experiences (e.g. type of management, hospital size)	The diverse experiences and backgrounds of doctors can significantly influence their receptiveness and commitment to Lean initiatives in hospitals. Research indicates that younger, less experienced doctors tend to be more committed to Lean initiatives, participating more readily in problem-solving compared to older, more experienced physicians who may resist questioning their established practices (Fournier and Jobin, 2018; Fournier et al., 2021). In practice, acknowledging this heterogeneity and tailoring engagement, roles, and support to different career stages and contexts can strengthen engagement and collaboration across medical teams.	Define an engagement plan that spans career stages and specialties; appoint respected physicians as project co-leaders and align participation with clinical schedules; provide training to build foundational knowledge of Lean principles and tools; and involve physicians in hospital management forums to develop Lean leadership.	1	1	Lack of engagement and collaboration (O)
(O) Barriers at the Organizational Level; (T) Barriers at the Group/Team Level; (I) Barriers at the Individual Level					

Source: Own authorship

The literature demonstrates the importance of having engaged leadership as a factor in overcoming barriers such as an organizational environment unfavorable to change (Al-Balushi et al., 2014; Noris et al., 2022), lack of engagement and collaboration (Freitas, Mendonça and Resende, 2023; Bruno et al., 2017), and skepticism (Costa et al., 2017) and individual resistance to change (Chmielewska et al., 2023). This is a strategic pathway that impacts almost all barriers identified in the literature and can enable the elimination of organizational, team, and individual barriers. The commitment of top management can provide material resources and time to dedicate to Lean activities and projects (Leite, Bateman and Radnor, 2016), and it also enables Lean to become institutional and to conduct Lean projects. Resources enable training and can solve insufficient individual knowledge about Lean (Bruno, 2017; Costa, 2017), which is also a proposed means of solving the organizational barriers (Abdallah, 2020; Leite, Bateman and Radnor, 2016) and poor project management (Amran et al., 2020).

Among the potential solutions found in the literature is the importance of carrying out training to prepare for the cultural change (Leite, Bateman and Radnor, 2016; Waring and Bishop, 2010) and to demonstrate the objectives, principles, and benefits for Lean implementation stands out (Almutairi et al., 2021; Costa et al., 2017; De Souza and Pidd, 2011; Fournier and Jobin, 2018; Patri and Suresh, 2018). Ensuring greater engagement and collaboration throughout the execution and success of Lean implementation (Aguilar-Escobar and Garrido-Vega, 2013). Training helps to overcome barriers related to the three learning levels (organizational, team, and individual), as it can assist in organizational culture, learning, and knowledge management; team member characteristics and the leadership style; and in the individual abilities and attitudes.

Effective communication between everyone involved in Lean implementation makes it possible to increase employee engagement and collaboration (Rosa, Marolla, and McDermott, 2023) once people feel involved in the Lean implementation process and reduce individual resistance (Almutairi et al., 2021). Communication helps to overcome the complexity of the hospital structure since it allows breaking down the barriers of departmental silos (Freitas, Mendonça and Resende, 2023). Communication can act on both individual-related barriers, improving their perception and ability in relation to Lean, and organizational barriers. The creation of multidisciplinary teams also helps to reduce the lack of collaboration faced in Lean projects (De Souza and Pidd, 2011; Drotz and Poskinska, 2014; Reijula and Tommlein, 2012; Zepeda-Lugo et al., 2020). Multidisciplinary teams also help to overcome the complexity of the hospital structure (Noris et al., 2022), allowing cooperation between professionals from different areas and increasing knowledge about Lean through the exchange of information between individuals (Guarilha et al., 2023).

Hiring outsourced Lean specialists, such as external consultants, helps overcome the lack of engagement from senior management (Reijula and Tommlein, 2012) and addresses another organizational barrier, such as the complexity of the hospital environment (Abdallah, 2020). These third-party specialists can present organizational solutions and even change individual skills and attitudes, reducing resistance (Rosa, Marolla, and McDermott, 2023) through increased knowledge about Lean (Garcia, Mendonza, and Reys, 2021). Aligning the project with the interests of physicians is a pathway to overcome individual resistance to change (Al-Balushi et al., 2014; Fournier and Jobin, 2018; Fournier et al., 2021). Carrying out benchmarks with successful cases of Lean implementation in hospitals (Almutairi et al., 2021) can minimize organizational and individual barriers since as it can increase top management commitment by seeing promising results (Almutairi et al., 2021); Chmielewska et al., 2023), and decrease individual beliefs of resistance (Costa et al., 2017) and skepticism (Rosa, Marolla and McDermott, 2023).

In this study, strategic pathways to overcome Lean barriers were associated with the Marsick and Watikins (2003) seven OL dimensions model since OL can drive the elimination of the barriers found. Classifying pathways into different OL dimensions allows for a greater understanding of the ways to overcome the identified barriers and to establish, through OL, ways to implement the strategic pathway (Table 2.4).

Table 2.4 – Strategic pathways to overcome barriers and connect with OL dimensions

OL Dimensions	Strategic pathways	Reasons to this classification
Create continuous learning opportunities	Allocate resources that support implementation Provide training for Lean Provide evidence that LH works Reorganize processes with patient-focused	Creating learning opportunities (resources) provided for ongoing education and growth (training and evidence that LH works). Learning is

	quality practices and programs Having doctors with different experiences	designed into work (reorganize processes and doctors with different experiences) so that people can learn on the job.
Promote inquiry and dialogue	Adopt efficient communication Hire third-party specialists Create multidisciplinary teams Prioritization of actions and adequate team planning	Promote inquiry and dialogue (share information and teams). People must develop skills to express their opinions (share information and teams) and the ability to listen and investigate the opinions of others through questioning, feedback, and experimentation (supported by experts).
Encourage collaboration and team learning	Prepare for cultural change Have a reward and recognition system Create multidisciplinary teams	Work is designed to use groups (interdisciplinary teams) to encourage collaboration and team learning, to access different modes of thinking, learn and work together (cultural change), and collaboration is valued by the culture and rewarded (cultural change and reward and recognition system).
Create systems to capture and share learning	Have a reward and recognition system Use of information technology Have clear and measurable metrics for project evaluation Look for additional fundraising	Create both high- and low-technology systems (information technology) to capture and share learning and integrated with work and projects (reward and recognition system and clear and measurable metrics for project evaluation).
Empower people toward a collective vision	Align with doctors' interests Adopt efficient communication Provide training for Lean Create multidisciplinary teams Have clear and measurable metrics for project evaluation Adopt action guidelines for implementation	People are involved in defining (clear and measurable metrics, adopting action guidelines, sharing information), owning (doctors' interests), and implementing (training, multidisciplinary teams) a collective vision. Responsibility is distributed close to decision-making so that people are motivated to learn about what they are held accountable to do.
Connect the organization to its environment	Provide evidence that LH works Implement Lean throughout the hospital	People are helped to see the effect of their work on the entire enterprise (provide evidence, implement lean) and to connect the organization to its environment.
Provide strategic leadership for learning	Have engaged leaders Hire third-party specialists Adopt action guidelines for implementation Implement Lean throughout the hospital	Provide strategic leadership (engaged leaders, action guidelines, implement Lean) and have leaders model, champion, and support learning (engaged leader, third-party specialists).

Source: Own authorship

Table 2.4 brings together strategic pathways that enable the creation of a specific dimension of OL and, in turn, help eliminate LH barriers in a more structured manner. In other words, it allows the organization to structure itself to implement ways of mitigating barriers jointly so that these actions reinforce each other and create a more solid foundation, based on OL, for overcoming the difficulties of implementing LH. For example, for a hospital organization to “provide strategic leadership for learning, " it can invest in having engaged

leaders, hire third-party specialists, adopt action guidelines for LH implementation, and implement LH throughout the hospital, strengthening this learning dimension together.

2.4.3 Connecting LH barriers, strategic pathways and OL Dimensions

To connect the relationships between barriers, strategic pathways and OL dimensions, a Sankey diagram (Figure 2.7) was created, showing both relationships: the pathways proposed in the literature and the barriers that help to overcome them according to the literature and the relationship between pathways and the OL dimensions.

The figure allows three analyses: first, to identify which strategic pathways can help eliminate a given barrier; second, to identify which OL dimensions a given pathway is related to; and third, to identify which OL dimensions are key in eliminating a given barrier through the pathways.

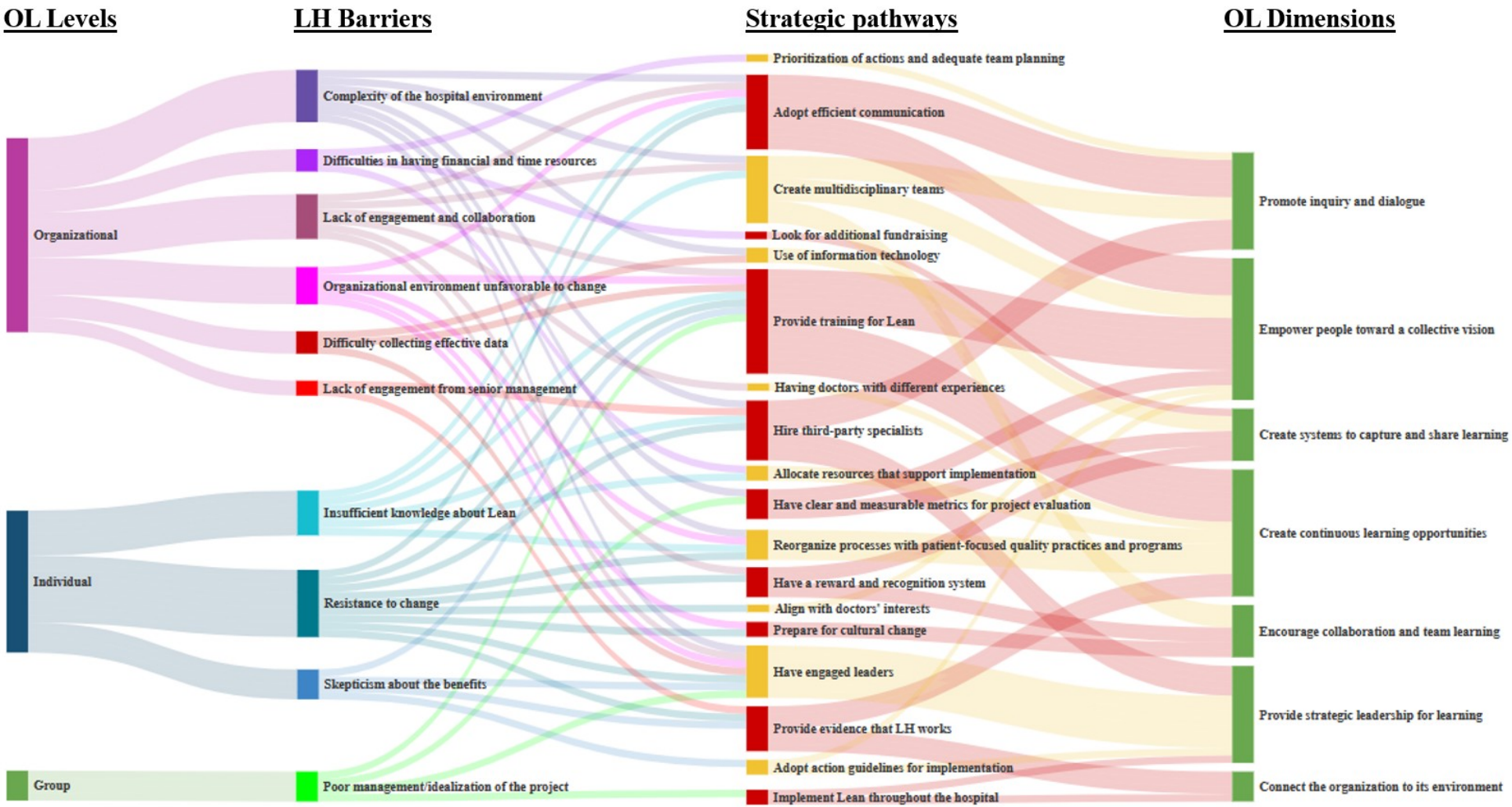
For example, in the first possibility of analysis, the individual barrier "Insufficient knowledge about Lean" has six pathways (Allocate resources that support implementation; Reorganize processes with patient-focused quality practices and program; Adopt efficient communication. Provide training for Lean; Have engaged leaders and hire third-party specialists) that can be implemented to help overcome this barrier. In the second possibility of analysis, the pathway "Allocate resources that support implementation" is related to the following OL dimension "Create continuous learning opportunity". In the third possibility of analysis, by investigating pathways that can help overcome the barrier "Insufficient knowledge about Lean" it is possible to identify that several are related to the "Create continuous learning opportunity" dimension, and which may be an essential dimension to be reinforced in the case of eliminating this barrier.

The analyzes derived from the results presented in Figure 2.7 allow to identify that the barriers at the individual level (Insufficient knowledge about Lean, Resistance to change, and Skepticism about the benefits) are mainly related to the dimensions Create continuous learning opportunities, Empower people toward a collective vision and Provide strategic leadership for learning. At the Team/Group level, the barrier of poor management/idealization of the project is mainly related to the dimensions Empower people toward a collective vision and Provide strategic leadership for learning.

