Designing Futures for Healthcare: A Framework for Identifying Innovation Opportunities through Desirable Future Visions in Hospital Sociotechnical System

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Abstract

Hospitals are sociotechnical systems, in which technologies, professionals, routines and rules are deeply interdependent, making them difficult to transform even as the pressures upon them grow. This dissertation addresses the scarcity of practical instruments through which hospital stakeholders can collectively discover the dynamics of their present regime and locate innovation opportunities within it. Following a Design Science Research approach, the study derives a five-phase conceptual framework from sociotechnical transition theory, systemic design and participatory systems mapping, and operationalises its discovery component as the research artifact: a participatory workshop protocol, structured through the PSD framework. The artifact was implemented through a workshop with ten stakeholders holding professional and experiential knowledge of the Portuguese hospital system, and evaluated through the outputs it produced and a post-session questionnaire. Its central premise, that a theory-grounded participatory protocol can support such a discovery and thereby identify opportunities for transition-oriented innovation, was substantially supported, within the limits of a single application. The discovery found the identified constraints to be reproduced by organisational and cultural arrangements, fragmented governance, unsegregated budgeting, and act-oriented performance metrics, rather than by technological deficits. Read against the smart hospital vision from the literature, it located the dynamics that would need to be reconfigured for such visions to take hold, establishing that organisational change precedes the technological capabilities that depend upon it. Participants evaluated the protocol as clear, useful and comprehensible. The dissertation contributes a replicable discovery method, an empirical account of a hospital regime, and design knowledge for participatory transition instruments in healthcare.

Keywords: Sociotechnical transitions; Multi-Level Perspective; Participatory systems mapping; Systemic design; Healthcare innovation

Resumo

Os hospitais são sistemas sociotécnicos, nos quais tecnologias, profissionais, rotinas e regras são profundamente interdependentes, o que os torna difíceis de transformar, mesmo quando as pressões sobre eles aumentam. Esta dissertação aborda a escassez de instrumentos práticos através dos quais os *stakeholders* hospitalares possam descobrir coletivamente as dinâmicas do seu regime atual e localizar, no seu interior, oportunidades de inovação. Seguindo uma abordagem de *Design Science Research*, o estudo deriva um quadro conceptual de cinco fases a partir da teoria das transições sociotécnicas, do design sistémico e do mapeamento participativo de sistemas, e operacionaliza a sua componente de descoberta como artefacto de investigação: um protocolo de workshop participativo, estruturado através do quadro *Participatory Systemic Discovery* (PSD). O artefacto foi implementado num workshop com dez *stakeholders* detentores de conhecimento profissional e experiencial sobre o sistema hospitalar português, e avaliado através dos resultados que produziu e de um questionário pós-sessão. A sua premissa central, a de que um protocolo participativo fundamentado na teoria pode apoiar essa descoberta e, desse modo, identificar oportunidades de inovação orientada para a transição, foi substancialmente corroborada, dentro dos limites de uma única aplicação. A descoberta revelou que os constrangimentos identificados são reproduzidos por configurações organizacionais e culturais, pela governação fragmentada, pela orçamentação não segregada e por métricas de desempenho orientadas para o ato, e não por défices tecnológicos. Lida à luz da visão do hospital inteligente (*smart hospital*) presente na literatura, a descoberta localizou as dinâmicas que teriam de ser reconfiguradas para que tais visões se enraizassem, estabelecendo que a mudança organizacional precede as capacidades tecnológicas que dela dependem. Os participantes avaliaram o protocolo como claro, útil e compreensível. A dissertação contribui com um método de descoberta replicável, um relato empírico de um regime hospitalar e conhecimento de design para instrumentos participativos de transição nos cuidados de saúde.

Palavras-chave: Transições sociotécnicas; Perspetiva Multinível; Mapeamento participativo de sistemas; Design sistémico; Inovação em saúde

Glossary of Key Concepts

Backcasting. Working backward from a desired future to the steps required to reach it (Bibri, 2018).

Causal chain. A sequence of cause-and-effect relations linking a root cause to a problem and its effects.

Causal loop diagram (CLD). A notation mapping for variables and their causal relations, expressing system behaviour through feedback loops (Kim, 1992)

Discovery. In this dissertation, the collective surfacing of a system's dynamics: its social function, the constraints and pressures bearing on it, and the mechanisms reproducing them.

Landscape. Broad exogenous forces beyond actors' control that pressure regimes (Geels & Schot, 2007).

Lock-in. The self-reinforcing stability of an incumbent configuration that resists alternative arrangements (Geels & Schot, 2007; Hekkert et al., 2007).

Multi-Level Perspective (MLP). Explains transitions through the interaction of niches, regimes and the landscape (Geels & Schot, 2007).

Niche. A protected space where radical innovations develop away from regime pressures (Geels & Schot, 2007).

Participatory Systemic Discovery (PSD) framework. This dissertation's operationalisation of discovery: pre-workshop configuration, workshop session, post-workshop refinement.

Participatory systems mapping. Stakeholders collaboratively building system representations, typically CLDs, to structure complex problems (Tourais & Videira, 2021).

PESTEL analysis. A scan of a system's context across political, economic, social, technological, environmental and legal factors.

Regime. The established rules, routines and organisational forms through which a societal function is currently delivered (Geels & Schot, 2007).

Social function. The societal need a system exists to fulfil, which bounds the system and anchors its analysis (Gaziulusoy & Brezet, 2015).

Sectoral system of innovation. Innovation as structured by sector-specific knowledge, institutions, actors and demand (Malerba, 2002).

Sociotechnical dimensions. The institutional, organisational, social/cultural and technological categories conditioning social function fulfilment (Gaziulusoy & Brezet, 2015).

Sociotechnical system. Interdependent technologies, actors, routines, rules and infrastructures delivering a societal function (Geels & Schot, 2007).

Sociotechnical transition. A shift between sociotechnical configurations through aligned developments across the three MLP levels (Geels & Schot, 2007).

Systemic design. Design practice for complex multi-stakeholder systems, centred on multiple perspectives and high-leverage interventions (Jones, 2020).

List of Abbreviations

CLD Causal Loop Diagram

DfS Design for Sustainability

DSR Design Science Research

FEP Faculdade de Economia da Universidade do Porto

FEUP Faculdade de Engenharia da Universidade do Porto

GenAI Generative Artificial Intelligence

LLM Large Language Model

MLP Multi-Level Perspective

PESTEL Political, Economic, Social, Technological, Environmental, Legal

PRISMA Preferred Reporting Items for Systematic Reviews and Meta-Analyses

PSD Participatory Systemic Discovery

RQ Research Question

SQ Sub-Question

WoS Web of Science

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1. Introduction

1.1. Problem Statement

Health systems in high-income countries are confronting demands that the current model of care lacks the resources and structures to address (Barbero & Pallaro, 2017). The pattern of illness itself is changing, with ageing populations shifting care needs from acute episodes toward long-term chronic conditions (Barbero & Pallaro, 2017). At the same time, public spending on health and long-term care is expected to keep rising under this combined demographic and budgetary pressure (Pereno & Eriksson, 2020). Staffing, too, rarely matches the level of need, Jovy-Klein et al. (2024) describe a hospital sector approaching an inflection point, in which labour shortages and an ageing, increasingly chronically ill population strain the balance between providers and patients. Against this backdrop, Barbero & Pallaro (2017) argue that the model of care currently in place was not designed for such conditions and that adjusting it at the margins is no longer sufficient, leaving hospitals to absorb much of the pressure, expected to deliver more, and more efficiently, without compromising the quality or safety of care.

Part of the difficulty is that a hospital cannot be easily reconfigured to better deliver its intended social function. It is a sociotechnical system, in which technologies, professionals, routines, patients, rules, and infrastructure are closely interdependent and shape one another over time (Geels & Schot, 2007). A change in one part tends to have effects on the others, which is precisely what makes the outcome of any improvement so difficult to anticipate. Established ways of working become entrenched through prior investment, familiar routines, and shared expectations, and this inertia tends to resist new arrangements (Hekkert et al., 2007; Mok & Gaziulusoy, 2018).

This gives rise to a persistent tension. These systems clearly need to change, yet the interlocking nature of the hospital makes system-wide transformation impractical. A more realistic route is to intervene at a smaller scale, at the level of the individual hospital, through innovations suited to that setting but designed to influence the wider system to which it belongs. Sociotechnical systems are nested, and a smaller unit can, through deliberate action, contribute to change in the larger scales that contain it (A. I. Gaziulusoy & Brezet, 2015). Recent literature proposes multidimensional visions of the future hospital, such as the "*smart hospital*" or "*Hospital 6.0*" (Aliahmadi et al., 2024; Jovy-Klein et al., 2024). These visions are

normative in nature, and it remains unclear how their implementation would help transition the hospital toward a more sustainable sociotechnical system, better able to deliver its social function.

Before change can be pursued, the actors who make up a hospital need a shared, systemic understanding of how its present regime actually works, how internal constraints and external pressures jointly hold current conditions in place. Without this understanding efforts to innovate risk addressing symptoms rather than the mechanisms that reproduce them. It is this gap, the lack of a shared basis for diagnosing the present hospital as a sociotechnical system, that the present dissertation sets out to address.

1.2.Motivation and Significance

Throughout the Master's in Innovation and Technological Entrepreneurship, the question that has most held my interest is why the contexts where innovation could deliver the greatest societal value are often those where it proves most difficult. Sociotechnical systems such as energy, mobility and healthcare are deeply interdependent configurations of technologies, actors, rules and infrastructures, and the difficulty of innovating in them grows with their scale. My motivation lies in understanding how these systems can be transitioned toward more sustainable and resilient configurations, better able to deliver value to society.

The choice of the hospital as the setting for this inquiry is not incidental. Health is a foundational condition of human life and one from which everyone should be able to draw the fullest possible benefit. Improving the quality of the system through which health is delivered is therefore among the most direct ways in which innovation can serve humanity. Because sociotechnical systems are nested, and a smaller unit can, through deliberate action, influence the larger scales that contain it (A. I. Gaziulusoy & Brezet, 2015), developing the means to understand and intervene in an individual hospital carries relevance for the wider healthcare system to which it belongs.

1.3.Scope of the Work

This research develops and evaluates a participatory process for the collective discovery of the dynamics of a hospital understood as a sociotechnical system. The process brings together a diverse set of stakeholders to map the hospital's social function, its internal

constraints and the external pressures acting upon it, and to trace the relationships among them, so that areas of potential innovation can be identified. Situated within a broader transition-oriented perspective, the study concentrates on this discovery stage and is instantiated through a single workshop in a real hospital context, which serves as the empirical basis for its evaluation.

The work pursues three outcomes. First, a structured, replicable method through which the actors of a hospital can collectively surface the dynamics of their present system. Second, the design knowledge underlying that method, articulated so that others can adapt it to different settings. Third, an empirical account of the system dynamics discovered in the case in which the method was applied, read against the visions of the future hospital found in the literature, as a basis for identifying where innovation might intervene.