Organizational barriers (Lack of engagement from senior management, Lack of engagement and collaboration, complexity of the hospital environment, Organizational environment unfavorable to change, Difficulties in having financial and time resources and Difficulty collecting effective data) are mainly related to the OL dimensions Empower people

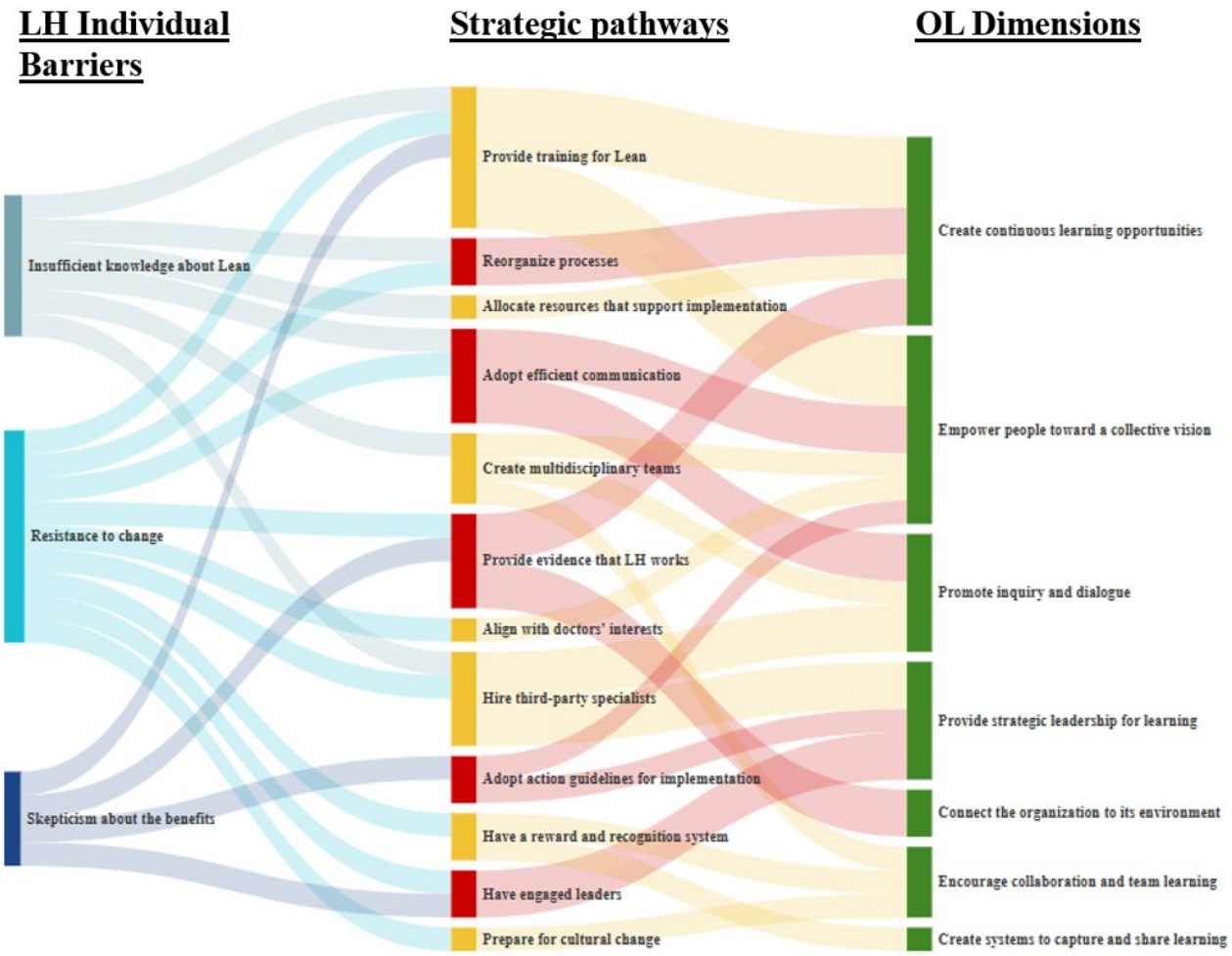
toward a collective vision, Create Continuous Learning opportunity and Promote inquiry and dialogue.

Figure 2.7 – Strategic Pathways and OL Dimensions related to barriers of different levels



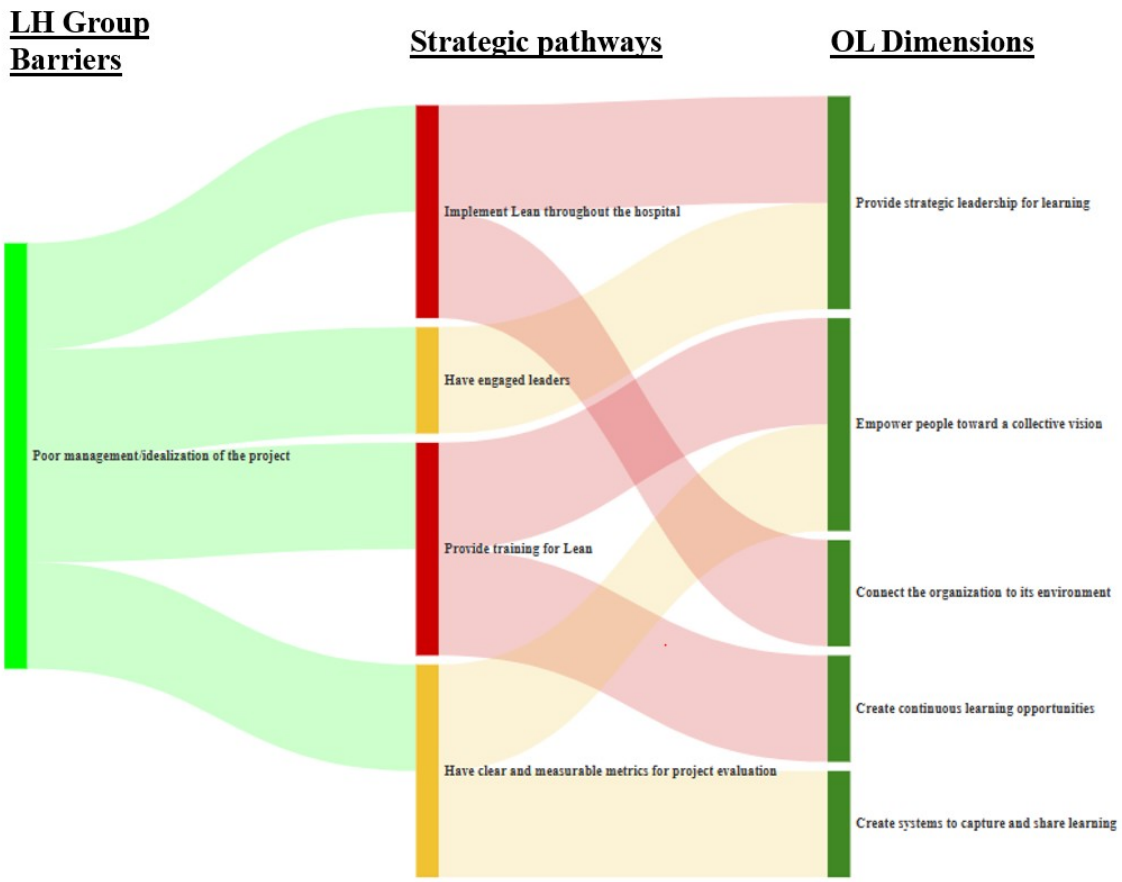
Source: Own authorship

Figure 2.8 – Strategic Pathways and OL Dimensions related to barriers of the Individual level



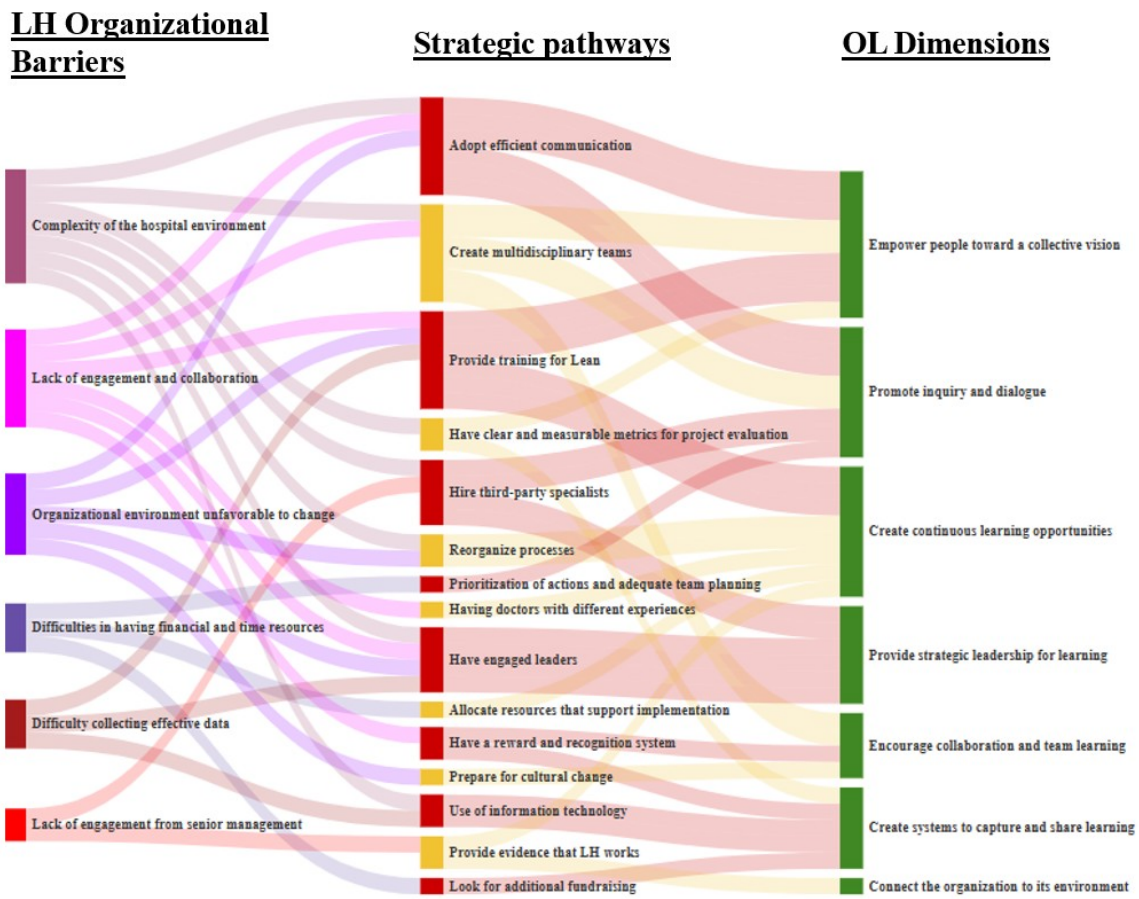
Source: Own authorship

Figure 2.9 – Strategic Pathways and OL Dimensions related to barriers of the Group level



Source: Own authorship

Figure 2.10 – Strategic Pathways and OL Dimensions related to barriers of the Organizational level



Source: Own authorship

2.5 CONCLUSIONS

Understanding and prioritizing LH barriers, and developing strategies to overcome them, are essential for the success and sustainability of LH implementation (Almutairi et al., 2021; Fournier et al., 2021). This research aimed to answer two central research questions: to identify the barriers to LH and the strategic pathways to overcome the barriers. The questions were answered through the application of an SLR and content analysis. Additionally, the research aimed to catalog the barriers and strategic pathways using the lens of OL theory to contribute to the enhancement of LH practices and a more nuanced understanding of Lean transformation within the healthcare sector.

2.5.1 Academic contributions

The first contribution of the paper to the literature was the identification of the main barriers to the implementation of LH in hospitals, since the literature pointed out the absence and need for an in-depth exploration into the nature and origins of these barriers, (Almutairi et al., 2021; Chmielewska et al., 2023; Fournier et al., 2021; Noris et al., 2022). The second contribution was the in-depth investigation of barriers from the perspective of learning levels (individual, group/team, and organizational), contributing to the comprehensive evaluation of the LH barriers, which allowed generating insights into the causes of such barriers, issue highlighted as relevant by several researchers (e.g., Freitas, Mendonça and Resende, 2023; Noris et al., 2022; Rosa, Marolla and McDermott, 2023). It was identified that organizational barriers are mainly caused by structural and systems issues, as well as problems in resource allocation, OL, knowledge management, and cultural issues associated with LH. The barrier classified at the Team/Group level (poor project management) is related to team structure, process, and leadership, while individual barriers are related to team structure, team climate, team processes, member characteristics, and leadership style. Barriers classified as individual are related to the attitude of individuals towards LH, in addition to the lack of knowledge about LH, which reduces the ability of individuals in relation to the topic and increases resistance to its implementation. This classification facilitated the analysis and proposition of ways to deal with it considering this relationship with the OL theory. In addition, the study advances barrier prioritization by reporting their citation frequency and organizing them into organizational learning (OL) dimensions, providing a structured basis for managers to prioritize interventions both within specific barriers and across OL dimensions.

The third contribution was the systematic identification of strategic pathways to eliminate existing barriers. This point was noted in the literature as still missing (Almutairi et al., 2021; Leite, 2024), and that such a survey would be essential to achieve the true objectives of Lean in healthcare settings (Leite et al., 2024; Bueno et al., 2023). As a fourth contribution, it was possible to systematize the pathways according to the barriers they help to eliminate. Therefore, it is possible to identify which barriers a given pathway allows to eliminate. This is a contribution since, in the literature, it was identified that there is insufficient understanding of the LH obstacles and the strategies needed to address them effectively (Leite, Radnor, Bateman, 2022; Chmielewska et al., 2023).

As a final contribution, the study made a systematization of barriers through OL dimensions, proposed by Marsick and Watikins (2003), which allowed the grouping of pathways according to learning dimensions, which enables the formulation of systematic strategies to overcome the barriers, which is also absent in the literature (Chmielewska et al.,

2023; Noris et al., 2022; Leite, 2024). The grouping allowed an analysis of pathways that can be implemented together, facilitating understanding and establishing guidelines for implementing changes and learning that generate overcoming barriers. By linking barriers and pathways to OL dimensions, the study offers a structure to understand complementarities among actions.

2.5.2 Practical Implications

Several managerial contributions can be attributed to the results obtained. The first contribution was the identification of barriers related to the implementation of LH, allowing managers to identify existing barriers more quickly. The second contribution was the classification of barriers and the perspective of learning levels, which allowed the identification of common causes among barriers and knowledge of primary causes by managers. The third contribution was the identification of strategic pathways to overcome specific barriers, allowing managers who identify a barrier to direct specific actions. Additionally, these actions can be thought of in a broader way, since the study also grouped the strategic pathways into OL dimensions, which allowed a view of similar paths that can be applied together to reinforce actions. As a final contribution, the study proposed a relationship between barriers, ways of overcoming them, and dimensions of OL to enable practical application by hospital managers and people in the healthcare sector.

This study can be used as a guide for implementation. Hospital managers may begin by diagnosing their local barrier profile and, based on this diagnosis, identify the strategic pathways most directly related to those barriers. Table 2.3 operationalizes this step by linking pathways to specific barriers and illustrating, through concise examples, how each pathway can be enacted in practice. In this way, serves as a practical reference to move from abstract recommendations to actionable steps, enabling managers to select context-appropriate pathways and anticipate the organizational conditions required for their success.

Once priority pathways have been selected, Table 2.3 can further support execution and learning. Managers can specify pathway owners, set objectives and patient-centred KPIs, protect time for staff participation, and institute simple review routines to monitor progress. The examples provide concrete starting points to launch focused pilots, align stakeholders, and convert early results into standardized practices and governance arrangements. Taken together, the framework, barrier–pathway mapping, and implementation examples position the present work as a practical roadmap to guide hospitals from barrier identification to pathway selection, implementation, evaluation, and scale-up. Table 2.3 operationalizes the barrier–pathway links with concise implementation examples, allowing managers to move from diagnosis to action by selecting context-appropriate pathways.

2.5.3 Limitations and future studies

Some limitations are present in this study, even though we used different renowned databases, the selection of databases and some chosen selection criteria may have omitted some potential studies. Books, conference papers and gray literature were excluded. The rigorous review method should counteract and reduce the probability that critical information is not included in the review which would substantially alter our results.

Future research should focus on prioritizing barriers, identifying the relationship between them, and proposing ways to implement Lean more successfully. Future research should assess hospitals' organizational readiness for LH by using the identified barriers as diagnostic inputs, to enable better preparation and targeted use of the strategic pathways to address those barriers, being able to assist in the construction of frameworks for the analysis of readiness for the implementation of LH. In addition, studies should deepen the understanding of pathway implementation across diverse organizational contexts (e.g., different hospital sizes, specialties, and funding sources), examining which strategy bundles and sequences are most effective in each setting. Subsequent research may leverage these findings to prioritize barriers in hospital implementations, using clear prioritization criteria and methods to guide action and increase awareness among healthcare professionals of the key obstacles to Lean adoption in their context. Finally, although American countries have stood out in the number of authors, there are few empirical analyses carried out in South American countries and in developing countries in general, representing an interesting field for future research.

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DECLARATION OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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APPENDIX A: LEAN HEALTHCARE BARRIERS

Table A1 – Barriers to implementing Lean Healthcare

Reference	Lack of engagement from senior management	Resistance to change	Complexity of the hospital environment	Lack of engagement and collaboration	Insufficient knowledge about Lean	Skepticism about the benefits	Organizational environment unfavorable to change	Poor management /idealization of the project	Difficulties in having financial and time resources	Difficulty collecting effective data
Abdallah (2020)	P		P	P	X					
Al-Balushi et al. (2014)	P	X	X	X			X			
Almutairi et al. (2021)	X	P	X	X	P		X	X		
Amran et al. (2020)	X	X	X	X	P	X	X	P	X	X
Bruno (2017)				X	X		X	X		X
Chmielarz et al. (2023)		X			P	X		X	X	
Chmielewska et al. (2023)	P	X	X		P	X	X	X	P	X
Costa et al. (2017)	X	X	X		P	P				
D'Andreamatteo et al. (2015)			X	X	X	X		X		
Drotz and Poksinska (2014)	X	X	P	X	X	P	X			
Escobar and Veja (2013)			X	X	X					
Escuder, Tanco and Santoro (2015)	X	X	X							
Fournier and Jobin (2018)		P	X	X						
Fournier et al. (2021)		P								

Source: Own authorship

Table A1 – Barriers to implementing Lean Healthcare (Continuation)

Reference	Lack of engagement from senior management	Resistance to change	Complexity of the hospital environment	Lack of engagement and collaboration	Insufficient knowledge about Lean	Skepticism about the benefits	Organizational environment unfavorable to change	Poor management /idealization of the project	Difficulties in having financial and time resources	Difficulty collecting effective data
Freitas, Mendonça and Resende (2023)	X	X	P	P		P				X
Garcia, Mendonza and Reyes (2021)	X		X	X	X			X		
Guarilha et al. (2023)	X	X	X	X	P			X	P	P
Leite, Bateman and Radnor (2016)	X	X	X	X	X	X	X	X	X	
Leite, Bateman and Radnor (2020)	X	X		X	X	X	X		X	
Mannon (2014)	X	X		X			X			
Noris et al. (2022)		P	X		X		X		P	X
Parkhi (2019)	P	X	X	X	X	X	X			
Patri and Suresh (2018)	P	X		X	X	X	X			
Patri, Suresh and Prasad (2021)	P			X						
Portioli-Staudacher (2008)						X				
Reijula e Tommlein (2012)	X	X	X	X	X	X				
Rosa, Marolla and McDermott (2023)	P	x	X	X		X		P	X	X
Santos et al. (2020)	X		X		P		P			

Source: Own authorship

Table A1 – Barriers to implementing Lean Healthcare (Continuation)

Reference	Lack of engagement from senior management	Resistance to change	Complexity of the hospital environment	Lack of engagement and collaboration	Insufficient knowledge about Lean	Skepticism about the benefits	Organizational environment unfavorable to change	Poor management /idealization of the project	Difficulties in having financial and time resources	Difficulty collecting effective data
Souza and Pidd (2011)	X	X	X	P	X	X	X		X	X
Vitásková (2015)	P				P					
Waring and Bishop (2010)	X	X				X				
Zdeba-Mozola et al. (2023)		X	X							X
Zepeda-Lugo et al. (2020)	X		X	X				X		
Number of mentions	**24**	**23**	**23**	**22**	**21**	**16**	**14**	**11**	**9**	**9**
Number of priorizations	**8**	**4**	**3**	**3**	**8**	**3**	**1**	**2**	**3**	**1**

The “X” represents when the barrier was mentioned by the article, while “P” indicates when the barrier was prioritized by the authors as one of the main barriers to implementing Lean Healthcare.

Source: Own authorship

3 FROM BARRIERS TO STRATEGIC PATHWAYS: A HIERARCHICAL FRAMEWORK FOR SUSTAINABLE LEAN HEALTHCARE IMPLEMENTATION

This chapter will present the second article that makes up this dissertation. This article will present the hierarchical model of the barriers to Lean Healthcare and the pathways to overcome them, built through the ISM approach. To complement the investigation into the relationships between barriers to LH, the MICMAC fuzzy analysis was carried out.

3.1 INTRODUCTION

Healthcare organizations operate in environments characterized by increasing demands for quality, efficiency, and sustainability, which has driven the progressive adoption of structured improvement approaches originally developed in industrial contexts (Leite et al., 2024; Costa et al., 2024). Within this movement, Lean Manufacturing has been extensively adapted to healthcare settings, giving rise to Lean Healthcare (LH) as a systematic approach to improving patient value and operational performance (Mansour and Chênevert, 2024). The application of Lean principles in hospitals requires careful contextualization, as concepts such as define value, identify the value stream, create flow, establish pull, and seek perfection must be aligned with the complexity of patient care and hospital management (Womack and Jones, 1996; Tiso, Crema, Verbano, 2021; Zdeba-Mozola et al., 2023). As a result, LH has been increasingly recognized as a promising pathway for enhancing operational efficiency and patient-centered outcomes in hospital environments (Lima et al., 2024).

More recently, the application of Lean in healthcare has evolved beyond its traditional focus on waste minimization to encompass broader objectives such as process optimization, staff engagement, and the enhancement of working conditions, reflecting a shift toward more systemic and sustainable improvement approaches (Parkhi, 2019; Rosa, Marolla and McDermott, 2023). Although Lean is widely recognized as an effective performance-enhancement methodology, its translation into the healthcare environment frequently encounters resistance and operational limitations that impede sustainability (Almutairi et al., 2021; Leite, Bateman and Radnor, 2020; Pozzan et al., 2025).

A critical contributor to the limited success of LH initiatives lies in the insufficient understanding of implementation barriers and, more importantly, of the strategic pathways

required to overcome them (Leite, Radnor, Bateman, 2022; Chmielewska et al., 2023). While existing studies have identified several obstacles to LH adoption, they often treat these barriers in isolation, offering limited insight into how strategies interact, reinforce one another, or depend on prior conditions. Addressing this gap requires moving beyond barrier identification toward a structured understanding of the interdependencies among the pathways designed to mitigate them.

Accordingly, the literature emphasizes the need for deeper investigation into the nature, hierarchy, and relational structure of LH barriers and the strategies proposed to surmount them (Almutairi et al., 2021; Chmielewska et al., 2023; Fournier et al., 2021; Noris et al., 2022). While a limited number of studies have identified barriers to LH implementation, the relationships among them remain poorly understood. Identifying and overcoming barriers to LH adoption is essential to guide the application of Lean principles in healthcare settings (Nawanir et al., 2025). Exploring these interconnections would enable healthcare managers to identify leverage points for intervention, thereby facilitating the design of coherent strategies or pathways to reduce or eliminate obstacles to Lean adoption. Such understanding is crucial for enhancing the decision-making capacity of healthcare leaders, aligning strategic priorities, and ensuring the long-term success and sustainability of Lean Healthcare initiatives (Freitas, Mendonça and Resende, 2023; Noris et al., 2022; Rosa, Marolla and McDermott, 2023).

This study aims to bridge this knowledge gap by conducting a Systematic Literature Review (SLR), together with an ISM approach (Interpretive Structural Modeling) and fuzzy MICMAC analysis (Cross-Impact Matrix Multiplication Applied to Classification). This study delves into the evolution of LH barrier research, aiming to identify and understand the strategic pathways proposed to overcome them. Through the expert's opinion, the relationship and interdependence between the strategic pathways is designed, enabling the construction of a framework to guide stakeholders to overcome LH barriers, making the implementation of Lean Healthcare in hospitals more sustainable.

To achieve this aim, the following research questions (RQs) are posed:

RQ1: Which strategic pathways can be employed to overcome the main barriers to Lean Healthcare implementation?

RQ2: What is the dependency relationship between the strategic pathways to overcome LH barriers on each other?

This study is structured as follows. Section 2 presents the concepts of Lean Healthcare, followed by Section 3, which exhibits the research method applied. Section 4 is dedicated to the

presentation and discussion of the results obtained in the research. In Section 5, limitations and opportunities for future research are discussed.

3.2 THEORETICAL BACKGROUND

The concept of *Lean* has a relatively recent history, originating from the Toyota Production System in the 1950s. Lean is founded upon five guiding principles: defining value, identifying the value stream, creating flow, establishing pull, and pursuing perfection (Womack and Jones, 1996). Together, these principles aim to eliminate all forms of waste, thereby enhancing efficiency and promoting continuous improvement (Lanza-León, Sanchez-Ruiz and Cantarero-Prieto, 2021; Zdeba-Mozola et al., 2023). The outstanding success and diffusion of Lean practices in industrial environments stimulated its adaptation to other sectors, including the healthcare industry (Danese, Manfé and Romano, 2018; Lima et al., 2024). However, within healthcare, due to the sector's organizational complexity and the relative novelty of Lean adoption, the literature predominantly addresses Lean as a collection of process-improvement tools focused on waste reduction and value creation, rather than as a holistic management philosophy encompassing culture, leadership, and strategic alignment (Al-Balushi et al., 2014).

Although the precise moment when Lean principles were first applied in healthcare remains uncertain - most likely in the early 2000s - authors found that global interest in Lean Healthcare (LH) has grown significantly over the past two decades (Rosa, Marolla and McDermott, 2023). This increasing attention is largely attributed to the recognition of Lean's potential benefits within healthcare settings. The methodology has demonstrated capacity to transform hospital operations, enabling improvements in quality of care, error reduction, shorter waiting times, and the removal of interdepartmental barriers that often hinder patient flow and operational efficiency (Zdeba-Mozola et al., 2023).

Despite the considerable volume of literature celebrating the successes of LH in promoting organizational transformation and performance improvement (e.g., Fillingham, 2007; Holden, 2011; Costa et al., 2017; Rosa, Marolla and McDermott, 2023; Zdeba-Mozola et al., 2023), persistent challenges continue to constrain its full potential. Moreover, skepticism regarding the applicability and benefits of Lean in healthcare, compounded by its still-emerging status, further challenges its institutional acceptance (Chmielarz et al., 2023).The relative immaturity of LH - particularly when compared with its industrial precursor, Lean Manufacturing - underscores the

necessity of further research into the barriers that hinder its effective implementation (Chmielewska et al., 2023; Leite et al., 2024).

These barriers are multifaceted, encompassing cultural resistance, inadequate leadership commitment, insufficient technical expertise, and limited human resources capable of guiding Lean transitions in healthcare contexts (Leite, Bateman and Radnor, 2016; Amran et al., 2020; Pozzan et al., 2025). Although these obstacles have been widely recognized, the literature reveals a significant gap in systematic efforts to understand their underlying causes and to develop strategies for overcoming them. According to Leite, Bateman and Radnor (2020), comprehending the root causes of these barriers is critical to ensure the successful and sustainable implementation of LH practices.