1.4.Structure of the Work

This dissertation is organised into seven chapters. This first chapter introduces the research, presenting the problem, the motivation and significance of the study, and its scope. Chapter 2 reviews the literature, describes the review method, synthesises the themes that ground the study, and closes with the research gap and the research questions (RQs) it motivates. Chapter 3 sets out the research design, situating the study within a Design Science Research (DSR) approach and describing how the research artifact is characterised, instantiated, analysed and evaluated. Chapter 4 develops the conceptual framework derived from the literature and operationalises its discovery component as the artifact of the study, a participatory workshop protocol. Chapter 5 describes the implementation of the artifact, from the configuration of the workshop and the selection of its participants to the consolidation of its outputs. Chapter 6 presents and discusses the results, from the discovery of the present hospital regime to its reading against visions of the future hospital, reports the participant evaluation, and reflects on the study's limitations and contributions. Chapter 7 concludes, answering the RQs and outlining the implications and directions for future work. Chapter 7 concludes, answering the research questions and outlining the implications and directions for future work. Finally, in the interest of transparency, the author's use of Generative Artificial Intelligence tools during the preparation of this dissertation, limited to structuring, language refinement, and translation, is disclosed in Annex M.

2. Literature Review

2.1. Initial considerations

This chapter reviews the literature that grounds the dissertation. It pursues five objectives, the first four of which correspond directly to the thematic sections in which the review is synthesised: (i) to understand the multi-level dynamics of landscapes, regimes and niches through which sociotechnical transitions unfold; (ii) to understand system innovation and design for sustainability (DfS), and how design practice has extended from products to sociotechnical systems; (iii) to understand the participatory and foresight methods through which diverse stakeholders can be engaged in complex problem spaces; and (iv) to understand governance and agency in transitions, and the role of design in steering them. On this basis, the chapter pursues its fifth objective: (v) to identify the gap these literatures leave open, from which the RQs of the dissertation are formulated.

The chapter is organised as follows: (i) Section 2.2 describes the review method, including the search strategy and study selection; and presents the themes that emerged from the selected literature; (ii) Section 2.3 draws out the research gap and formulates the research questions; and (iii) Section 2.4 presents the conclusion.

2.2. Review Method

This section describes the search strategy, the screening process and the resulting study set. To ensure that the review was transparent, systematic, and reproducible, the search and selection of studies followed a structured procedure informed by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines (Page et al., 2021). The inclusion and exclusion criteria are reported in Annex A.

The search was organised around three complementary objectives, each addressed through a dedicated query in Scopus and Web of Science (WoS): (i) to determine whether existing literature provides design processes, methods, or frameworks to support sociotechnical system transitions; (ii) to gather work on the systemic instruments applicable to sociotechnical systems, such as systems mapping, causal loop diagrams (CLDs), backcasting and scenario methods, in order to understand how different methods might contribute to the development of the conceptual framework; and (iii) to characterise how the literature envisions the future of the hospital, providing a reference against which the outputs of the

study could later be interpreted. The initial searches were conducted in February and March 2026. Because the second line of enquiry was central to the conceptual framework, and the third addresses a rapidly evolving literature, the corresponding searches were repeated on 22 June 2026, using identical terms and filters to preserve comparability, in order to capture studies indexed after the initial searches; these repetitions did not identify eligible studies beyond those already included, indicating that the study set remained current. Table 1 presents the full search strings, the publication-year filters applied, which reflect the maturity of each literature, the date on which each search was last run, and the number of records returned by each database, presented in the order of the three review objectives set out above.

Table 1. Search strings, publication-period filters, retrieval dates, and records returned per database (Scopus and WoS), in chronological order of first retrieval.

String	Date	Filters Applied	Scopus Results	WoS Results
("complex system*" OR "complex sociotechnical system*" OR "socio-technical" OR "sociotechnical") AND ("systemic design" OR "transition design" OR "design thinking" OR "human-centered design" OR "user-centered design" OR "design for sustainability" OR "design innovat*") AND ("framework" OR "methodolog*" OR "design process" OR "design method*")	19/02/26	Publication years: 2014–2026	46	215
("socio-technical system*" OR "sociotechnical system*" OR "sustainability transition*" OR "system innovation for sustainability" OR "system innovation") AND ("systems mapping" OR "system mapping" OR "causal loop diagram*" OR "group model building" OR "systemic design" OR "transition design" OR "backcasting" OR "scenario method")	22/06/26	Publication years: 2015–2026	120	92
("hospital of the future" OR "future hospital*" OR "next generation hospital*" OR "future healthcare system*" OR "smart hospital*" OR "hospital 4.0") AND ("vision" OR "foresight" OR "scenario*" OR "future vision" OR "strategic innovation" OR "innovation roadmap" OR "healthcare innovation") AND ("hospital*" OR "healthcare")	22/06/26	Publication years: 2023–2026	76	46

After the removal of duplicates, screening followed a two-stage procedure: titles and abstracts were first examined to remove records clearly outside the review boundaries, and the remaining records were then assessed in full text against the inclusion and exclusion criteria, with all decisions documented in a screening log. A further five studies,

foundational to the review but predating the temporal filters, were identified through backward citation searching and prior knowledge of the field and assessed against the same criteria (A. I. Gaziulusoy et al., 2013; Geels, 2004; Geels & Schot, 2007; Hekkert et al., 2007; Malerba, 2002). The selection process and the record counts at each stage are summarised in the PRISMA flow diagram in Figure 1, yielding a final set of 24 studies.

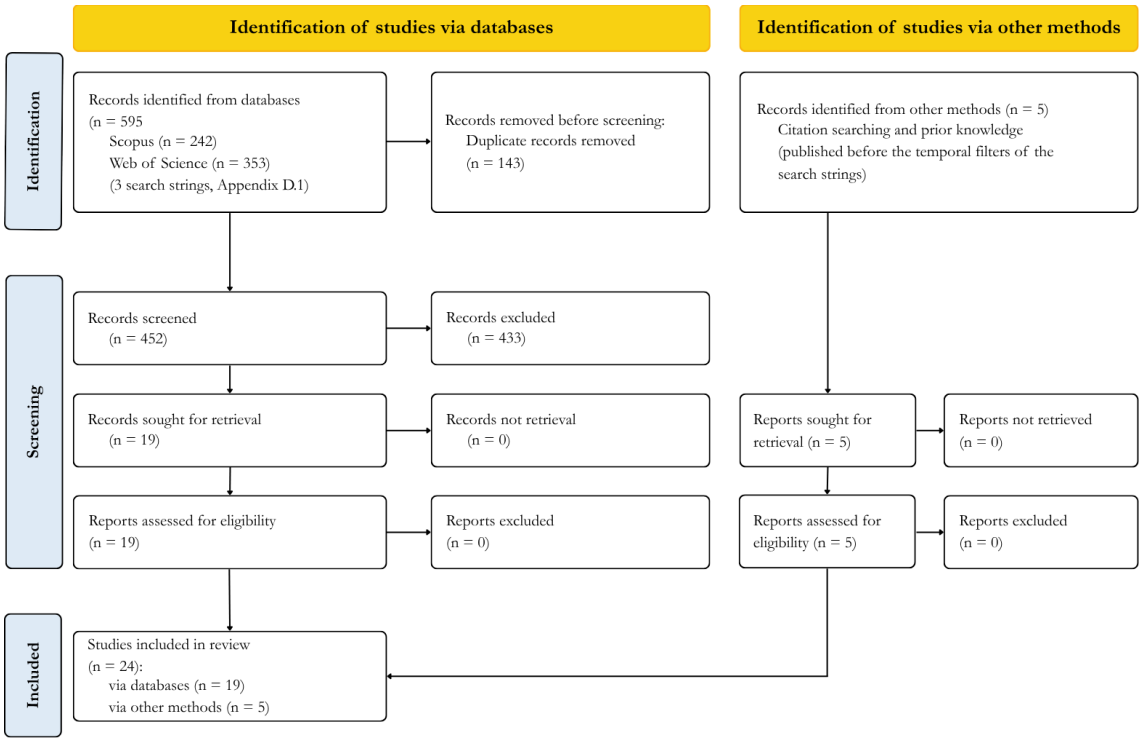


Figure 1. PRISMA 2020 flow diagram of the study selection process, covering identification, screening and inclusion via databases and via other methods (adapted from Page et al., 2021).

Beyond meeting the formal criteria, studies were prioritised according to their contribution to the review's concept-based synthesis: greater weight was given to papers that clearly explained relevant processes and mechanisms, offered robust conceptual or methodological contributions, ensured coverage of the principal themes, and added diversity of empirical context, and the set was considered sufficiently developed when further screening no longer produced substantively new concepts or mechanisms. The included studies were organised into a concept matrix, summarised in Annex B, recording each study by authorship, year and conceptual or empirical contribution; this structure enabled a systematic cross-study comparison, from which four themes emerged, corresponding to the four objectives stated in Section 2.1 and developed in the sections that follow: (i) the multi-level dynamics of

landscapes, regimes and niches; (ii) system innovation and design for sustainability (DfS); (iii) participatory and foresight methods; and (iv) governance and agency in transitions. A small number of further sources are drawn upon later in the dissertation for specific methodological components rather than for the thematic synthesis, and therefore fall outside this review set: the Five Whys technique (Serrat, 2017), the causal-loop-diagram notation (Kim, 1992), and the DSR framework and process model that structure the study's methodology (Hevner et al., 2004; Vaishnavi et al., 2004).

2.2.1 Multi-level Dynamics of Landscapes, Regimes, and Niches

The literature establishes the Multi-Level Perspective (MLP) as a foundational analytical pillar for understanding sociotechnical transitions. Geels (2004)grounds this pillar by defining the socio-technical system as the interplay of material elements, the social groups that sustain them, and the rules guiding their action. Geels & Schot (2007) argue that transitions are non-linear processes driven by the alignment of developments across three functional levels: radical novelties at the niche level, established rules within regimes, and exogenous landscape pressures. They provide a typology of transition pathways, such as transformation, reconfiguration, substitution, and de-alignement and re-alignment which serves as a template for understanding how system structures shift over time depending on the timing and nature of these interactions. Complementing this, Malerba (2002) characterises sectors through the "s*ectoral system of innovation,*" in which a distinctive knowledge base, set of institutions and pattern of demand co-evolve and differ markedly across sectors — a framing that, applied to healthcare, implies its transition dynamics are shaped by conditions specific to it.

While Geels & Schot (2007) focus on the high-level structural patterns of change, Persson et al. (2025) and Tourais & Videira (2021) demonstrate how these levels can be operationalized through participatory workshops. Tourais & Videira (2021) specifically use systems mapping to help actors identify niche, regime, and landscape variables in real-time, revealing the hidden causal relations that sustain current practices. However, a tension exists regarding the appropriate scale of analysis, what appears as a radical regime shift at one level might be viewed as incremental change in inputs for a wider regime at another. By engaging with these multi-level dynamics, design-oriented approaches surface the "lock-ins" that prevent transformation and identify windows of opportunity for systemic shifts.