Scientific evidence on how to overcome such barriers (pathways) remains scarce, as most studies continue to emphasize the benefits of Lean adoption rather than its implementation challenges (Chmielewska et al., 2023). Some research has proposed preliminary solutions (e.g., Almutairi et al., 2021), but a comprehensive framework capable of addressing the complex nature of LH barriers has yet to be established (Nawanir et al., 2025). Chmielewska et al. (2023) argue that awareness and proactive management of these constraining factors are essential preconditions for effectively applying Lean principles within healthcare systems. Similarly, Leite, Bateman and Radnor (2016) highlight the need for studies focusing on the strategic pathways to overcoming barriers related to patient behavior and the inherent complexity of public healthcare systems. The limited success of many LH initiatives can often be traced to insufficient understanding of the barriers themselves and to the absence of robust strategies to mitigate their effects (Leite, Radnor and Bateman, 2022; Chmielewska et al., 2023).

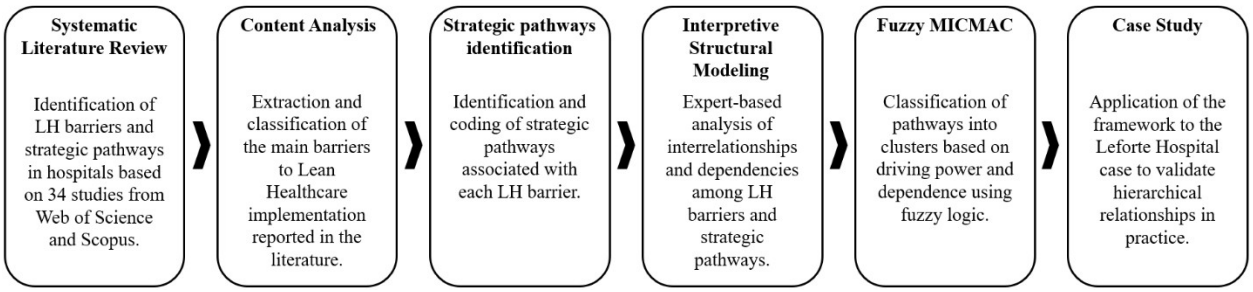
3.3 RESEARCH METHOD

This study can be classified as a mixed methods research approach, which according to Bryman (2012), since 2001 has become very popular among researchers in the field of study of social sciences. This term is used to represent research that integrates quantitative and qualitative strategies into a single project (Creswell; Clark, 2017).

The research employed a Systematic Literature Review (SLR) following the PRISMA protocol to identify barriers and strategic pathways to overcome them. Followed by an Interpretive Structural Modeling (ISM) approach and Fuzzy MICMAC analysis (Cross-Impact Matrix Multiplication Applied to Classification) to understand and define the level and relationship

between the identified pathways. Finally, a case study was conducted to contrast and validate the results obtained (Figure 3.1).

Figure 3.1 – Research planning



Source: Own authorship

3.3.1 Systematic Literature Review (SLR)

Systematic reviews synthesize research results in a structured, transparent, and repeatable manner (Tranfield, Denyer, Smart, 2003; Nunez-Merino et al., 2020; Thomé et al. 2016; Hiebl, 2023). This study uses the guidelines of Tranfield, Denyer and Smart (2003) to conduct the Systematic Literature Review (SLR), which includes the stages of planning (definition of the research question, establishment of the research protocol, definition of search bases and inclusion and exclusion criteria), conduction (selection and compilation of information obtained) and presentation of the results obtained.

The planning stage should identify the need for a review, specify the research questions and develop a review protocol with methods for conducting the review, all to provide effective answers (Brereton et al., 2007; Maia, Lizarelli and Gambi, 2023; Rossini et al., 2022). To support the planning stage the PRISMA 2020 Protocol (Page et al., 2021) was used.

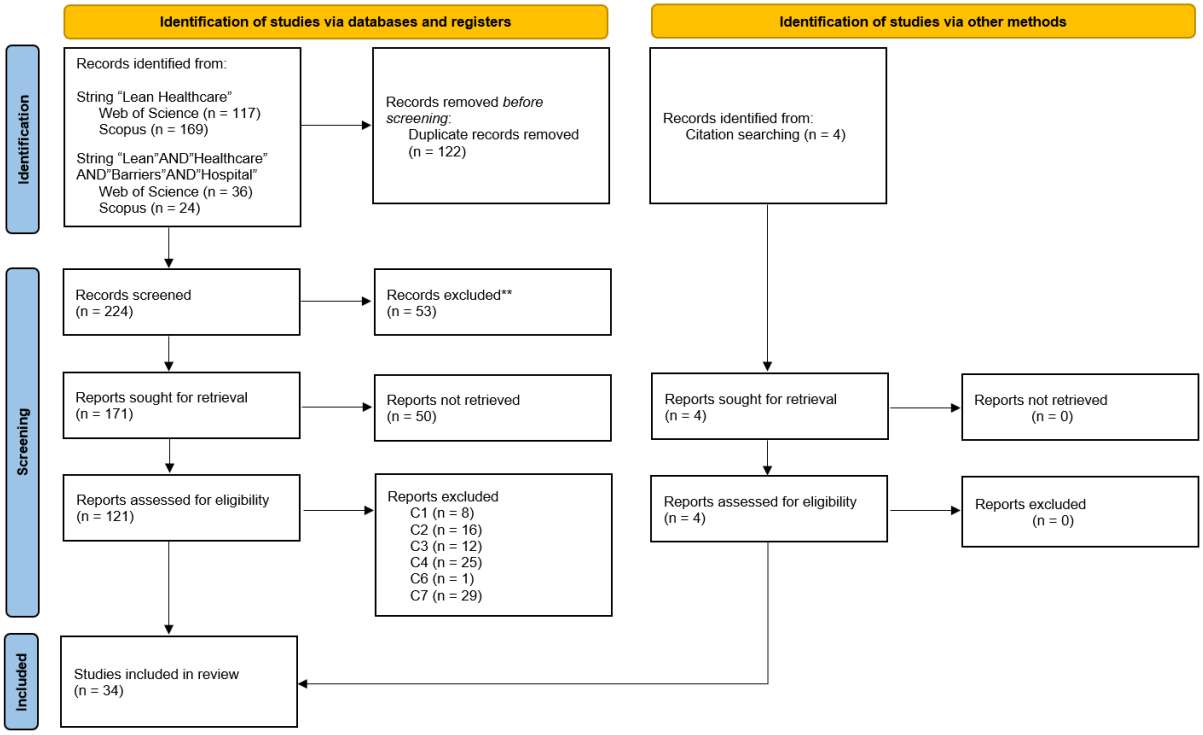
After carrying out an exploratory review of the literature, a research question was defined to be answered through SLR:

RQ1 - Which strategic pathways can be employed to overcome the main barriers to Lean Healthcare implementation?

The search was carried out on the Web of Science and Scopus databases. Two of the largest multidisciplinary databases with selective journal-based inclusion policies (Gupta et al. 2020; Buer et al., 2018). These databases serve as data sources for systematic reviews in the management and operations management literature (e.g., Nunez-Merino et al. 2020; Maia, Lizarelli and Gambi, 2023), underscoring their relevance to the field. The results of each step of the PRISMA 2020 flow diagram for new systematic reviews are presented in Figure 3.2.

The Screening step was carried out by partial reading (title, abstract and keywords) and then complete reading of the documents by two experienced researchers and the application of the inclusion and exclusion criteria presented in Table 3.1 in both screening steps (Maia, Lizarelli and Gambi, 2023). No subject-area restrictions were applied in Web of Science or Scopus; searches were run across all subject areas to maximize coverage. No time frame was made to obtain greater coverage and because it is a relatively recent topic in the literature (articles found since 2008), selecting everyone until February 2024, when the step was carried out. The study included 34 out of 224 articles screened in the Identification step.

Figure 3.2 – PRISMA 2020 flow diagram



Source: Own authorship

Table 3.1 – Inclusion and exclusion criteria

Code	Exclusion Criteria	Code	Inclusion Criteria
C1	Does not deal with hospitals	C8	The focus is on Lean applied in hospitals
C2	Focuses on methodologies other than Lean Healthcare	C9	Study about Lean Healthcare
C3	Full article not available	C10	Full article is available
C4	The article does not address the implementation or review of the literature on Lean	C11	The article presents an implementation or review of the literature on Lean
C5	Articles in other languages	C12	Article in English, Portuguese or Spanish
C6	Books and book chapters	C13	Journal articles or reviews
C7	Does not answer any of the research questions	C14	Answer at least one of the research questions

Source: Own authorship

In the second stage, the conduction of the SLR is done, which involves the selection and compilation of information obtained (Tranfield, Denyer and Smart, 2003). The documents were coded to identify the characteristics for quantitative analysis and the coding of variables used to answer the research question (Brereton et al., 2007; Rossini et al., 2022).

3.3.2 Specialists validation

The research method used includes the participation of experts to consolidate and refine the list of strategic pathways coming from the SLR through an empirical perspective. **To refine the set of** pathways **to** the **Lean Healthcare** implementation, this study followed the methodological requirements proposed by Lewis (1998) and Silveira et al. (2017). Accordingly, two key research requirements were established to ensure a rigorous and meaningful synthesis: (i) the careful selection of experts with substantial experience in Lean Healthcare; and (ii) the adoption of a systematic procedure for collecting, analyzing, and synthesizing data from the systematic literature review.

The list of barriers and pathways was validated by four Lean experts. The experts were identified through purposive sampling targeting individuals who combined academic experience (to facilitate rapid comprehension of the methodological protocol) and practical Lean expertise in healthcare setting. Candidates were screened via curriculum analysis and peer nominations provided by the research team. Inclusion criteria comprised: (a) ≥10 years of experience with Lean; (b) experience in LH; and (c) roles in practice, training, or consulting, and being an academic/researcher in the field. Table 3.2 presents the experts profiles.

Table 3.2 - Experts profile

Expert ID	Sector background	Experience	Years of experience
E1	Consulting	Research; Consulting	> 20 years
E2	Service (Healthcare) and Industry	Research; Practice	> 20 years
E3	Service (Healthcare) and Industry	Research; Practice	> 20 years
E4	Academia and projects in LH training	Research	> 15 years

The data collected in the literature was recorded and a list of barriers was generated. The experts validated that these could be considered relevant barriers in the implementation of LH. Therefore, the strategic pathways are identified and related to the corresponding barriers.

3.3.3 Interpretive Structural Modeling (ISM)

To model barriers, the literature discusses several multi-criteria decisions making (MCDM) techniques applied in different disciplines, for example, Interpretive Structural Modeling (ISM), Analytical Hierarchy Process (AHP), Structural Equation Modeling (SEM), DEMATEL, Simulation, and Mathematical Programming (Drohomeretski et al., 2014; Abu-Salim et al., 2023; Seth et al., 2018). Bianco et al. (2021) presents a detailed comparison of some of these techniques (Table 3.3), including the ISM and Fuzzy MICMAC techniques that justify our choice in this study.

Table 3.3 – Summay of MCDM Methods

Evaluation approach	Cost of implementation	Data requirement	Ease of sensitivity	Economic rigour	Decision-maker involvement	Management understanding and comfort	Mathematical complexity	Parameter mixing/ flexibility
AHP	M	M	L	L	H	M	L	H
DEA	M	M	L	M	L	L	H	M
Expert system & AI	H	H	L	H	M	M	H	H
Mathematical Programming	M	M	M	H	M	L	H	L
MAUT	H	H	M	M	H	M	M	H
Outranking	M	M	L	M	H	L	M	M
Simulation	H	H	H	H	L	H	H	M
Scoring	L	L	L	L	H	H	L	H
Latent class Cluster	H	L	L	M	L	L	H	H
Categorical	L	L	L	L	H	H	L	H
TCO	H	H	L	H	H	H	L	M
ANP	M	M	L	L	H	M	M	H
Taguchi loss method	M	M	L	H	M	M	M	L
Dimensional analysis	H	L	L	M	M	M	L	L
ISM	L	M	L	L	H	H	L	L
Fuzzy MICMAC	M	L	L	L	M	M	M	H

Note: H, M, L stand for high, medium, and low. Adapted from Seth et al. (2018) except for the last two rows, the information for which is provided by the authors.

Source: Bianco et al. (2021)

Like other authors who study the relationship between Lean factors (e.g. Abu-Salim et al., 2023; Vinodh and Asokan, 2018; Hussain et al., 2023), we found in the ISM method the tool that met the present study, from the selection of respondents to the discussion of the results. Among the reasons, some criteria presented in Table 3.3, such as the low implementation cost, high decision-maker involvement and high management understanding and comfort (Bianco et al., 2021), were decisive for choosing the ISM approach.

Since it was developed by Warfield (1974), ISM has been widely used to assist with a variety of complex problems for hierarchy of variables and decision making. The ISM methodology was used to understand and define the level and relationship between the identified pathways (Ahmad et al., 2020; Mundra; Mishra, 2020; Abu-Salim et al., 2023). It helps professionals visualize the implementation structure more accurately and is well recognized in management and engineering research to understand the complex relationships between the elements of a system (Abu-Salim et al., 2023; Hussain et al., 2019).

A weakness of the ISM approach is that it does not allow the analysis of different strengths (such as the number of interactions between barriers) for the relationship between variables (Attri, Dev, and Sharma, 2013; Bianco et al., 2021). Thus, Fuzzy logic was introduced to capture in-depth relationship strength from a non-binary perspective (Abu-Salim et al., 2023). The Cross-Impact Matrix Multiplication Applied to Classification (MICMAC) method helps to present information in the form of specific groups/clusters of barriers - autonomous, dependent, linking and independent (Patri; Suresh, 2017; Abu-Salim et al., 2023; Hussain et al. 2019), assisting in its study and understanding by practitioners and theorists. We adopted ISM and Fuzzy MICMAC analysis as our methods to conduct the study. While ISM can build a contextual relationship between LH barriers, MICMAC can analyze LH barriers using driving powers and dependency.

To explore the interrelationships and interdependencies among the barriers and strategic pathways, the ISM method was applied following seven sequential steps (Abu-Salim et al., 2023; Attri, Dev, and Sharma, 2013; Vinodh and Asokan, 2018): Self-Interaction Structural Matrix (SSIM), Accessibility Matrix, Reliability testing, Partition of levels, Digraph, ISM Model and Fuzzy Logic/MICMAC.

Initially, individual meetings were conducted with each specialist to ensure a shared understanding of the fourteen strategic pathways identified (Step 1). This preliminary phase was essential to minimize interpretative discrepancies regarding the conceptual meaning of each pathway. Following these discussions, each expert independently completed the SSIM, indicating perceived directional relationships between pairs of pathways using four symbols: *V* (pathway *i* influences pathway *j*), *A* (pathway *j* influences pathway *i*), *X* (mutual influence), and *0* (no relationship). The individual matrices were then aggregated to generate a consolidated reachability matrix (Step 2), representing the consensus among experts.

In Step 3, the consolidated matrix underwent reliability testing based on the principle of transitivity, which asserts that if pathway *X* influences pathway *Y*, and pathway *Y* influences pathway *Z*, then *X* indirectly influences *Z*. This transitivity check strengthened the logical consistency of the relational structure and enhanced the robustness of the ISM model. The verified matrix was subsequently converted into a triangular format to facilitate the partition of levels (Step 4). At this stage, each pathway was positioned within a hierarchical structure according to its degree of driving power and dependence, enabling the identification of foundational pathways with higher systemic influence and those that are more dependent or reactive within the network.

Based on the established hierarchy, a directed graph (digraph) was developed to visually represent the relationships among the pathways (Step 5). This digraph provided an interpretive visualization of both direct and indirect dependencies, illustrating how pathways interact within the system. Steps 6 and 7—construction of the final ISM model and subsequent application of Fuzzy Logic and MICMAC analysis—further refined the interpretation by categorizing pathways according to their driving and dependence power, offering comprehensive insights into the structural dynamics underlying Lean Healthcare implementation.

3.3.4 Cross-Impact Matrix Multiplication Applied to Classification (MICMAC)

MICMAC (Cross-Impact Matrix Multiplication Applied to Classification) is a well-known variant of the cross-impact analysis method proposed by Duperrin and Godet (1973). Due to its ability to analyze and evaluate the influence/dependence between variables in a network, several authors have used MICMAC in addition to ISM (Cherrafi et al. 2017; Bianco et al., 2021; Hussain et al., 2023). MICMAC investigates a complicated set of variables based on their driving powers and dependence and groups them into four groups (Iqbal et al. 2022). The driving power of a variable is the total number of variables affected by it, and the dependence power is estimated by the total number of variables that influence it (Hussain et al., 2023).

MICMAC inputs are data provided by experts through panels, interviews and opinion surveys of a subjective nature. However, as MICMAC analysis only suggests binary relationships between barriers, to overcome this limitation, Fuzzy set theory was also used to increase the sensitivity of MICMAC analysis (Abu-Salim et al., 2023). In the Fuzzy MICMAC analysis, different weights are considered for the strength of the relationships between Lean barriers and pathways, and the driving and dependency powers are calculated. This method adds reliability to the research method used in this article. According to Kandasamy, Smarandache and Ilanthenral (2007), the capacity of fuzzy sets not only helps in representing the measurement of uncertainties but also provides a meaningful representation of vague concepts in a simple natural language.

The Fuzzy MICMAC analysis also makes it possible to prove that all the variables raised by the SLR (barriers) are in fact part of the system under study (Lean Healthcare) (Bianco et al., 2021). The fuzzy MICMAC approach is composed of 4 steps (Bianco et al., 2021):

1. Determination of the Binary Direct Reachability Matrix (BDRM): The BDRM is obtained by replacing all diagonal entries in the initial reachability matrix with zeros. BDRM is

used to identify the relationships between competencies evaluated by fuzzified values in the fuzzy direct reachability matrix.

2. Construction of the Fuzzy Direct Accessibility Matrix (FDAM): According to Villacorta et al. (2014), fuzzy variables allow a better evaluation of the relationships between the elements of a network in a more adequate way than the traditional MICMAC approach with crisp values of 0 or 1. In this work, the number of experts who agree with the existence of the influence of competence i on competence j is fuzzified through seven linguistic terms. The FDAM is obtained by replacing the non-zero values of the BDRM with the respective characteristic values of the relationship between the two competencies.

3. Calculation of the Stabilized Fuzzy MICMAC Matrix: The stabilization of the fuzzy MICMAC matrix is obtained through a process of multiplying the initial matrices until the sum values of its rows (driving power) and columns (dependency power) do not change.

4. Formation of the cluster diagram: From the stabilized MICMAC fuzzy matrix, the driving power of each competency is determined by the sum of all entries in its respective line. Likewise, the dependence power of each competency is determined by the sum of all entries in its respective column. Thus, the fuzzy MICMAC results are described using a four-cluster diagram.

In the MICMAC analysis, barriers are divided into four clusters (Abu-Salim et al., 2023; Vinodh and Asokan, 2018; Bianco et al., 2021; Hussain et al., 2023; Iqbal et al. 2022):

- Autonomous variables (Cluster I): barriers that are relatively isolated from the system and have little or no dependence on other factors;
- Dependent variables (Cluster II): barriers that depend mainly on other factors;
- Connection variables (Cluster III): connection barriers that are unstable and that most influence others; and
- Independent variables (Cluster IV): barriers that are weakly influenced by other factors and should receive maximum attention, due to strong key factors.

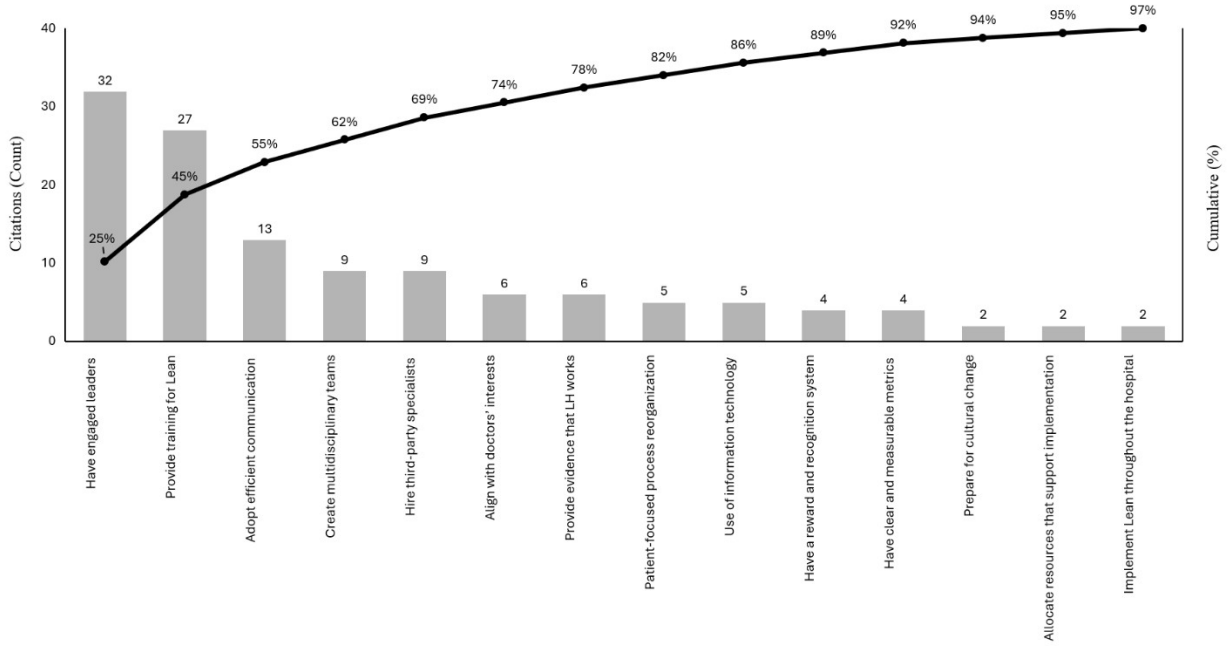
3.4 RESULTS

Each methodological procedure within the previously outlined multi-method approach yields specific, yet mutually reinforcing, outcomes. The subsequent subsections present, in detail, the results associated with each stage of the methodology.

3.4.1 SLR Results

The initial phase of this study consisted of a Systematic Literature Review (SLR), which provided the basis for the subsequent methodological steps. The results of this phase served as input for the following stage, enabling the identification of strategic pathways to overcome barriers through content analysis. By analyzing the 34 papers, it was possible to derive a list containing the 14 strategic pathways. Figures 3.3 present a Pareto chart of the strategic pathways to overcome LH barriers, ordered respectively by the number of times it was mentioned by different authors.

Figure 3.3 – Number of citations of the strategic pathways in the literature



Source: Own Authorship

These pathways were then systematized according to the barriers they address, making it possible to determine which obstacles each pathway contributes to eliminating. Table 3.4 presents the 14 pathways identified and their corresponding barriers. Building on these results, the next phase applied ISM and MICMAC analyses to explore the interrelationships among the pathways, and to classify them according to their driving and dependence power.

Table 3.4 – Strategic Pathways to overcome barriers to LH implementation (1/4)

Code	Strategic Pathways to overcome barriers	Mentions	Barriers	Authors
M1	Have engaged leaders (e.g. providing material resources, data availability)	32	Complexity of the hospital environment	Fournier and Jobin (2018); Noris et al. (2022); Zepeda-Lugo et al. (2020)
			Insufficient knowledge about Lean	Bruno (2017); Costa et al. (2017); Vitásková (2015)
			Lack of engagement and collaboration	Al-Balushi et al. (2014); Bruno (2017); Costa et al. (2017); Freitas, Mendonça and Resende (2023); Guarilha et al. (2023); Leite, Bateman and Radnor (2016); Parkhi (2019); Patri, Suresh and Prasad (2021)
			Organizational environment unfavorable to change	Al-Balushi et al. (2014); Noris et al. (2022)
			Poor management/idealization of the project	Noris et al. (2022)
			Resistance to change	Chmielewska et al. (2023); Costa et al. (2017); Drotz and Poksinska (2014); Fournier et al. (2021); Freitas, Mendonça and Resende (2023); Guarilha et al. (2023); Parkhi (2019); Waring and Bishop (2010)
			Skepticism about the benefits	Costa et al. (2017); Parkhi (2019); Portioli-Staudacher (2008); Reijula and Tommlein (2012); Waring and Bishop (2010)
			Difficulty collecting effective data	Guarilha et al. (2023); Rosa, Marolla and McDermott (2023)
M2	Provide training for Lean	27	Insufficient knowledge about Lean	Abdallah (2020); Chmielarz et al. (2023); Chmielewska et al. (2023); Costa et al. (2017); D'Andreamatteo et al. (2015); Garcia, Mendonza and Reys (2021); Guarilha et al. (2023); Leite, Bateman and Radnor (2016); Reijula and Tommlein (2012); Souza and Pidd (2011); Vitásková (2015)

Source: Own authorship

Table 3.4 – Strategic Pathways to overcome barriers to LH implementation (continuation 2/4)

Code	Strategic Pathways to overcome barriers	Mentions	Barriers	Authors
M2	Provide training for Lean (cont.)	27	Lack of engagement and collaboration	Escobar and Vega (2013); Freitas, Mendonça and Resende (2023); Rosa, Marolla and McDermott (2023)
			Organizational environment unfavorable to change	Almutairi et al. (2021)
			Poor management/idealization of the project	Amran et al. (2020)
			Resistance to change	Chmielarz et al. (2023); Chmielewska et al. (2023); Costa et al. (2017); Fournier and Jobin (2018); Freitas, Mendonça and Resende (2023); Rosa, Marolla and McDermott (2023); Souza and Pidd (2011)
			Skepticism about the benefits	Costa et al. (2017); Patri and Suresh (2018); Rosa, Marolla and McDermott (2023)
			Difficulty collecting effective data	Guarilha et al. (2023)
M3	Adopt efficient communication (Share information openly with a common goal for the project)	13	Complexity of the hospital environment	Abdallah (2020); Freitas, Mendonça and Resende (2023); Noris et al. (2022)
			Insufficient knowledge about Lean	Patri e Suresh (2017)
			Lack of engagement and collaboration	Almutairi et al. (2021); Garcia, Mendonza and Reys (2021); Rosa, Marolla and McDermott (2023)
			Organizational environment unfavorable to change	Al-Balushi et al. (2014); Bruno (2017); Noris et al. (2022)
			Resistance to change	Al-Balushi et al. (2014); Almutairi et al. (2021); Rosa, Marolla and McDermott (2023)

Source: Own authorship

Table 3.4 – Strategic Pathways to overcome barriers to LH implementation (continuation 3/4)