2.2.2 System Innovation and Design for Sustainability (DfS)

A second core pillar involves the evolution of design practices toward system innovation. Ceschin & Gaziulusoy (2016) observe a significant paradigm shift in DfS, moving from a focus on improving single products to enabling radical transformations at the sociotechnical system level. They argue that sustainability is a property of entire systems, not individual artifacts. İ. Gaziulusoy & Öztekin (2019) trace the rise of an explicitly transition-oriented strand of design, comparing its main formulations by how each defines sustainability and the designer's role, and confirming the field's shift toward system-level ambitions. Central to this transition is the concept of "*social function fulfillment*", proposed by A. I. Gaziulusoy & Brezet (2015) which suggests that design should focus on how societal functions are delivered through new configurations of artifacts, infrastructures, and policies. Applied to a specific sector, Barbero & Pallaro (2017) contend that the established linear organisation of healthcare is poorly matched to the interdependent pressures now bearing upon it, and advance systemic design as a way of engaging that complexity as a whole rather than resolving it into isolated problems.

This theme highlights a convergence among authors on the need to link micro-level innovation activity with macro-level societal transformations. (2018) extend this by framing design as a strategic practice capable of identifying foreseeable obstacles in niche-regime interactions that impede transformation. A notable gap identified in the review is the lack of practical tools to translate long-term normative visions into actionable innovation portfolios specifically capable of navigating and disrupting current regimes. Design-oriented approaches bridge this gap by facilitating "*double-flow*" scenarios that connect present conditions with future pathways that are both feasible and desirable (A. I. Gaziulusoy et al., 2013).

2.2.3 Participatory and Foresight Methods

Participatory and foresight methods constitute the methodological pillar of sociotechnical transitions, providing the means to engage diverse stakeholders in complex problem spaces. Wilkerson & Trellevik (2021) address Sustainability-Oriented Innovation (SSOI), proposing a method that combines design thinking with systems mapping to strengthen the problem-definition stage. They argue that such processes often begin from a narrow or incomplete framing of the problem, and that systems mapping helps situate innovation within its wider

societal and systemic context. Similarly, Melles et al. (2021) position human-centered design in healthcare as a systemic approach that explicitly addresses interactions across micro, meso, and macro levels of care systems. Bornes (2023) offers a method and tool that prompt designers to situate an interactive system within its wider sociotechnical context, guarding against narrow solutions and rebound effects. Rouchitsas et al. (2025) likewise combine systems, design and futures thinking in one framework, trialled in a workshop, to foster more holistic and anticipatory problem framing.

The literature reveals a contrast between expert-led and stakeholder-driven methodologies. For instance, Jovy-Klein et al. (2024) and Aliahmadi et al. (2024) utilize Delphi studies to forecast the technical components of "*Smart Hospitals,*" emphasizing expert consensus on AI and automation. In contrast, Bibri (2018) and Toni et al. (2024) draw on foresight methods to explore alternative innovation pathways and investment directions: Toni et al. (2024) construct qualitative scenarios of possible healthcare futures from expert input and secondary sources, whereas Bibri (2018) uses normative backcasting, transcending regime constraints by starting from a desirable future and working backward to identify the strategic steps required today. Applied to healthcare, Pereno & Eriksson (2020) combine collaborative foresight and participatory workshops with Nordic stakeholders to build a long-term sustainability scenario and reveal where innovation might take hold.

2.2.4 Governance and Agency in Transitions

The final pillar explores the role of agency and reflexive governance in steering transitions. Jones (2020) frames systemic design as an integrative practice that moves beyond isolated problem-solving toward locating the points where intervention can exert the greatest leverage, working through anticipation and stakeholder variety. He holds that complex systems can only be understood by combining multiple standpoints, and that lasting change depends on genuinely involving the actors whose lives the system will shape rather than designing on their behalf. Because sociotechnical systems are nested, moreover, action taken at a smaller scale can, depending on the agency of those involved, propagate to influence the larger systems that contain it (A. I. Gaziulusoy & Brezet, 2015). Extending this concern to the territorial scale, Pereno & Barbero (2020) survey the design tools available for steering socio-technical system innovation and argue that systemic design can align the many actors

and resources of a place toward more sustainable configurations, casting the designer as a coordinator of relations rather than a solver of isolated problems.

Goss et al. (2025) contribute a critical framework for framing system dynamics, specifying how future system principles must be linked to evolving organizational roles and shifts in social practices. They contrast this with system mapping, suggesting that designers must explicitly navigate power, values, and constraints to foster transition profiles. Meanwhile, Hekkert et al. (2007) focus on the functions of innovation systems, explaining how virtuous cycles of knowledge creation and search guidance build the momentum necessary for creative destruction within incumbent systems. Together, these perspectives show that governance involves managing distributed agency across semi-autonomous levels. Design-oriented approaches engage with this pillar by acting as facilitators of strategic dialogue, enabling stakeholders to negotiate shared meanings and reconfigure the rules of a new regime.

2.3.Research Gaps and Final Remarks

The literature reviewed in this chapter reveals a growing convergence between sociotechnical transition theory, systemic design and participatory approaches: the MLP offers a robust account of how transitions unfold across niche, regime and landscape levels(Geels & Schot, 2007); Design for Sustainability has extended its scope from individual products to whole sociotechnical systems (Ceschin & Gaziulusoy, 2016); and participatory methods provide the means to engage diverse actors in structuring complex problems (Tourais & Videira, 2021; Wilkerson & Trellevik, 2021). A significant gap nonetheless persists between this theoretical apparatus and the practical instruments through which it might be applied: the literature is rich in frameworks for analysing transition dynamics but poor in tools that enable stakeholders to collectively surface and frame the dynamics of the system they inhabit as a basis for innovation. Several authors make this shortfall explicit, calling for concepts and tools that connect small-scale innovation with system-level change (Ceschin & Gaziulusoy, 2016), for methods that situate innovation problems within wider societal contexts (Wilkerson & Trellevik, 2021), and for the integration of transition theory with design practice (A. I. Gaziulusoy & Brezet, 2015).

The gap is especially pronounced in the hospital sector, the setting this dissertation addresses. The future-oriented literature offers several multidimensional visions of the hospital of the future (Aliahmadi et al., 2024; Jovy-Klein et al., 2024), yet provides little concrete guidance on how such visions relate to the dynamics of the hospital as a sociotechnical system, or where in the present regime they could realistically take hold. Before pathways toward any such vision can be reasoned about, the actors who make up a hospital require a shared, systemic understanding of the dynamics that hold present conditions in place, a discovery of the system as it currently operates. It is the absence of practical, participatory instruments for this discovery that constitutes the research gap of this dissertation.

This gap motivates the RQs that guide the study: the first concerns how a participatory process can be designed to surface the dynamics of a hospital sociotechnical system, complemented by a sub-question (SQ) articulating the design knowledge such a process should yield; the second concerns whether the dynamics it surfaces can be read against the visions of the future hospital, in order to identify where aligned innovation opportunities might exist. Table 2 presents the questions and the means through which each is addressed.

Table 2. RQs and SQ guiding the dissertation, and the means through which each is addressed.

Research Question	How it is addressed
RQ1. How can a participatory process be designed to support the discovery of the dynamics of a hospital sociotechnical system, as an instrument to facilitate innovation?	Through the conceptual framework derived from the reviewed literature (Chapter 4) and its operationalisation as a workshop protocol, developed and instantiated in a real hospital context.
SQ1. What are the key components and design principles of a methodological tool to support the discovery of system dynamics?	Through the development of the artifact, whose components and design principles are articulated as reusable design knowledge (Chapter 4).
RQ2. How does the discovery produced by this participatory process contribute to identifying innovation opportunities aligned with visions of the future hospital?	Through the analysis of the outputs of the protocol's instantiation, read against the visions of the future hospital identified in the literature (Chapter 6).

2.4.Conclusion

This chapter established the theoretical foundations of the dissertation and derived from them its RQs. Following a review conducted under the PRISMA 2020 guidelines, the selected literature was synthesised into four themes, the multi-level dynamics of landscapes, regimes and niches, system innovation and DfS, participatory and foresight methods, and governance and agency in transitions, which together supply the concepts on which the study

rests. Against these foundations, a persistent gap was identified: practical, participatory instruments through which stakeholders can collectively discover the dynamics of a present regime, and locate where innovation might intervene, remain scarce, and especially so in the hospital sector. From this gap, the RQs that guide the dissertation were formulated. The following chapter presents the research design and methodology through which they are pursued.

3. Research Design and Methodology

3.1. Methodology and Research Approach

To address the research questions formulated in the preceding chapter, this dissertation adopts a Design Science Research approach to develop and evaluate a participatory method for the discovery of systemic dynamics in hospital sociotechnical systems. Rather than attempting to specify complete transition pathways, the research concentrates on supporting the discovery of present hospital dynamics in a manner that can inform such transitions. This positioning is consistent with the understanding of DSR as an approach centred on the creation and evaluation of artifacts intended to address relevant practical problems (Hevner et al., 2004), which makes it suited to a study whose questions are answered through the design of a process rather than through the analysis of an existing one.

The study follows the Design Science Research framework of (Hevner et al., 2004), presented in Figure 2, where research draws relevance from the environment, rigor from the knowledge base, and advances through iterative artifact building and evaluation. From the standpoint of relevance, the work is grounded in a practical context in which hospital stakeholders confront a combination of internal organisational difficulties and broader external pressures, while typically lacking methods to relate these two dimensions in a shared and systemic way. From the standpoint of rigor, the artifact is informed by the conceptual foundations established through the review of the state of the art, conducted following the PRISMA 2020 guidelines (Page et al., 2021), principally sociotechnical systems and the Multi-Level Perspective, the notion of social function, and participatory systems mapping. From the standpoint of design, the dissertation develops and instantiates an artifact that translates these foundations into a concrete process for collective discovery, and evaluates it through the outputs of its instantiation and the perceptions of those who took part. This framing is compatible with the iterative logic described by (Vaishnavi et al., 2004), who characterise DSR as a cyclical movement from awareness of the problem, through suggestion, development and evaluation, to conclusion, with the knowledge gained in each cycle feeding back into the next.