Code	Strategic Pathways to overcome barriers	Mentions	Barriers	Authors
M4	Create multidisciplinary teams	9	Complexity of the hospital environment	Drotz and Poksinska (2014); Noris et al. (2022)
			Insufficient knowledge about Lean	Guarilha et al. (2023)
			Lack of engagement and collaboration	Drotz and Poksinska (2014); Guarilha et al. (2023); Reijula and Tommlein (2012); Rosa, Marolla and McDermott (2023); Souza and Pidd (2011); Zepeda-Lugo et al. (2020)
M5	Hire third-party specialists (e.g. consultancies)	9	Complexity of the hospital environment	Abdallah (2020); Freitas, Mendonça and Resende (2023); Noris et al. (2022)
			Insufficient knowledge about Lean	Amran et al. (2020); Garcia, Mendonza and Reys (2021); Reijula and Tommlein (2012)
			Lack of engagement from senior management	Reijula and Tommlein (2012); Rosa, Marolla and McDermott (2023)
			Resistance to change	Rosa, Marolla and McDermott (2023)
M6	Align with doctors' interests	6	Resistance to change	Al-Balushi et al. (2014); Almutairi et al. (2021); Chmielarz et al. (2023; Fournier et al. (2021); Fournier and Jobin (2018); Freitas, Mendonça and Resende (2023)
M7	Provide evidence that LH works (e.g. successful benchmarks)	6	Lack of engagement from senior management	Almutairi et al. (2021); Chmielewska et al. (2023)
			Resistance to change	Costa et al. (2017); Rosa, Marolla and McDermott (2023)
			Skepticism about the benefits	Rosa, Marolla and McDermott (2023); Souza and Pidd (2011)
M8	Prepare for cultural change	2	Organizational environment unfavorable to change	Drotz and Poksinska (2014)
			Resistance to change	Drotz and Poksinska (2014)

Source: Own authorship

Table 3.4 – Strategic Pathways to overcome barriers to LH implementation (continuation 4/4)

Code	Strategic Pathways to overcome barriers	Mentions	Barriers	Authors
M9	Reorganize processes with patient-focused quality practices and programs	5	Complexity of the hospital environment	D'Andreamatteo et al. (2015); Reijula and Tommlein (2012)
			Insufficient knowledge about Lean	Garcia, Mendonza and Reys (2021)
			Organizational environment unfavorable to change	Souza and Pidd (2011)
			Resistance to change	Reijula and Tommlein (2012)
M10	Use of information technology (control sheet/eletronic system)	5	Difficulty collecting effective data	Guarilha et al. (2023); Noris et al. (2022); Zdeba-Mozola et al. (2023)
			Complexity of the hospital environment	Almutairi et al. (2021); Guarilha et al. (2023)
M11	Have a reward and recognition system	4	Lack of engagement and collaboration	Al-Balushi et al. (2014); Almutairi et al. (2021); Rosa, Marolla and McDermott (2023)
			Resistance to change	Fournier et al. (2021)
M12	Have clear and measurable metrics for project evaluation	4	Complexity of the hospital environment	Al-Balushi et al. (2014); Rosa, Marolla and McDermott (2023)
			Poor management/idealization of the project	Garcia, Mendonza and Reys (2021); Rosa, Marolla and McDermott (2023)
M13	Implement Lean throughout the hospital	2	Poor management/idealization of the project	D'Andreamatteo et al. (2015); Garcia, Mendonza and Reys (2021)
M14	Allocate resources that support implementation	2	Difficulties in having financial and time resources	Leite, Bateman and Radnor (2016)
			Insufficient knowledge about Lean	Drotz and Poksinska (2014)

Source: Own authorship

3.4.2 ISM Results

This stage details the procedures and results of the ISM analysis, which establishes the structural hierarchy of the strategic pathways designed to overcome barriers to Lean Healthcare implementation. The study interviewed 23 Lean Healthcare experts (Table 3.5) with professional experience ranging from 8 to 25 years in the field. Approximately 50% of the experts have academic experience in Lean Healthcare research, 20% have practical experience in hospitals as physicians or nurses directly involved in LH initiatives and projects, and 30% work as Lean Healthcare consultants, with experience in projects conducted in hospitals of different sizes and operational contexts.

Table 3.5 - ISM Experts profile

Expert ID	Experience	Years of experience
#1	Reasearch; Consulting; Practice	> 20 years
#2	Research	> 20 years
#3	Research	> 15 years
#4	Research; Consulting	> 20 years
#5	Research	8 years
#6	Practice	> 20 years
#7	Practice; Consulting	> 15 years
#8	Research; Consulting	> 10 years
#9	Research; Consulting	> 10 years
#10	Research; Consulting	> 15 years
#11	Research	> 15 years
#12	Research; Consulting	> 20 years
#13	Practice	8 years
#14	Research; Consulting	> 20 years
#15	Research; Consulting	> 10 years
#16	Research	8 years
#17	Research; Consulting; Practice	> 15 years
#18	Research	> 15 years
#19	Practice	> 10 years
#20	Research	8 years
#21	Research	> 10 years
#22	Practice	> 15 years
#23	Practice; Consulting	> 10 years

Source: Own authorship

Following preliminary interviews to confirm their expertise and to provide clarification on the methodology—particularly regarding the correct interpretation and completion of the matrix

within the context of Lean Healthcare implementation in hospitals—the 23 experts completed the Structural Self-Interaction Matrix (SSIM) (Figure 3.4), expressing their assessments of the interrelationships among the strategic pathways for overcoming implementation barriers.

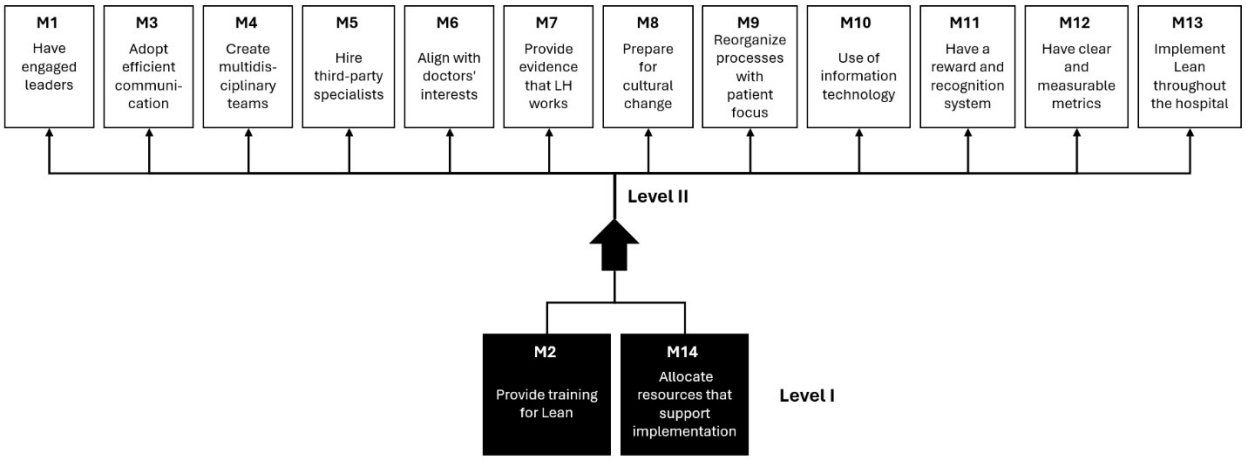
Figure 3.4 - SSIM Matrix

COMPLETE THE MATRIX USING ONLY **V, A, X, OR O**			*j14* M14	*j13* M13	*j12* M12	*j11* M11	*j1* M1	*j9* M9	*j8* M8	*j7* M7	*j6* M6	*j5* M5	*j4* M4	*j3* M3	*j2* M2	*j1* M1
i1	M1	Have engaged leaders														
i2	M2	Provide training for Lean														
i3	M3	Adopt efficient communication														
i4	M4	Create multidisciplinary teams														
i5	M5	Hire third-party specialists														
i6	M6	Align with doctors' interests														
i7	M7	Provide evidence that LH works														
i8	M8	Prepare for cultural change														
i9	M9	Reorganize processes with patient-focused quality practices and programs														
i10	M10	Use of information technology														
i11	M11	Have a reward and recognition system														
i12	M12	Have clear and measurable metrics for project evaluation														
i13	M13	Implement Lean throughout the hospital														
i14	M14	Allocate resources that support implementation														

Source: Own authorship

The ISM supporting matrix are presented in Appendix B. The Structural Self-Interaction Matrix (SSIM) was constructed from expert evaluations, and the mode of responses was adopted for each pair of pathways (Figure B1, Appendix B). The SSIM was subsequently converted into a binary matrix and, after the application of the transitivity rule, into the final reachability matrix (Figure B2, Appendix B). Figure B3 (Appendix B) presents the reachability, antecedent, and intersection sets, which served as the basis for determining the hierarchical levels of the model. From this structure, a graphical representation of the ISM model was generated (Figure 3.5). The 14 pathways were ultimately arranged into two hierarchical levels, which are discussed in the following section.

Figure 3.5 - Final ISM model



Source: Own authorship

Figure 3.5 presents the final Interpretive Structural Modeling (ISM) model, illustrating the hierarchical structure of the strategic pathways for overcoming barriers to Lean Healthcare implementation in hospitals. The model reveals two distinct levels. Level I comprises M2 (Provide training for Lean) and M14 (Allocate resources that support implementation), which emerged as the most fundamental pathways in the system. Despite the high overall interdependence identified in the experts' responses - reflecting the inherent complexity of Lean Healthcare implementation - these two pathways exhibit the highest driving power and the lowest relative dependence. This indicates that investments in Lean training and in the allocation of financial, human, and time-related resources are prerequisite conditions that enable the activation of all other pathways positioned in Level II. The pathways in Level II, including leadership engagement, communication, multidisciplinary teamwork, cultural change, technological support, measurement systems, and hospital-wide Lean deployment, are largely dependent on the foundational conditions established in Level I.

3.4.3 MICMAC Results

The following subsections report the results of the Fuzzy MICMAC analysis, developed according to the methodological steps previously described. All supporting matrices are provided in Appendix B. The analysis began with the construction of the Binary Direct Reachability Matrix (BDRM) (Figure B4, Appendix B), derived by replacing the diagonal entries of the Initial Reachability Matrix with zeros. Next, the Fuzzy Direct Reachability Matrix (FDRM) (Figure B5) was generated using the characteristic values corresponding to the number of expert assessments classified as V, A, X, or O in the SSIM (Table B1, Appendix B). The stabilized matrix was

obtained through iterative multiplication, as outlined in Section 3.3.4 (step 3), and is presented in Figure B6.

MICMAC analysis was used to examine the driving power and dependence among the identified elements. Based on these two dimensions, the variables can be classified into four categories according to their level of influence within the system. **Autonomous variables** present weak driving power and weak dependence, indicating limited interaction with other elements in the model. **Dependent variables** are characterized by weak driving power but strong dependence, meaning that they are strongly influenced by other variables in the system. **Linkage variables** have both strong driving power and strong dependence, indicating that they are highly interactive and that changes in these variables may generate feedback effects throughout the system. Finally, **independent variables**, also referred to as driving variables, present strong driving power and weak dependence, meaning that they exert significant influence on other variables while being less affected by them.

Based on the stabilized matrix, a five-cluster diagram was developed to illustrate the driving and dependence powers of the identified strategic pathways (Figure 3.6). The diagram depicts the distribution of 15 pathways across five distinct clusters.

Cluster A comprises M1 (Have engaged leaders), M2 (Provide training for Lean), M14 (Allocate resources that support implementation), and M5 (Hire third-party specialists), which exhibit high driving power and low dependence and can therefore be classified as independent variables. These pathways occupy a foundational position within the system, serving as the basis for the effective performance of other pathways.

Cluster B includes M3 (Adopt efficient communication) and M7 (Provide evidence that LH works), characterized by high driving power and medium dependence. These pathways present characteristics close to independent variables, as they exert significant influence while maintaining strong interconnections with other pathways.

Cluster C encompasses M4 (Create multidisciplinary teams) and M12 (Have clear and measurable metrics), which, despite demonstrating high driving power, also display substantial dependence. As such, they can be classified as linkage variables, positioned at higher levels of the framework, where they primarily contribute to enhancing transparency and enabling advanced forms of monitoring and analysis.

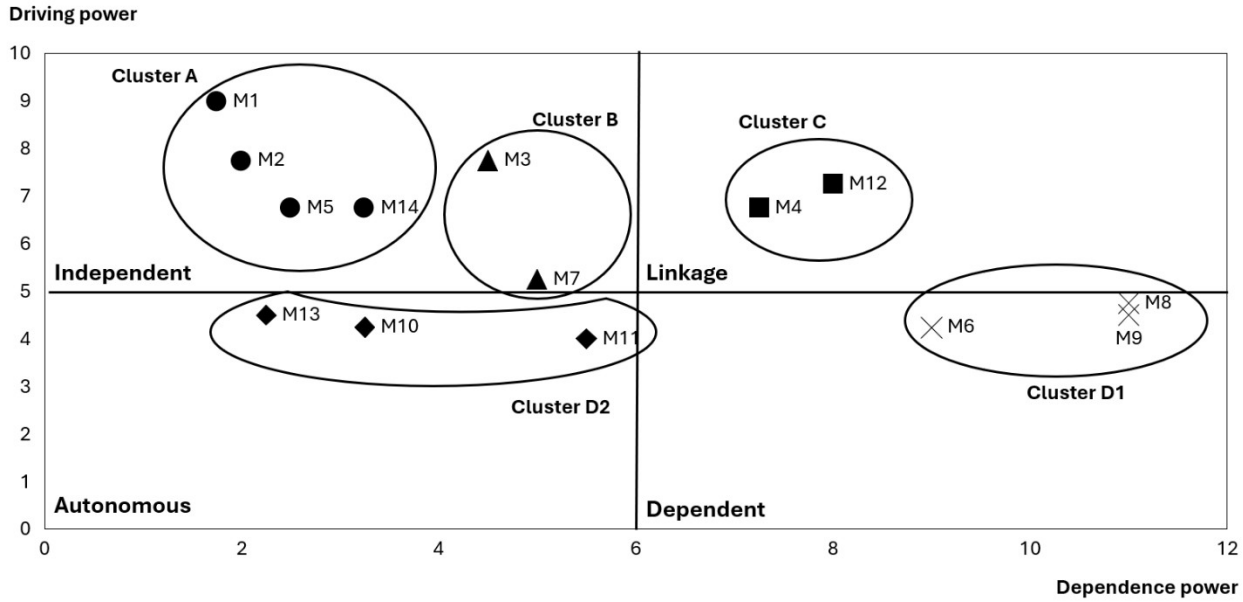
Cluster D1 consists of M6 (Align with doctors' interests), M8 (Prepare for cultural change), and M9 (Reorganize processes with patient focus), which present low driving power but

high dependence and are therefore classified as dependent variables. Their implementation relies heavily on the prior establishment of other pathways, reflecting their supportive and derivative role within the system.

Finally, **Cluster D2** is composed of M10 (Use of information technology), M11 (Have a reward and recognition system), and M13 (Implement Lean throughout the hospital), which are classified as autonomous variables, defined by minimal influence and minimal dependence. While these pathways may provide complementary contributions during the implementation of Lean Healthcare, they do not play a decisive role in facilitating or enabling other pathways.

Taken together, this classification not only highlights the systemic relevance of each pathway but also reinforces the coherence of the proposed framework, offering a structured basis for prioritization and guiding subsequent analysis and discussion.

Figure 3.6 - Five-cluster Diagram



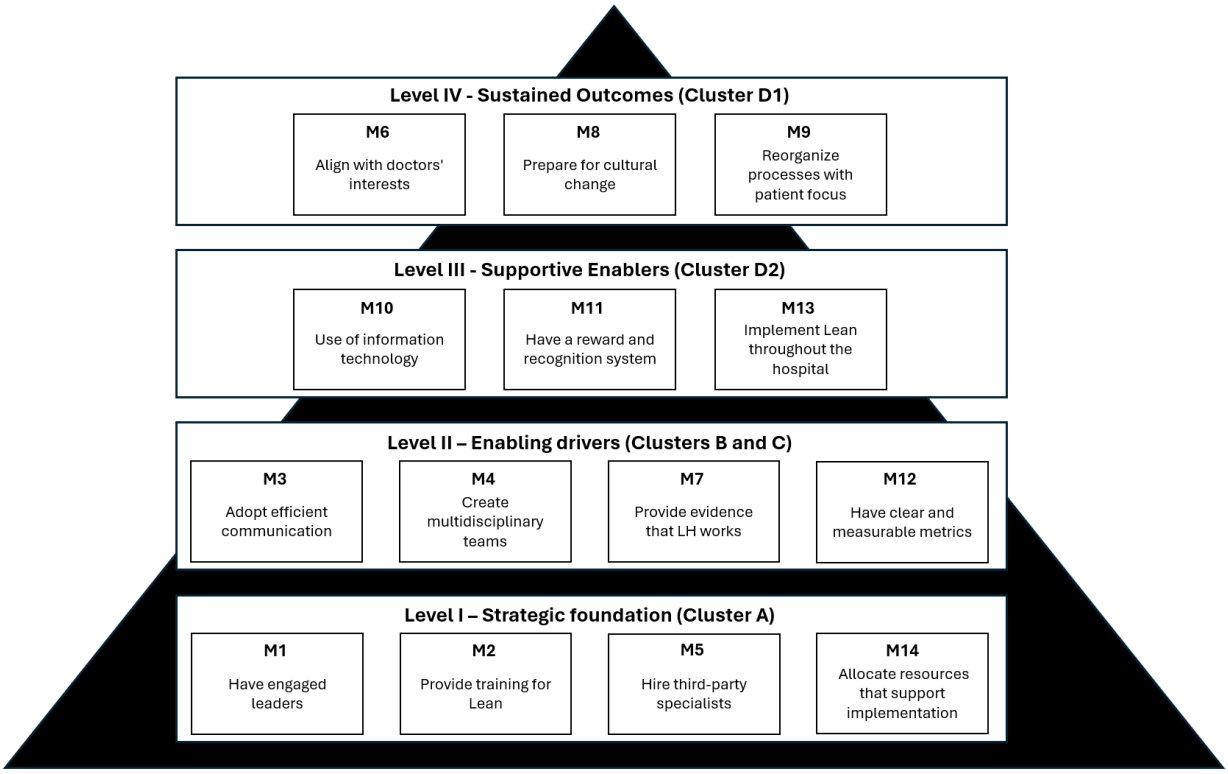
Source: Own authorship

3.4.4 Comprehensive Framework

Based on the results presented in the previous sections, Figure 3.7 illustrates the proposed framework, demonstrating the structural hierarchy among the strategic pathways to overcome Lean Healthcare implementation barriers. The divergence between the levels identified through ISM and the clusters obtained from MICMAC can be explained by the high degree of interrelationships among the factors. Owing to the application of the transitivity rule in ISM,

numerous transitive connections were generated, which ultimately produced distinct structural divisions compared to the clustering derived from MICMAC analysis.

Figure 3.7 - Lean Healthcare Strategic Pathways Compreensive Framework



Source: Own authorship

Level I, Strategic Foundation, forms the structural base of LH implementation, comprising pathways from Cluster A (*M1, M2, M5,* and *M14*). These elements show high driving power and low dependence, providing the essential foundation for implementation by ensuring leadership engagement, training, expert support, and the allocation of necessary resources.

Level II, Enabling Drivers, integrates pathways from Clusters B and C (*M3, M4, M7,* and *M12*), which exhibit strong influence with moderate dependence. Positioned as key enablers, these pathways strengthen coordination, communication, teamwork, and performance monitoring, thus bridging foundational readiness with broader organizational engagement.

Level III, Supportive Enablers, incorporates pathways from Cluster D2 (*M10, M11,* and *M13*), which have moderate driving and dependence powers. These supportive enablers consolidate Lean practices across the hospital, integrating technology, motivation systems, and the expansion of Lean principles throughout the organization.

The final level, level IV, Sustained Outcomes, encompasses pathways from Cluster D1 (*M6, M8,* and *M9*), characterized by high dependence and low driving power. These elements represent the ultimate outcomes of Lean implementation, emphasizing alignment with medical professionals, cultural transformation, and patient-centered process redesign.

3.4.5 Illustrating the Strategic Pathways: Evidence from the Leforte Hospital Case

This chapter aims to test the proposed framework by applying it to the case study of Lean Healthcare implementation at Leforte Hospital, drawing on evidence from the book *"Quebrando Paradigmas: O Desafio do Lean nos Hospitais Leforte".*

The implementation trajectory of Lean Healthcare at Leforte Hospital provides rich empirical support for the hierarchical structure identified in the ISM and ISM–MICMAC analyses. In particular, the case illustrates how the Level I: Strategic Foundation pathways (Provide training for Lean (M2) and Allocate resources that support implementation (M14), together with Have engaged leaders (M1) and Hire third-party specialists (M5) function as high-driving, low-dependence enablers that make all other pathways feasible. Lean at Leforte did not start with isolated tools, it started with an explicit decision to invest in people and infrastructure for learning and change. As the hospital reports, "we first started a project to develop the teams and ensure that everyone received the information and training needed to begin this new journey," supported by a formal partnership with an external consultancy.

Training (M2) was the central mechanism through which Lean principles were diffused and internalized across the organization. The creation of the Lean Healthcare Academy and the delivery of short courses, value-stream mapping workshops, Kaizen events, A3 training and practical simulations ensured that employees understood both the philosophy and the tools of Lean. According to the hospital, "all hospital staff needed to know Lean, adopt Lean thinking and understand the purpose of this methodology, its tools and the role of each person for the results to be achieved." The early training cycles were extensive (38 sessions involving 78% of employees) and generated unexpected enthusiasm: "we did not imagine that a small four-hour training session could generate such repercussion and enthusiasm among employees, and such significant results during project implementation." These accounts exemplify how M2 operates as a prerequisite for other pathways, such as adopting efficient communication (M3), creating multidisciplinary teams (M4), preparing for cultural change (M8) and reorganizing patient-focused processes (M9).

The Leforte case also shows clearly that these training initiatives were only possible because the organization allocated resources to support implementation (M14) and maintained a high level of leadership involvement (M1). The executive board "closely monitored everything, providing full support for the development of improvement projects," including resource release, in-person visits and ongoing encouragement. This support was perceived as a key source of motivation: "this support undoubtedly brought more motivation to the teams, which presented new ideas every day." Resources were invested in internal structures, such as the Continuous Improvement Office, and in external expertise, demonstrating the interaction between M14 and Hire third-party specialists (M5): the hospital established partnerships with consultancies to conduct Yellow Belt training, open courses and project mentoring. These investments created the organizational capacity needed to run Gemba walks, value-stream mapping, pilot projects and benchmarking visits, confirming the high driving power of the Level I pathways.

Once this strategic foundation was in place, Leforte was able to activate the Level II: Enabling Drivers, notably Adopt efficient communication (M3), Create multidisciplinary teams (M4), Provide evidence that LH works (M7) and Have clear and measurable metrics (M12). In the emergency department case, managers from diagnostic services, the emergency unit, hemodynamics, pharmacy, laboratory and administrative areas were brought together to map the current state, visit the Gemba and identify problems across the care pathway. The hospital notes that "in the first meeting all areas involved participated, with the objective of improving emergency care processes," and that "all employees involved in the stages of the care process were interviewed," which enabled a shared understanding of bottlenecks and waste. This collaborative approach illustrates how multidisciplinary teams (M4) and efficient communication (M3) emerge directly from the earlier investment in training and leadership support. Similarly, the development of visual management panels in the surgical center and IT solutions in the pharmacy (such as the mobile pharmacy system) improved communication and traceability, and provided measurable indicators of performance, reinforcing the role of M10 and M12 as part of a broader enabling structure.

The case narratives also give concrete expression to the Level III: Supportive Enablers and Level IV: Sustained Outcomes of the framework. Supportive enablers such as Use of information technology (M10), Have a reward and recognition system (M11) and Implement Lean throughout the hospital (M13) helped consolidate Lean practices and extend them beyond isolated pilots. In the pharmacy, the introduction of the mobile system based on barcode scanning and handheld

devices was designed to “achieve better traceability, strengthen systemic barriers to patient and logistics safety, increase team productivity and improve stock management and control.” In the surgical center, Lean projects reduced unnecessary movements, rework, stock inaccuracies and billing errors, while encouraging greater engagement from surgical, anesthesia, pharmacy and nursing teams. These improvements produced visible benefits for both staff and patients and created the conditions for Level IV outcomes, such as Align with doctors’ interests (M6), Prepare for cultural change (M8) and Reorganize processes with patient focus (M9). Over time, “resistance to change was replaced by great enthusiasm,” and the interdisciplinary, practical experience of Lean “helped in strategic planning and decision-making.”

Finally, the Leforte experience illustrates the feedback loop predicted by the framework between evidence of success and cultural transformation. The hospital reports that initial projects in the emergency department and operating room generated “encouraging changes,” with “micro and macro-objectives” achieved and improvements perceived by all participants, especially patients. These visible results constituted concrete evidence that Lean works (M7), which in turn strengthened leadership commitment, justified continued resource allocation and reinforced the hospital’s decision to expand Lean to other units and to external audiences through open courses. As one participant observed, the Lean course was “a watershed” that changed how processes were perceived, allowing professionals to “see details previously hidden by lack of perception.” This kind of experiential learning exemplifies how strategic foundation pathways (M1, M2, M5, M14) and enabling drivers (M3, M4, M7, M12) interact to produce sustained cultural change and patient-centered process redesign, consistent with the top levels of the ISM–MICMAC model.

In summary, the Leforte Hospital case offers a rich empirical illustration of the proposed hierarchical framework. It shows that Lean Healthcare implementation in hospitals becomes viable and sustainable only when training and resource allocation are treated as strategic investments, enabling leadership engagement, multidisciplinary collaboration, technological support and cultural transformation. The observed sequence: from foundation to enabling drivers, supportive enablers and sustained outcomes, closely mirrors the structure identified through ISM and MICMAC, reinforcing the validity and practical relevance of the model.

3.5 CONCLUSION

This study was motivated by recurring gaps identified in the Lean Healthcare (LH) literature, particularly the limited understanding of how implementation barriers interact and the

lack of structured, empirically grounded guidance on the strategic pathways required to overcome them (Almutairi et al., 2021; Chmielewska et al., 2023; Leite, Radnor and Bateman, 2022). The findings from the Systematic Literature Review (SLR) directly address the call for deeper investigation into both the nature of LH barriers and the strategies proposed to overcome them (Chmielewska et al., 2023; Fournier et al., 2021). By synthesizing evidence from 34 peer-reviewed studies, the SLR identified fourteen strategic pathways linked to the most recurrent barriers, including insufficient Lean knowledge, lack of leadership engagement, resistance to change, and constrained resources - barriers repeatedly highlighted as critical yet poorly managed in prior research (Leite, Bateman and Radnor, 2020; Pozzan et al., 2025).

Building on this foundation, the application of Interpretive Structural Modeling (ISM) and Fuzzy MICMAC analysis directly responds to the gap concerning the absence of relational and hierarchical perspectives in LH research (Noris et al., 2022; Leite, Radnor and Bateman, 2022). The framework reveals that pathways related to Lean training and resource allocation function as primary drivers, enabling the activation of other strategies associated with communication, teamwork, technological support, and cultural transformation. This hierarchical insight addresses the need identified by Almutairi et al. (2021) and Chmielewska et al. (2023) for prioritization mechanisms that support decision-making under conditions of organizational complexity.