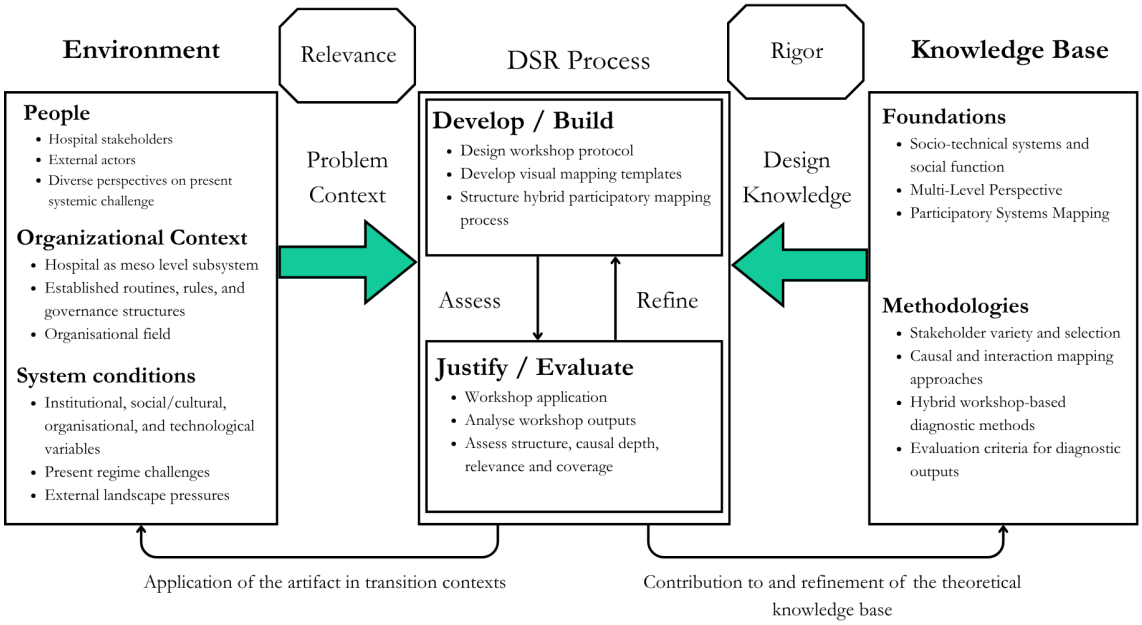


Figure 2. Design Science Research framework developed for the dissertation, adapted from Hevner et al. (2004).

3.2.The Workshop Protocol as Research Artifact

The core artifact developed in this dissertation is a participatory workshop protocol, supported by a facilitation script and a set of visual mapping templates and canvases, designed to elicit current regime constraints, external pressures and their interrelations within a hospital sociotechnical system. Its purpose is to support a structured understanding of the present system as a basis for identifying potential areas for design intervention in transition contexts. From a DSR standpoint, it is characterised primarily as a method artifact, supported by the scripts, templates and canvases that structure collaborative inquiry in a real-world setting (Hevner et al., 2004; Vaishnavi et al., 2004).

The conceptual grounding of the artifact, its components and the design principles that govern their sequencing are presented in Chapter 4, where the first sub-question is addressed. The sections that follow set out how the artifact is instantiated, analysed and evaluated.

3.3.Instantiation, Analysis and Evaluation Strategy

The instantiation of the artifact was planned as a single in-person workshop bringing together a heterogeneous group of stakeholders connected to the hospital sociotechnical system. Stakeholder variety was treated as a condition of the instantiation rather than a

convenience, since the diversity of actors engaged conditions what such a process is able to see (Jones, 2020). Selection was therefore to combine the formal identification of relevant roles and perspectives with snowball referral, pairing formal criteria with iterative methods to broaden system understanding and remain open to less visible actors (Tourais & Videira, 2021). The composition sought combined clinical, managerial, operational, economic and experiential knowledge relevant to hospital transitions, including the perspective of patients.

The analysis of the workshop outputs was planned as a post-session consolidation phase, in which the session's material would be organised, digitised and interpreted, preserving participants' contributions while translating them into a more coherent analytical representation. Such refinement of workshop outputs to improve their clarity and analytical usefulness is consistent with participatory systems mapping practice (Tourais & Videira, 2021). To support interpretation, the causal variables surfaced by participants would be examined through the four sociotechnical dimensions proposed by A. I. Gaziulusoy & Brezet (2015), which together condition the fulfilment of the social function. Throughout, a distinction would be maintained between participant-generated content and subsequent analytical consolidation, so that claims resting on each could carry their appropriate evidentiary weight.

The protocol was to be evaluated in two complementary ways, in keeping with the Design Science Research logic of directing evaluation at the artifact rather than at the participants (Hevner et al., 2004). The first source of evidence is the discovery the protocol produces: whether its outputs reach the mechanisms that sustain present regime conditions rather than a catalogue of difficulties, and whether they can be read against visions of the future hospital, the analysis through which the second RQ is addressed. The second is a post-session questionnaire of Likert-scale items grouped around three constructs, the clarity of the process, its utility for structuring the problem, and the comprehension it fostered, with an open field for suggestions. Given the ordinal scale and the small number of expected respondents, responses would be analysed descriptively, as frequencies with medians. This questionnaire forms part of the test method of the artifact: its results inform the conclusions drawn about the protocol rather than constituting a research question in their own right.

3.4.Ethical Considerations

Participation in the workshop was defined as voluntary, with informed consent to be obtained from all participants before the session (see Annex C). Consent was to cover participation in the activities, the anonymous use of the materials produced during them, and the collection of photographs for research purposes. To protect participants' privacy, all data used in the dissertation were to be treated confidentially, with identifying information removed or withheld from the analysis. The study was not submitted to a formal research ethics committee; its safeguards rested on the informed consent and anonymisation measures described here.

Because the workshop would involve stakeholders connected to healthcare settings, and would include both professional and patient perspectives, particular care was required to preserve anonymity in the presentation of results. Participants were to be represented through aggregated role categories rather than by name or institutional affiliation, and any individual profiles reported would be abstracted to the level of role and relevant expertise, without the names, ages, specific positions or institutional details that would allow individuals to be identified. This level of abstraction was adopted as a design requirement, anticipating that participants might occupy senior or otherwise distinctive positions in the Portuguese health sector that a fuller description would render recognisable.

Any optional contact details collected through the evaluation questionnaire, offered so that participants could receive the study's results, were to be used solely for that purpose and not reported. No personal data were to be placed in any part of the analysis or its supporting materials from which an individual could be identified.

3.5.Conclusion

This chapter has set out the methodological approach through which the research questions are addressed. Design Science Research was adopted because the study's contribution lies in designing and evaluating an artifact, not in analysing an existing process (Hevner et al., 2004; Vaishnavi et al., 2004). Within this framing, the participatory workshop protocol constitutes the central method artifact. It is supported by a facilitation script and visual mapping templates, and it is intended to make present regime constraints, external pressures and the relations between them collectively visible within a hospital sociotechnical system.

The chapter also described how the artifact was to be instantiated, analysed and evaluated. Instantiation took the form of a single workshop with a deliberately heterogeneous group of stakeholders, including patients. The analysis consolidated the participants' outputs and read them through the sociotechnical dimensions proposed by Gaziulusoy and Brezet (2015), while keeping participant-generated content distinct from subsequent analytical interpretation. Evaluation drew on two complementary sources of evidence: the depth of the discovery the protocol produced, and participants' perceptions of its clarity, utility and contribution to comprehension. Finally, the ethical safeguards rested on informed consent, anonymisation and role-level reporting, given the potentially identifiable positions of the participants. Chapter 4 now turns to the conceptual grounding and design principles of the artifact, addressing the first sub-question.

4. Conceptual Framework and Artifact Development

The preceding chapter set out the research design and characterised the artifact this dissertation develops. The present chapter carries out that development in two movements. It first draws the foundations synthesised in the literature review into a conceptual framework for analysing and intervening in sociotechnical systems, structured as a sequence of interconnected phases. The framework is presented in full, although the empirical work of this dissertation instantiates only its discovery component. It then operationalises that component as the workshop protocol, articulating the components and design principles through which it translates the underlying theory into a structured participatory process, and thereby **addressing the first sub-question.**

The chapter is organised as follows: (i) Section 4.1 presents the foundations of the framework and its five phases; (ii) Sections 4.2 to 4.6 develop each phase, from Defining the Social Function to Transition Pathway Design; (iii) Section 4.7 the framework and presents the workshop protocol that operationalises its discovery component; and (iv) Section 4.8 concludes

4.1.Framework Overview

The framework rests on three premises drawn from the literature. A **sociotechnical system** is bounded by the social function it delivers rather than by its technical components, so that the societal need offers a more durable basis for analysis than the artifacts serving it (A. I. Gaziulusoy & Brezet, 2015). **The desirability of a system's configuration** is a property of the whole rather than of its parts, and is therefore a moving target requiring continuous alignment between short-term action and long-term vision (Ceschin & Gaziulusoy, 2016). And **transitions** are understood through the MLP, as shifts arising from the interaction of niche, regime and landscape (Geels & Schot, 2007). On these premises, the framework structures the process into five phases, of which the first three form the discovery component instantiated in this study. Figure 3 presents the framework as a whole: the phases proceed from the bounding of the system through its social function to the design of transition pathways, connected by iterative relationships, a scoping loop through which the discovery feeds back into stakeholder identification, and refinement loops through which

visioning and pathway design are progressively sharpened. Each phase is developed in the sections that follow.

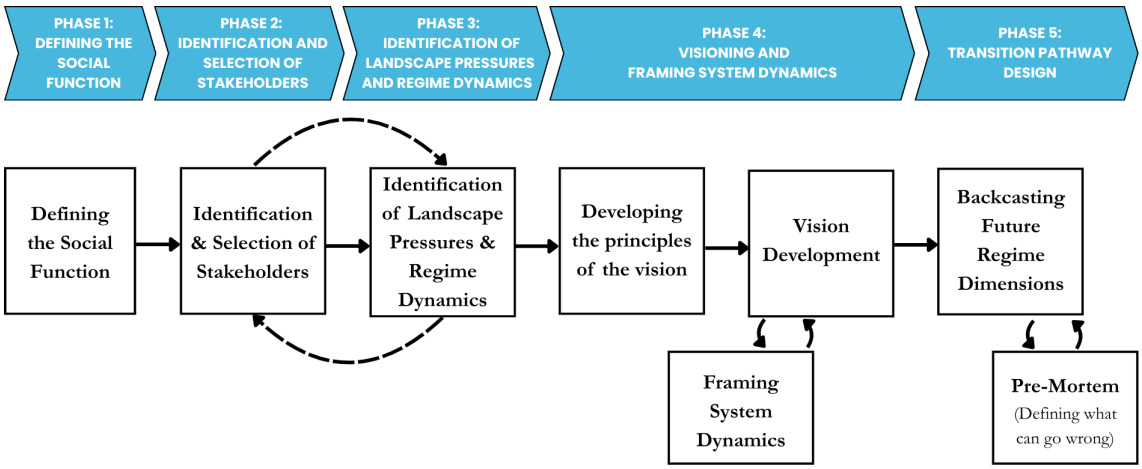


Figure 3. Conceptual framework for transition-oriented analysis and intervention in hospital sociotechnical systems with five phases connected by scoping and refinement loops (author's elaboration).