The resulting four-level framework (Strategic Foundation, Enabling Drivers, Supportive Enablers, and Sustained Outcomes) offers a structured response to the literature's call for comprehensive models capable of addressing the systemic nature of LH implementation (Nawanir et al., 2025). By explicitly linking foundational organizational conditions to long-term outcomes such as cultural change, clinical alignment, and patient-centered process redesign, the framework advances current understanding of how LH initiatives can evolve from isolated projects into sustainable organizational transformations, a challenge repeatedly emphasized in prior studies (Leite, Bateman and Radnor, 2020; Rosa, Marolla and McDermott, 2023).

The practical validation of the framework through the Leforte Hospital case further strengthens its contribution by addressing the lack of empirical grounding noted in earlier research (Chmielewska et al., 2023; Freitas, Mendonça and Resende, 2023). The case demonstrates how the foundational strategic pathways identified in the model enable the sequential development of other pathways in practice, confirming the framework's applicability to real hospital contexts.

3.5.1 Theoretical and Practical Contributions

From a theoretical standpoint, this study bridges a critical gap between descriptive analyses of LH barriers and prescriptive frameworks for overcoming them (Leite, Radnor and Bateman, 2022; Nawanir et al., 2025). By integrating qualitative insights with quantitative prioritization methods, the proposed model offers a systemic representation of how interdependent strategies reinforce one another to support sustainable Lean implementation. It advances the field by clarifying not only which pathways are essential, but how they interact hierarchically within the organizational system.

From a practical perspective, the hierarchical structure provides hospital managers and policymakers with detailed guidance on how to plan and prioritize Lean actions. The framework clarifies that foundational pathways, such as leadership engagement, Lean training, and resource allocation, must be firmly established before pursuing enabling and supportive mechanisms. The later stages, centered on cultural change, alignment with medical professionals, and patient-centered redesign, represent long-term outcomes of a well-orchestrated Lean transformation. The framework directly addresses managerial challenges related to sequencing, resource allocation, and change management highlighted in previous studies (Almutairi et al., 2021; Freitas, Mendonça and Resende, 2023). The validation offered by the Leforte case reinforces the framework's utility as a roadmap for phased, context-sensitive implementation in hospital environments.

3.5.2 Limitations and Future Research Directions

Despite its contributions, this study presents limitations. The SLR relied on the published literature, which may not reflect the full diversity of LH practices across healthcare systems. The ISM and MICMAC analyses depended on expert judgment, introducing inherent subjectivity despite careful validation procedures. Further research could investigate whether different groups of experts involved in the ISM process hold distinct perceptions of the relationships among barriers and strategic pathways, particularly by comparing the perspectives of practitioners and academics. In addition, future studies could explore the temporal dynamics of the framework by examining how its levels interact over time, as they may not follow a strictly sequential progression but instead involve overlapping phases and transition periods. Future research should also seek to validate and refine the framework through longitudinal case studies, cross-institutional comparisons, and survey-based assessments. Furthermore, deeper investigation into the behavioral and cultural factors that shape Lean adoption would provide richer insights into the transition from

foundational enablers to sustained organizational outcomes. Finally, although the Leforte case provided practical confirmation of the framework, broader empirical testing is needed to examine its generalizability across institutions of different sizes, specialties, and governance models.

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APPENDIX B

Figure B1 – Accessibility Matrix

COMPLETE THE MATRIX USING		*j14* M14	*j13* M13	*j12* M12	*j11* M11	*j1* M10	*j9* M9	*j8* M8	*j7* M7	*j6* M6	*j5* M5	*j4* M4	*j3* M3	*j2* M2	*j1* M1
i1	M1	V	O	V	V	O	V	V	V	V	X	X	X	V	
i2	M2	A	V	V	O	O	V	V	V	V	A	V	V		
i3	M3	O	O	X	V	X	X	V	V	V	O	X			
i4	M4	A	V	X	X	O	X	X	X	X	A				
i5	M5	A	A	V	O	O	V	X	V	V					
i6	M6	X	A	X	X	O	X	X	A						
i7	M7	V	O	X	O	O	V	V							
i8	M8	A	A	A	X	X	X								
i9	M9	A	A	X	X	X									
i10	M10	A	V	X	O										
i11	M11	A	O	X											
i12	M12	X	A												
i13	M13	V													
i14	M14														

Source: Own authorship

Figure B2 – Reliability testing

		j1	j2	j3	j4	j5	j6	j7	j8	j9	j10	j11	j12	j13	j14
		M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
i1	M1	1	1	1	1	1	1	1	1	1	*1	1	1	*1	1
i2	M2	*1	1	1	1	*1	1	1	1	1	*1	*1	1	1	*1
i3	M3	1	*1	1	1	*1	1	1	1	1	1	1	1	*1	*1
i4	M4	1	*1	1	1	*1	1	1	1	1	*1	1	1	1	*1
i5	M5	1	1	*1	1	1	1	1	1	1	*1	*1	1	*1	*1
i6	M6	*1	*1	*1	1	*1	1	*1	1	1	*1	1	1	*1	1
i7	M7	*1	*1	*1	1	*1	1	1	1	1	*1	*1	1	*1	1
i8	M8	*1	*1	*1	1	1	1	*1	1	1	1	1	*1	*1	*1
i9	M9	*1	0	1	1	*1	1	*1	1	1	1	1	1	*1	*1
i10	M10	*1	0	1	*1	*1	*1	*1	1	1	1	*1	1	1	*1
i11	M11	*1	0	*1	1	*1	1	*1	1	1	*1	1	1	*1	*1
i12	M12	*1	*1	1	1	*1	1	1	1	1	1	1	1	*1	1
i13	M13	*1	*1	*1	*1	1	1	*1	1	1	*1	*1	1	1	1
i14	M14	*1	1	*1	1	1	1	*1	1	1	1	1	1	*1	1

Source: Own authorship

Figure B3 – Partition of levels

	Reachability Set	Antecedent Set	Intersection Set	Level
M1	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M2	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M12,M13,M14	I
M3	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M4	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M5	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M6	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M7	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M8	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M9	M1,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M10	M1,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M11	M1,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M12	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M13	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	II
M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	M1,M2,M3,M4,M5,M6,M7,M8,M9,M10,M11,M12,M13,M14	I

Source: Own authorship

Figure B4 – Binary Direct Reachability Matrix

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
M1	0	1	1	1	1	1	1	1	1	0	1	1	0	1
M2	0	0	1	1	0	1	1	1	1	0	0	1	1	0
M3	1	0	0	1	0	1	1	1	1	1	1	1	0	0
M4	1	0	1	0	0	1	1	1	1	0	1	1	1	0
M5	1	1	0	1	0	1	1	1	1	0	0	1	0	0
M6	0	0	0	1	0	0	0	1	1	0	1	1	0	1
M7	0	0	0	1	0	1	0	1	1	0	0	1	0	1
M8	0	0	0	1	1	1	0	0	1	1	1	0	0	0
M9	0	0	1	1	0	1	0	1	0	1	1	1	0	0
M10	0	0	1	0	0	0	0	1	1	0	0	1	1	0
M11	0	0	0	1	0	1	0	1	1	0	0	1	0	0
M12	0	0	1	1	0	1	1	1	1	1	1	0	0	1
M13	0	0	0	0	1	1	0	1	1	0	0	1	0	1
M14	0	1	0	1	1	1	0	1	1	1	1	1	0	0

Source: Own authorship

Table B1 – Fuzzy Direct Reachability Matrix support table

Strength	Value Assigned	% of experts that agreed
No	0	0%
Weak	0.25	> 0% and ≤ 30%
Medium	0.5	> 30% and ≤ 60%
Strong	0.75	> 60% and ≤ 85%
Very Strong	1	> 85%

Source: Own authorship

Figure B5 – Fuzzy Direct Reachability Matrix

	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14
M1	0	0.75	0.75	0.75	0.5	0.75	0.75	1	0.75	0	0.75	0.5	0	0.75
M2	0	0	0.75	0.75	0	0.75	1	1	1	0	0	0.75	0.75	0
M3	0.5	0	0	0.5	0	1	1	1	0.75	0.5	0.75	0.75	0	0
M4	0.5	0	0.75	0	0	0.75	0.5	0.75	0.75	0	0.5	0.75	0.75	0
M5	0.75	0.75	0	0.75	0	0.75	1	0.75	0.75	0	0	0.75	0	0
M6	0	0	0	0.5	0	0	0	0.75	0.75	0	0.5	0.5	0	0.5
M7	0	0	0	0.5	0	0.75	0	1	0.75	0	0	0.75	0	0.75
M8	0	0	0	0.75	0.5	0.75	0	0	0.75	0.5	0.75	0	0	0
M9	0	0	0.5	0.5	0	0.75	0	0.5	0	0.75	0.75	0.75	0	0
M10	0	0	1	0	0	0	0	0.5	0.75	0	0	0.75	0.75	0
M11	0	0	0	0.5	0	0.75	0	0.75	0.75	0	0	0.5	0	0
M12	0	0	0.75	0.5	0	0.75	0.75	0.75	1	0.75	0.75	0	0	0.5
M13	0	0	0	0	0.75	0.75	0	0.75	0.75	0	0	0.75	0	0.75
M14	0	0.5	0	0.75	0.75	0.5	0	0.75	0.75	0.75	0.75	0.5	0	0

Source: Own authorship

Figure B6 – Stabilized Fuzzy MICMAC Matrix

	Dependence	Driving
M1	1,75	9
M2	2	7,75
M3	4,5	7,75
M4	7,25	6,75
M5	2,5	6,75
M6	9	4,25
M7	5	5,25
M8	11	4,75
M9	11	4,5
M10	3,25	4,25
M11	5,5	4
M12	8	7,25
M13	2,25	4,5
M14	3,25	6,75

Source: Own authorship

4 CONCLUSIONS

This dissertation focused on understanding the implementation of Lean Healthcare (LH) in hospitals, emphasizing the barriers that hinder its adoption and the strategic pathways that can enable its success and sustainability. Through a multi-method approach combining qualitative and quantitative analyses, this research developed a comprehensive and structured framework to guide hospital managers, researchers, and policymakers in advancing Lean transformation within complex healthcare systems.

The first study, presented in Chapter 2, applied a Systematic Literature Review (SLR) and Content Analysis to identify and classify the main barriers and strategies discussed in the literature concerning LH implementation in hospitals. The analysis of thirty-four peer-reviewed studies led to the identification of ten major barriers and fourteen strategic pathways proposed to overcome them. When analyzed through the lens of Organizational Learning (OL) Theory, these findings demonstrated that successful LH implementation in hospitals depends on fostering learning processes at individual, group, and organizational levels. The study highlighted that leadership engagement, staff training, open communication, and knowledge sharing are essential to building a culture conducive to Lean transformation in hospital environments.

The second study, presented in Chapter 3, advanced this understanding by employing Interpretive Structural Modeling (ISM) and Fuzzy MICMAC analysis to model the interdependencies among the identified pathways. The results revealed how certain strategies act as foundational drivers for others, culminating in a four-level comprehensive framework for hospital-based LH implementation: (1) Strategic Foundation, (2) Enabling Drivers, (3) Supportive Enablers, and (4) Sustained Outcomes. This framework illustrates the progression from foundational conditions - such as leadership, training, and resource allocation - to higher-order results, including cultural change and patient-centered process redesign. Together, these levels represent a systemic pathway for hospitals to achieve sustainable Lean implementation outcomes.

Overall, this dissertation reinforces that the implementation of Lean Healthcare in hospitals is a complex, interdependent, and learning-driven process that requires coordinated managerial actions and strategic prioritization. By integrating SLR, ISM, and MICMAC methodologies, the research contributes both theoretically and practically, offering hospitals an evidence-based model to guide Lean adoption in a structured and sustainable manner.

4.1 Theoretical Implications

From a theoretical perspective, this study advances the integration of Organizational Learning Theory with Lean Healthcare implementation by emphasizing the central role of learning as an enabler in hospital contexts. In doing so, it reinforces the understanding of Lean not merely as a set of tools, but as a learning-oriented and systemic process. Additionally, the study demonstrates the applicability of the ISM-MICMAC methodological combination for analyzing complex interdependencies within healthcare operations, offering a structured approach to capture the relationships among barriers and strategic pathways. By framing Lean Healthcare implementation as a hierarchical and interconnected process within hospital organizations, this research contributes to the advancement of theory by providing a more comprehensive and system-oriented perspective.

4.2 Practical Implications

From a practical standpoint, the findings offer relevant insights for hospital managers by providing a structured framework that supports the prioritization of actions based on their levels of influence and dependence, thereby facilitating more effective Lean implementation planning. Moreover, the study provides evidence-based guidance to strengthen key organizational aspects, such as leadership engagement, training initiatives, and communication strategies, which are critical for successful implementation. Finally, the proposed framework serves as a practical roadmap for the phased and sustainable implementation of Lean across hospital departments, contributing to the alignment of improvement initiatives with patient-centered care objectives.

4.3 Limitations and Future Research

Despite its contributions, this research has limitations. The Systematic Literature Review was based on published studies, potentially excluding relevant gray literature or empirical evidence from practice. The ISM and MICMAC analyses relied on expert opinions, which, although validated, carry inherent subjectivity. Furthermore, the proposed framework has not yet been empirically tested in hospital settings. Future research should focus on validating and refining this model through longitudinal case studies in hospitals of different sizes, specialties, and governance structures. Expanding investigations into the behavioral, cultural, and leadership dynamics of hospital teams may also enrich understanding of how Lean principles can be effectively embedded in healthcare practice. Additionally, the integration of complementary methods, such as system

dynamics modeling or survey-based validation, could strengthen the empirical robustness and practical applicability of the framework.

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