4.2.Phase 1: Defining the Social Function

The first phase bounds the system by defining the societal purpose it fulfils. Because a sociotechnical system is delimited by its social function, naming that function determines what belongs to the system, whose perspectives are relevant, and against what the present configuration is assessed. Centring the analysis on the underlying need rather than on current technologies allows more leverage points for systemic change to be identified and provides a stable reference throughout the transition, since the societal need remains comparatively constant while the configurations serving it change (A. I. Gaziulusoy et al., 2013; A. I. Gaziulusoy & Brezet, 2015). A complex institution serves several functions rather than one; the framework accommodates this through the nested character of sociotechnical systems, in which a macro-level function is fulfilled through sub-functions at the subsystem level (A. I. Gaziulusoy & Brezet, 2015). The macro-function suffices to bound the system and assemble relevant actors, while the specific sub-function on which a discovery centres is defined in this phase.

4.3.Phase 2: Identification and Selection of Stakeholders

The second phase engages the actors whose perspectives are relevant to the system, recognising that transitions are collective processes occurring at the level of organisational fields rather than within individual organisations (Geels, 2004). Its effectiveness depends on ontological variety, the inclusion of actors from the different social systems and worldviews that make up the field, since actors hold differing interests, values and cognitive positions according to where they stand within it (Jones, 2020). To combine empirical grounding with openness to less visible actors, formal selection criteria are paired with iterative methods such as snowball sampling (Tourais & Videira, 2021). Stakeholder identification is itself iterative: as the discovery proceeds, it may emerge that relevant perspectives are missing, and the framework returns to this phase so that the group and the understanding of the system co-evolve (Tourais & Videira, 2021).

4.4.Phase 3: Identification of Landscape Pressures and Regime Dynamics

The third phase analyses the stability of the present system and the external forces acting upon it. Sociotechnical regimes are stabilised by configurations of rules, routines and actors, and transitions occur when exogenous landscape pressures destabilise these structures and open windows of opportunity for alternative configurations (Geels & Schot, 2007); characterising both the pressures and the regime they act upon is the analytical core of the discovery. The external field is first surveyed through a PESTEL scan, building on the use of PEST analysis as a systems-thinking device for situating a complex system within its broader context (Rouchitsas et al., 2025), here extended to environmental and legal factors. Because these forces lie beyond the actors' control, they correspond to the landscape level of the Multi-Level Perspective (Geels & Schot, 2007) and are read as landscape pressures on the regime. To map these landscape pressures and regime dynamics, the framework employs CLDs, which make interdependencies explicit and help locate root causes and leverage points for intervention (Goss et al., 2025; Tourais & Videira, 2021). Following A. I. Gaziulusoy & Brezet (2015), the variables can be examined through four co-dependent dimensions, institutional, organisational, social or cultural, and technological, which together condition the fulfilment of the social function.

4.5.Phase 4: Visioning and Framing System Dynamics

The fourth phase connects the discovery of the present system to a desirable future through normative visions and system principles, aligning short-term innovation with long-term societal goals (A. I. Gaziulusoy et al., 2013; A. I. Gaziulusoy & Brezet, 2015). Visioning centres on reimagining how the system's core social function is fulfilled, moving designers from solving isolated problems toward envisioning future practices, routines and capabilities, while scenarios link macro-level goals to everyday experience and support stakeholder engagement (Bibri, 2018; Goss et al., 2025). Relating the vision to existing regime barriers makes visible the challenges and change mechanisms a transition would require, and this framing feeds back iteratively into the vision itself (Goss et al., 2025).

4.6.Phase 5: Transition Pathway Design

The fifth phase connects the desirable future to present action through a double-flow approach combining normative backcasting, which works backward from the desired future to the steps required to reach it, with explorative foresight, addressing both current regime lock-ins and the need for transformative change (Bibri, 2018; A. I. Gaziulusoy et al., 2013). It is at this stage that niche innovations enter the analysis: having framed the desired future, the framework identifies which niche developments are relevant to the intended transition, whose interaction with regime and landscape shapes the resulting pathway along the typology of Geels & Schot (2007), which distinguishes transformation, reconfiguration, technological substitution, and de-alignment and re-alignment, as shown in Table 3. Finally, a pre-mortem analysis addresses the optimism bias of normative planning: by assuming future failure and identifying its causes, stakeholders uncover hidden risks, strengthening the robustness of the pathway (Persson et al., 2025)

Table 3- Typology of sociotechnical transition pathways, distinguishing the main actors and types of (inter)actions characterising each pathway (adapted from Geels & Schot, 2007).

Transition pathways	Main actors	Type of (inter)actions	Keywords
1. Transformation	Regime actors and outside groups (social movements)	Outsiders voice criticism. Incumbent actors adjust regime rules (goals, guiding principles, search heuristics)	Outside pressure, institutional power struggles, negotiations, adjustment of regime rules
2. Technological substitution	Incumbent firms versus new firms	Newcomers develop novelties, which compete with regime technologies	Market competition and power struggles between old and new firms
3. Reconfiguration	Regime actors and suppliers	Regime actors adopt component-innovations, developed by new suppliers. Competition between old and new suppliers	Cumulative component changes, because of economic and functional reasons. Followed by new combinations, changing interpretations and new practices
4. De-alignment and re-alignment	New niche actors	Changes in deep structures create strong pressure on regime. Incumbents lose faith and legitimacy. Followed by emergence of multiple novelties. New entrants compete for resources, attention and legitimacy. Eventually one novelty wins, leading to restabilisation of regime	Erosion and collapse, multiple novelties, prolonged uncertainty and changing interpretations, new winner and restabilisation

4.7.Artifact Design: the Participatory Systemic Discovery (PSD) Protocol Framework

Taken together, the five phases progress from the characterisation of a sociotechnical system to the design of its transition: the process bounds the system through its social function, assembles the actors that function requires, discovers the present regime and the pressures acting upon it, and on that basis develops a normative vision and works backward to feasible pathways. The framework thus comprises a discovery component, the first three phases, concerned with how the present regime constrains the fulfilment of the social function, and a prospective one, the final two, concerned with envisioning a desirable future and reaching it. This dissertation concentrates on the discovery component, since a rigorous understanding of the present system is the precondition for credible reasoning about its transformation.

The workshop protocol operationalises this discovery component as the Participatory Systemic Discovery (PSD) framework, presented in Figure 4. The PSD protocol framework translates the first three phases into three stages: (i) pre-workshop configuration, covering stakeholder selection, engagement and template preparation; (ii) the workshop itself, from social function alignment, through the identification of internal challenges and external

pressures, to interrelation mapping and causal interpretation; and (iii) post-workshop refinement, consolidating the outputs into a structured representation of the system's dynamics.

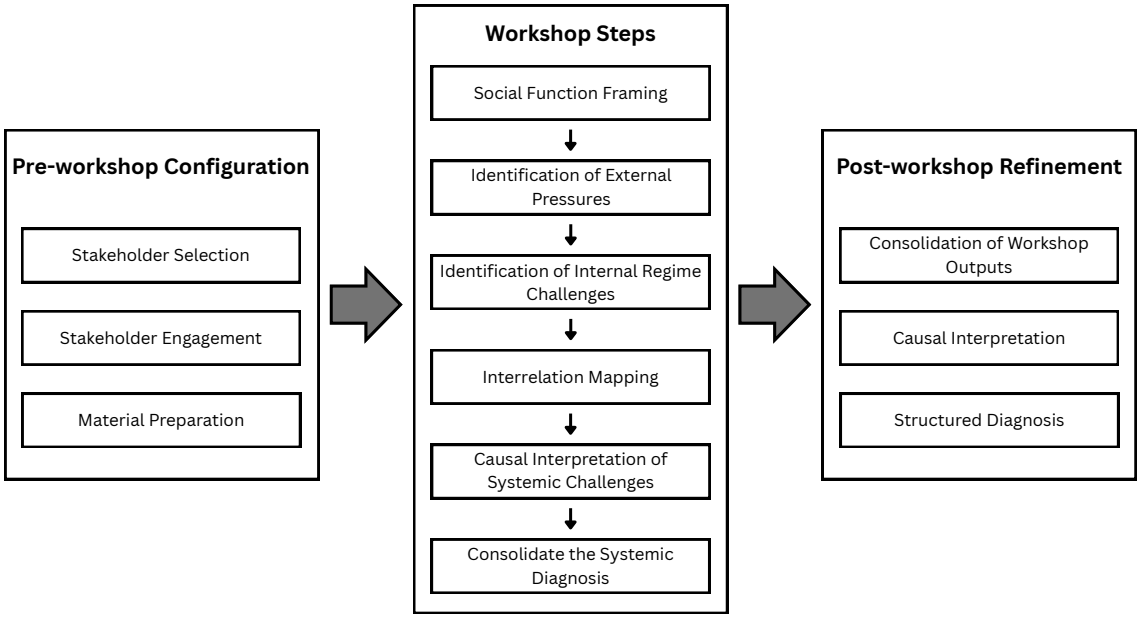


Figure 4. The Participatory Systemic Discovery (PSD) Protocol framework, the discovery component of the conceptual framework.

Conceptually, the protocol is composed of six components, each translating an element of the underlying theory into a workshop activity:

- **Social function framing:** supporting the collective definition of the hospital's core social function as the reference point for the discovery. Sociotechnical systems are bounded by the societal functions they deliver rather than by their technical components (A. I. Gaziulusoy & Brezet, 2015), and centering the analysis on that function provides a stable basis for reasoning about systemic change.
- **Stakeholder engagement:** supporting the inclusion of diverse perspectives relevant to the hospital sociotechnical system, on the premise that the diversity of actors engaged conditions what a systemic discovery is able to see (Jones, 2020).
- **Landscape pressure identification:** supporting the identification of relevant external forces acting upon the hospital, understood as the landscape level of the MLP (Geels & Schot, 2007).

- **Internal regime challenges identification:** supporting the identification and prioritisation of regime-level constraints that affect the hospital's ability to fulfil its social function.
- **Causal Interpretation:** supporting structured exploration of the causes behind the selected constraints, applying the Five Whys technique (Serrat, 2017), so that the mechanisms sustaining regime lock-ins may be surfaced rather than their symptoms alone.
- **Interaction mapping:** supporting the visualisation of causal relations linking constraints, their causes and their effects, produced collaboratively and subsequently refined analytically.

The sequencing of these components is governed by four design principles. First, societal function is established before constraints are examined, so that constraints are read as impediments to a function rather than as inefficiencies within existing arrangements. Second, the external field is characterised before the internal one, so that internal constraints are situated within forces the hospital does not control. Third, constraints are traced to their causes rather than merely catalogued, so that the discovery reaches the mechanisms that reproduce them. Fourth, participants supply the causal reasoning during the session, while the systemic integration of that reasoning is performed analytically afterwards, a division that preserves the distinction between participant-generated content and subsequent consolidation.

The protocol is supported by a set of materials that structure its application, such as: participant identification cards, a social function statement template, a PESTEL template, a causal mapping canvas, slide presentations to guide the session, and an activity guide to support facilitation, complemented by brief definitions of key concepts and examples of activities from other contexts to assist the facilitation process. Together with the facilitation script, these materials constitute the executable form of the artifact. The activity guide, which describes the process and the steps of each workshop phase, is presented in Annex D, while all materials used to support the session, together with the facilitator's time-keeping guide, are presented in Annex E.

Taken together, these components, principles and materials translate the theoretical foundations established in the literature review into an actionable, workshop-based protocol for collective discovery, thereby addressing the first sub-question.

4.8.Conclusion

This chapter developed the artifact of the dissertation in two movements. It first proposed a five-phase conceptual framework, from the bounding of the system through its social function, through the assembly of relevant actors and the discovery of the present regime, to the development of a normative vision and the design of transition pathways, distinguishing the discovery component, comprising the first three phases, from the prospective component comprising the final two. It then operationalised the discovery component as the PSD protocol framework and articulated the workshop protocol through which it is enacted: six components governed by four design principles, supported by the materials that constitute its executable form. In articulating these, the chapter answers the first sub-question, establishing the key components and design principles of a methodological tool to support the discovery of system dynamics. The following chapter describes the implementation of this artifact.

5. Implementation of the Artifact

The preceding chapter presented the artifact of this dissertation; this chapter describes its implementation. It reports how the instantiation strategy set out in Section 3.3 was executed: Section 5.1 describes the pre-workshop configuration and the stakeholder group assembled; Section 5.2 describes the workshop session as it took place, including the points at which its execution departed from the protocol as designed; and Section 5.3 describes the post-workshop consolidation and the preparation of the data for the analysis presented in the following chapter.

5.1. Pre-workshop Configuration and Stakeholder Selection

Following the selection strategy defined in Section 3.3, stakeholder identification was informed by an organisational map of a public hospital (see Annex L), used as a reference to locate the professional roles and perspectives relevant to the system. Participants were recruited through a combination of direct invitation and snowball referral. Although a broader set of stakeholders was approached, ten accepted and took part in the workshop. All ten gave informed consent before the session, in the terms set out in Section 3.4.

The final group combined professional and experiential knowledge of the hospital across a range of positions. It comprised two health economists, two professionals working in operations and research and development, two practising physicians, one experienced nurse, and three patients. The depth and diversity of expertise represented in the group is central to the value of the discovery it produced, and warrants description at the level of role and experience.

The two economists brought executive and academic expertise in health-services management, combining prior experience in the administration of public hospitals with senior teaching and scientific responsibilities in hospital administration and health economics. The two operations and research and development professionals held doctoral-level expertise, one in lean management and operational improvement in healthcare services, the other in digital transformation and human-centred design across health and other regulated sectors; both combined applied industry experience with current research affiliations. The two physicians contributed clinical perspectives from different career stages and multiple hospital contexts, one recently qualified and one with several years of

experience across several institutions. The nurse contributed more than four decades of experience, principally in the emergency setting of a public hospital. The three patients were included to represent contrasting relationships to the system: one an infrequent, health-conscious user; one with personal and family experience of chronic illness and of home care; and one a frequent user familiar with the hospital's internal dynamics. Table 4 presents the individual profiles, abstracted to the level of role and relevant expertise in accordance with Section 3.4.

Table 4 - Anonymised participant profiles;

ID	Role	Sector / affiliation type	Relevant expertise and experience
P1	Health economist	Academia and public hospital administration	Senior academic and executive experience in health-services management; prior executive role in the administration of a public hospital; teaching and scientific leadership in hospital administration and health economics
P2	Health economist	Academia and health-management education	Academic leadership in postgraduate programmes in hospital administration and health-services management
P3	Operations and R&D	Applied research and healthcare/industry	Doctoral-level expertise in lean management and operational improvement in healthcare services; applied experience in operations, supply chain and outsourcing; senior research and innovation role.
P4	Operations and R&D	Applied research and digital health	Doctoral-level expertise in digital transformation and human-centred design; experience leading digital programmes across health and other regulated sectors; current applied-research affiliation
P5	Physician	Public hospital	Recently qualified physician, early-career clinical perspective
P6	Physician	Multiple hospital contexts	Several years of clinical experience across public and private hospital settings
P7	Nurse	Public hospital (emergency)	40+ years of nursing experience, relevant experience in the emergency department; recently retired
P8	Patient	-	Infrequent, health-conscious user; relates to the hospital primarily as a means of maintaining health
P9	Patient	-	Personal history of respiratory illness and apprehension toward the health system; provides home care for a chronically ill family member.
P10	Patient	-	Frequent user owing to a chronic cardiac condition; familiar with the hospital's internal dynamics

This composition was considered adequate for the purpose of the study, since it brought together the clinical, managerial, operational, economic and experiential forms of knowledge sought by the selection strategy. The preparatory phase concluded with the assembly of the supporting materials described in Section 4.7, prepared for use in the session.

5.2.The Workshop Session

The workshop was held in person in Porto on 27 May 2026. The session lasted approximately two and a half hours and brought together the ten participants described in the previous

section. It was facilitated by three people: two master's students in Innovation and Technological Entrepreneurship, one of whom was the researcher, and a professor who also heads an innovation department.

At the beginning of the session, participants were introduced to one another and briefed on the purpose, structure and expected outputs of the session. The first activity concerned the collective definition of the hospital's social function. Through brainstorming, thematic clustering and voting, participants formulated three social function statements, which subsequently served as the basis for forming the working groups.

Participants then divided into three groups according to the social function they considered most relevant to explore. Each group used a PESTEL template to identify landscape pressures across political, economic, social, technological, environmental and legal categories, followed by a voting exercise to prioritise those judged most influential for the hospital's ability to fulfil its selected function. A brainstorming and clustering exercise on internal constraints followed, from which each group selected one constraint to develop further, weighing its urgency and potential impact together with its relation to the landscape pressures previously identified.

The final stage concerned causal exploration. For the selected constraint, each group first described a preferred future condition in which the constraint no longer existed, in order to align its understanding of the issue. Participants then applied the Five Whys technique to trace root causes, and subsequently identified the main effects associated with the constraint. Although the protocol had provided for a further step dedicated to identifying and ranking feedback loops, these activities could not be completed within the time available. The session therefore produced causal chains and interaction maps rather than fully elaborated causal loop diagrams.

Despite this constraint, the workshop generated the core empirical material required by the study: social function statements, prioritised landscape pressures, sets of internal constraints, and preliminary causal structures linking causes and effects. These outputs formed the basis for the post-workshop consolidation described in the following section.

5.3.Post-workshop Consolidation and Data Analysis

Following the session, the consolidation phase foreseen in Section 3.3 was carried out to organise, digitise and interpret the material produced during the workshop. The material collected comprised photographs of the workshop boards, the completed canvases and templates, and the sticky notes generated during the activities. These were first organised into three sets according to the social function each group had selected, in order to preserve the logic of the discussions that had taken place, and were then digitised using Canva to reconstruct the outputs in a format more suitable for comparison and interpretation.

The analysis focused on three forms of output. First, the prioritised landscape pressures identified by each group were recorded and compared to produce an overview of the external pressures considered most relevant across the workshop. Second, the internal constraints generated by each group were compiled and reviewed in relation to the social functions to which they had been connected. Third, the causal relations produced during the root-cause exercise were extracted from the workshop material and translated from Portuguese into English to support consistent coding and representation. This translation was carried out by the author, working iteratively with the assistance of a Large Language Model (LLM) to refine wording and check consistency, it was not independently verified by a second translator, a limitation noted in Section 6.5.

Because participants had produced causal chains rather than complete CLDs, the final causal representation was consolidated analytically after the session. This involved merging and refining the identified relations into a more structured diagram, while remaining as faithful as possible to the content generated by participants. Three operations in this consolidation were the author's rather than the participants': the integration of the prioritised landscape pressures into the causal structure, which participants had not carried out during the session; the identification of connections across the three groups; and the introduction of a small number of intermediate variables required to render those connections legible. The resulting diagram should therefore be understood as an analytical consolidation of workshop outputs resting on a participant-generated causal backbone, rather than as a direct transcription of a fully completed causal loop diagram. This distinction, defined as a requirement in Section 3.3, is maintained throughout the presentation and discussion of the results.

Following the analytical strategy set out in Section 3.3, the root and intermediate causes of the constraints carried forward were examined through the four sociotechnical dimensions. Only these causal variables were classified, since the framework characterises the determinants of social function fulfilment rather than its effects; downstream outcome variables, and the intermediate variables introduced during consolidation, were therefore left unclassified. Where a variable displayed characteristics of more than one dimension and the available evidence did not permit a single assignment, it was retained as ambiguous rather than resolved by assumption. This classification of causal variables into sociotechnical dimensions was performed by a single coder, the author, no second coder performed a reliability check, a limitation recorded in Section 6.5

In addition to the analysis of the workshop outputs, the feedback collected through the post-workshop questionnaire was prepared for descriptive analysis. Seven of the ten participants completed the questionnaire. Two of its original items referred to activities that were not carried out during the session, namely the identification of feedback loops and the formulation of intervention proposals; these items were excluded from the analysis, since responses to questions about activities that did not take place cannot inform an evaluation of the protocol as delivered. The instrument had been prepared against the protocol as originally designed, and this discrepancy is itself considered in the discussion of the results.

5.4.Conclusion

This chapter described the artifact's implementation: the assembly of a ten-person stakeholder group spanning clinical, managerial, operational, economic and experiential knowledge; the workshop held in Porto on 27 May 2026; and the consolidation of its outputs. The protocol was followed except that time constraints prevented the ranking of feedback loops, so the session produced causal chains and interaction maps rather than fully elaborated CLDs; these were integrated analytically afterwards, per the participant/author distinction in Section 3.3. The result was the empirical material for the next chapter: three social function statements, prioritised landscape pressures, three sets of clustered internal constraints, four root-cause chains, and a post-session questionnaire returned by seven of ten participants.

6. Results and Discussion

This chapter presents the outputs of the workshop and interprets them in relation to the RQs. Section 6.1 follows the discovery sequence the protocol produced, from the framing of the hospital's social function to the consolidated causal structure, examining at each stage both what was produced and what that stage contributed. Section 6.2 reads the resulting discovery against visions of the future hospital drawn from the literature, addressing the second RQ. Section 6.3 reports the participant evaluation of the protocol, and Section 6.4 draws from it the refinements a second iteration should incorporate. Section 6.5 reflects on the limitations of the study and the directions they open, and Section 6.6 states the research contributions and implications. Throughout, the distinction defined in Section 3.3 between participant-generated content and the author's analytical consolidation is maintained, and claims resting on each are marked accordingly; results are interpreted considering the existing literature, and both theoretical and practical significance are considered.

6.1.Discovery of the Present Hospital Regime

6.1.1 Framing the Hospital's Social Function

The workshop opened by asking participants to articulate the societal purpose of the hospital before any of its internal difficulties were examined. This ordering follows from the argument that sociotechnical systems are delimited by the social functions they deliver rather than by their constituent technologies or organisational arrangements, so that the social function operates as a stable reference point against which alternative arrangements can later be assessed (A. I. Gaziulusoy et al., 2013; A. I. Gaziulusoy & Brezet, 2015).

Participants organised the purposes they associated with the hospital into five thematic pillars: technical, social, economic, qualification of professionals, and lifecycle quality (see Annex F). These pillars were subsequently related by the author to the dimensions of environment, society and economy, as shown in Figure 5, following A. I. Gaziulusoy et al. (2013), whose scenario method has participants position their organisation within a model of these three subsystems; participants did not work within this structure during the session. In the vote that followed, six participants selected the technical cluster, three the qualification of professionals, and one the economic cluster, and three working groups were formed accordingly.

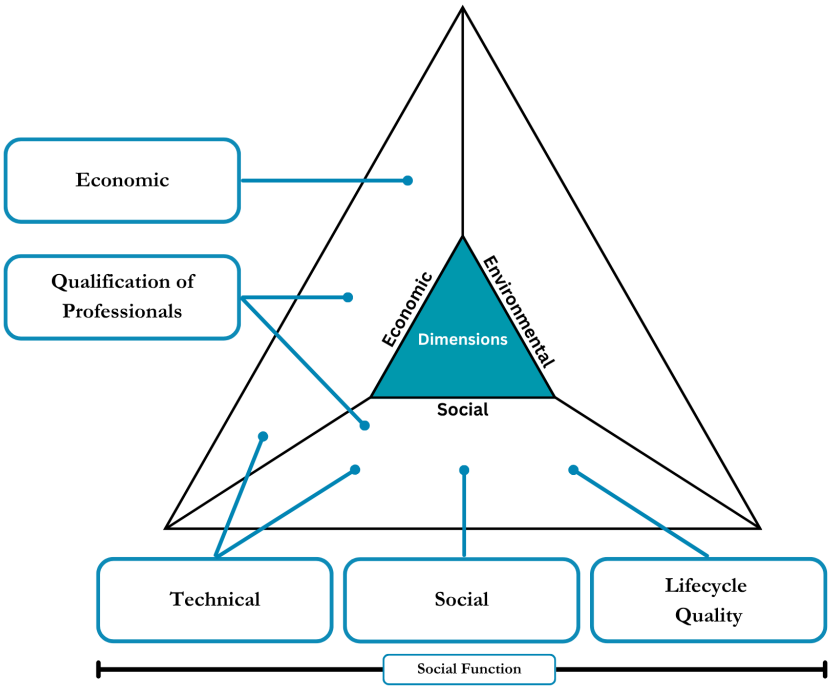


Figure 5. Thematic pillars of the hospital's social function generated by participants, related by the author to the economic, social and environmental dimensions.

Each group then produced a social function statement, presented together with the stakeholder composition of each group in Figure 6. The first framed the hospital as generating knowledge through the transformation of its own operations, contributing to scientific advancement, the education of healthcare professionals, and the improvement of clinical practice. The second, concentrating on the emergency department, framed its function as addressing the urgent needs of individuals and their surrounding context. The third framed the hospital's function as treating and preventing disease, contributing to the health of the population.

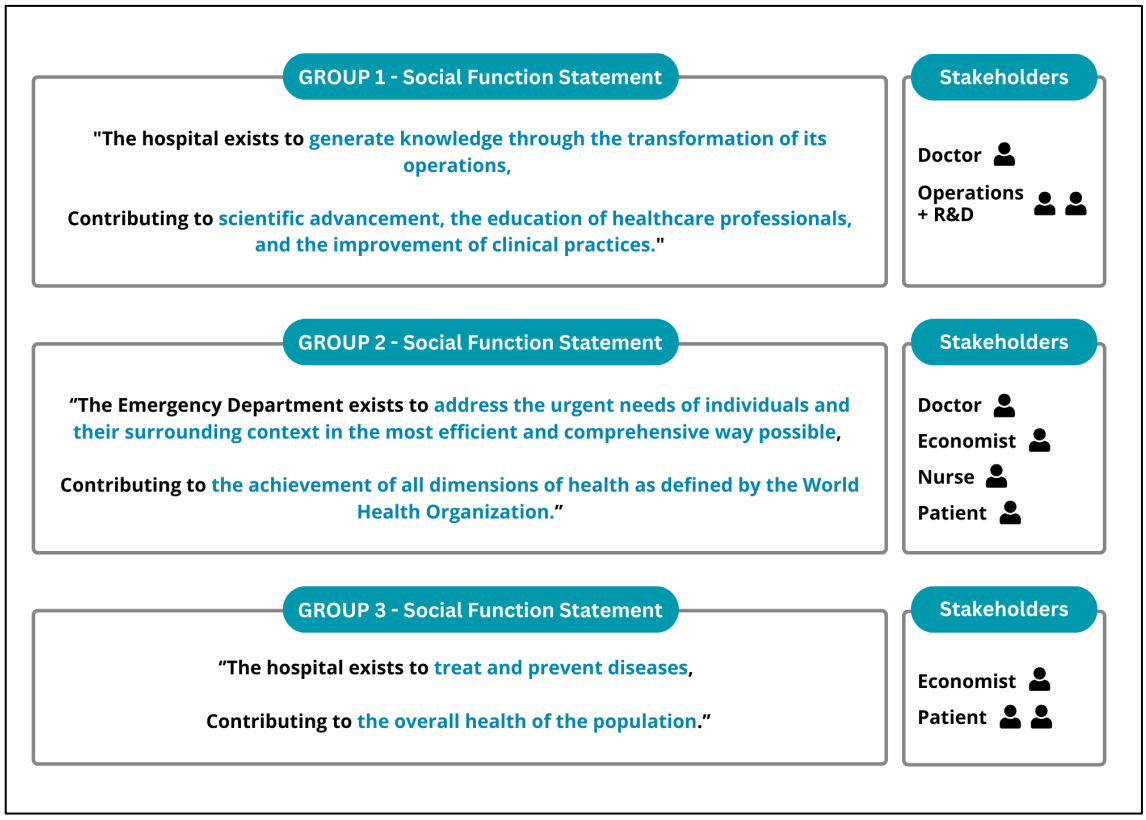


Figure 6. Social function statements formulated by the three working groups, together with the stakeholder composition of each group (participant-generated content).

The step performed its intended role. Each group articulated a coherent purpose expressed in terms of the hospital's impact on individuals and society rather than of the services or departments through which that impact is currently delivered, establishing a reference point against which internal constraints could later be evaluated as impediments to a societal function rather than as inefficiencies within existing arrangements. The plurality of the framings is a second contribution: three distinct accounts rather than one is better read as breadth than as failure to converge, since innovation processes grounded in overly narrow problem framings tend to situate them inadequately within wider systemic contexts (Wilkerson & Trellevik, 2021). As the next two sections show, each group carried its conception of the hospital's purpose into the activities that followed.

6.1.2 Landscape Pressures and the External Field

Having defined the hospital's social function, each group identified the external pressures capable of affecting its fulfilment and prioritised those judged most influential. As set out in Section 4.4, the exercise used a PESTEL scan to situate the hospital within its external field

(Rouchitsas et al., 2025), the pressures elicited are accordingly interpreted as landscape-level forces (Geels & Schot, 2007). The pressures identified were consolidated into a collective set representing the wider external context discussed during the session, presented in full in Annex G, from which each group selected those most influential for its own social function. Figure 7 presents the prioritised pressures by group, together with the PESTEL category of each.

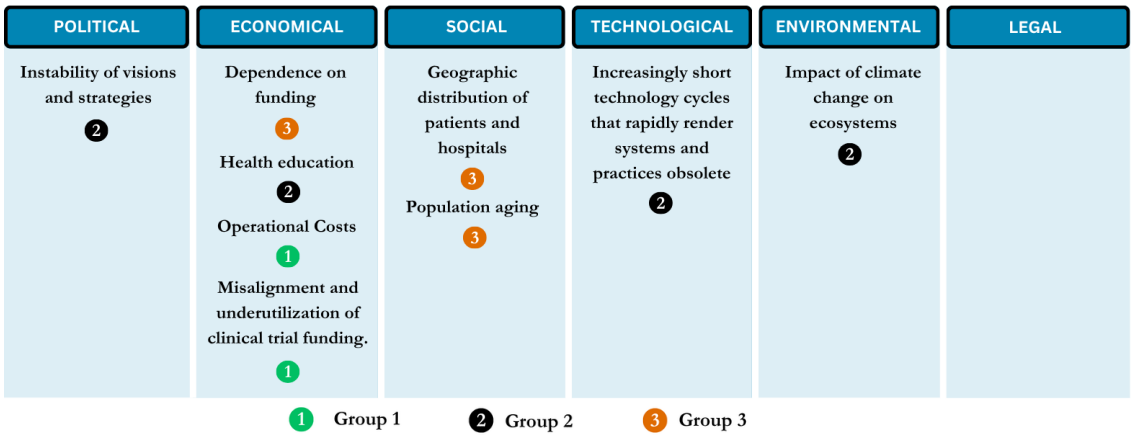


Figure 7. Landscape pressures prioritised by the working groups, organised by PESTEL category; numbered markers identify the group (1–3) that prioritised each pressure (participant-generated content).

The step contributed to the discovery by shifting where participants located the hospital's difficulties: not as internal problems belonging to the organisation alone, but as conditioned by forces the hospital cannot control. This matters for a transition-oriented discovery, since the Multi-Level Perspective describes regime destabilisation as arising partly from exogenous pressures that open space for alternative configurations (Geels & Schot, 2007).

The three groups prioritised largely different pressures, and the most plausible explanation is the social function each had adopted: a group examining the hospital as a site of knowledge generation has reason to attend to research funding, while a group examining disease prevention at population level has reason to attend to demographic and geographic determinants of demand. The social function operated as a lens that made some pressures salient and left others in the background, indicating that the framing step exerted real influence over the discovery. Group composition offers a competing explanation, since Group 1 contained the participants working in operations and research and development and prioritised precisely the pressures bearing on research funding. The interpretation

advanced here is that composition shaped which social function each group elected to develop, and that the social function then framed the identification of pressures; with three groups, this mediated reading cannot be distinguished empirically from a direct compositional effect.

6.1.3 Internal Constraints and Their Divergence

Each group then turned inward, identifying the constraints internal to the hospital that limit its capacity to fulfil the social function it had defined, clustering them into thematic groupings of their own devising, and prioritising them by urgency and impact in light of the landscape pressures previously identified. In the terms of the MLP, this material belongs to the regime: the established rules, practices and organisational forms that stabilise how a societal function is currently delivered (Geels & Schot, 2007). The full set of constraints identified by the groups, together with their clustering, is presented in Annex H. All three groups produced constraints expressed as impediments to the social function rather than as generic difficulties of hospital work, and the prioritisation narrowed the field productively: each group carried forward the constraint it judged most consequential, and Group 1 carried forward a second one. Figure 8 presents the constraints selected by each group, together with the thematic cluster in which each group placed them.

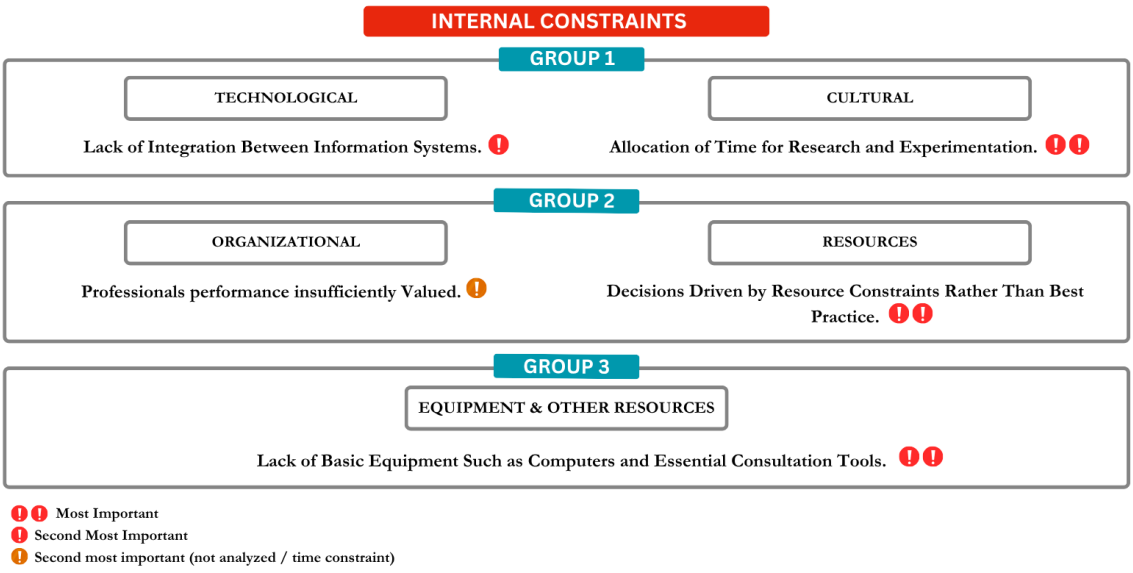


Figure 8. Internal regime constraints selected by each working group, presented within the participant-defined thematic clusters; markers denote each group's prioritisation, as per the legend (participant-generated content).

The constraints selected differ markedly. Group 1 selected the allocation of time for research and experimentation, and subsequently the lack of integration between information systems; Group 2 selected decisions driven by resource constraints rather than best practice; Group 3 selected the lack of basic equipment, such as computers and essential consultation tools. These are not variants of a common problem: they describe the regime from different angles and at different levels of abstraction. The divergence follows the lens mechanism established in the previous section, since constraints that impede one conception of the hospital's purpose are not necessarily those that impede another. Two further considerations qualify this reading. As before, group composition cannot be excluded as a contributing explanation. And participants drew their experience from different institutions rather than a single hospital, so organisational differences among those referents may also have contributed to the divergence. This heterogeneity does not undermine the object of the discovery, since sociotechnical regimes are situated at the level of organisational fields rather than of individual organisations (Geels, 2004); the discovery is accordingly best understood as bearing on the Portuguese public hospital regime as its actors perceive it, rather than on the internal configuration of any single institution.

Group 1's second constraint is instructive: clustered as a technological problem, it stands apart in character from that group's primary constraint concerning research time, indicating that the protocol does not force participants toward a single register of explanation; whether the two share underlying causes is taken up in the causal analysis that follows. Two further features bear on the discovery. The vocabulary of the clusters was determined by participants, which preserved the authenticity of their categorisations but produced headings not directly comparable across groups, so comparison was an analytical operation performed after the session. And two of the four pressures prioritised by Group 2, technology obsolescence and the impact of climate change on ecosystems, bear no traceable relation to the constraint that group selected, not an inconsistency, since the pressures served as context for judging impact rather than as criteria the constraint had to satisfy, but an indication that the discovery is correspondingly narrower than the external field the same participants described.

6.1.4 Root Causes of the Selected Constraints and Their Sociotechnical Dimensions

Each group then traced the causes of the constraint it had carried forward and identified the effects that constraint produces. Before examining the resulting chains, participants described a preferred future condition in which the constraint no longer existed, in order to align their understanding of the issue. The four causal chains produced, linking root causes, intermediate causes, the constraint, and its effects, are presented in full in Annex I; their content is summarised here, and the variables appearing in them were classified according to the sociotechnical dimensions and coding rules set out in Section 5.3.

Read across the four chains, the causes participants identified are overwhelmingly organisational and cultural. Group 1's chain concerning research time runs from an inefficient management model for research, through the institution's failure to recognise research as important, to incremental annual budgeting without segregation for research and training. The management model and the budgeting arrangements are organisational; the non-recognition of research is a matter of belief. That group's second chain, concerning the integration of information systems, originates in the same management model, which yields both decentralised budgets permitting adjustments without approval and an absence of information standardisation. These converge on a lack of system governance and thence on a proliferation of redundant, non-interoperable systems. The technological outcome is real, but its causes are organisational: the systems are fragmented because governance is fragmented.

Group 2's chain begins with the absence of a strategic vision, which permits a preference for immediate and less subjective quantification, makes clinical acts easier to monitor than health outcomes, shapes incentives around acts rather than outcomes, and issues finally in decisions taken according to available resources rather than best practice. Strategic vision is a cognitive and cultural variable; the monitoring and incentive arrangements that follow from its absence are organisational. Group 3's chain runs from the distance between senior decision-makers and the operational base, through an unclear definition of responsibility, to technicians not reporting equipment needs, and thence to the absence of any response. The reporting failure is dual in character: no structural requirement to report exists, which is organisational, and technicians do not report because they do not regard it as their responsibility and doubt that reporting would change anything, which is a matter of belief. The material does not permit

either to be identified as primary, and the variable is retained as ambiguous rather than resolved by assumption.

Two findings follow. The first is the near-absence of technology as a cause. Where technology appears, as in the fragmentation of information systems, it appears as a consequence of organisational arrangements rather than as a source of difficulty. This bears on how innovation opportunities may subsequently be conceived, since technological intervention alone would address a symptom whose cause lies elsewhere.

The second is the absence of the institutional dimension from the chains altogether. No root or intermediate cause identified by participants concerns regulation, formal rules, or the legal framework within which the hospital operates. This is striking, given the abundance of political and legal factors identified during the landscape exercise. Participants perceive institutional pressure acting upon the hospital but do not identify institutional mechanisms operating within it. Either such pressure is genuinely experienced inside the regime as organisational strain and cultural disposition rather than as discrete regulatory constraint, or its absence reflects the composition of the group, in which no regulator or policy-facing actor took part. The study cannot adjudicate between these readings. The point matters because institutions are constitutive of a sectoral system rather than incidental to it (Malerba, 2002), and a discovery that does not see them is incomplete in a specific and identifiable way.

6.1.5 The Consolidated Causal Structure and the Mechanisms of Lock-In

The causal relations produced by the three groups were consolidated into a single causal loop diagram, presented in Figure 9, through the three author-performed operations described in Section 5.3: the integration of the prioritised landscape pressures into the causal structure, the identification of connections across the three chains, and the introduction of two intermediate variables, the need for equipment and the availability of equipment, required to render those connections legible. The diagram should accordingly be read as an analytical consolidation resting on a participant-generated causal backbone, not as a transcription of what participants produced.

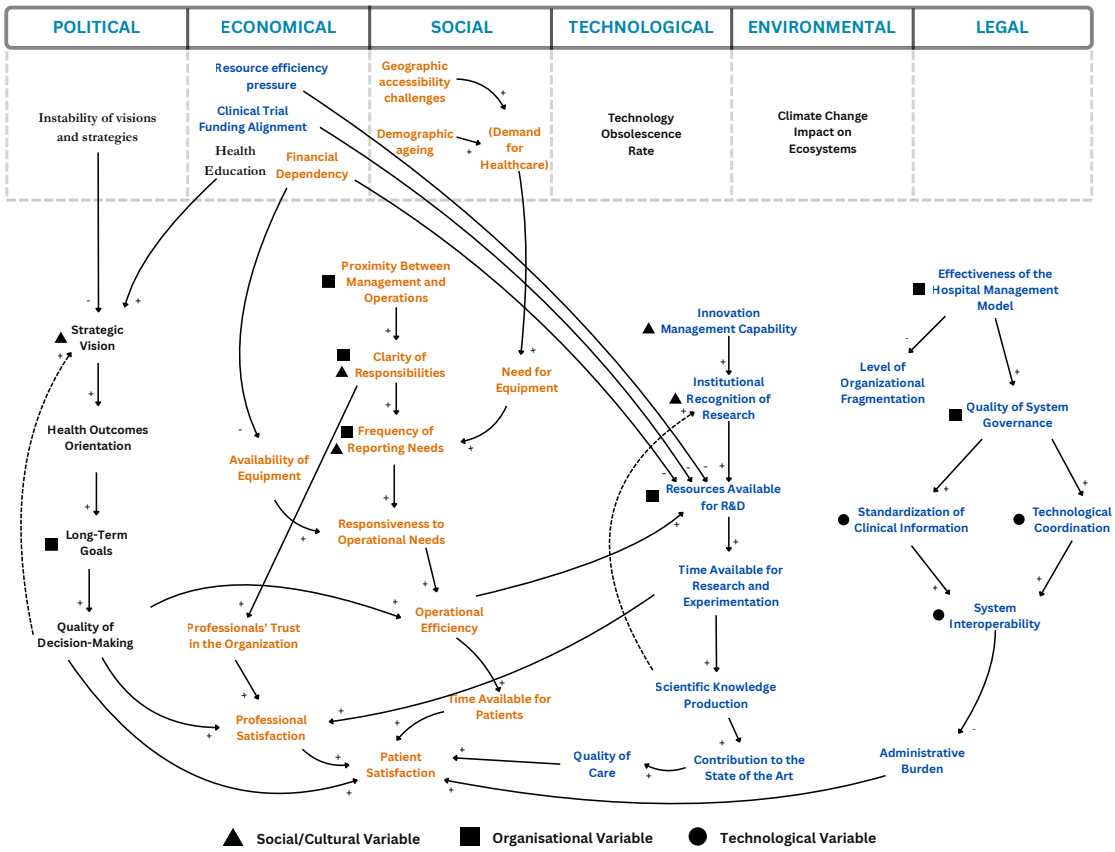


Figure 9. Consolidated CLD of the hospital regime. Coded causes are marked by their sociotechnical dimension.

One qualification attaches to the diagram itself. Because the identification and ranking of feedback loops could not be completed during the session, the material carried into consolidation consists of causal chains rather than closed loops, and the diagram represents those chains in the notation of a causal loop diagram without asserting that the loops have been identified. It maps causes, intermediate variables and effects, and the polarity of the relations between them; it does not establish the reinforcing and balancing structures through which the feedback-rich behaviour of the system would be expressed (Kim, 1992), and it does not rank leverage points. This narrows what the diagram delivers without emptying it. By making the dynamics that sustain the present regime explicit, the diagram renders them available for reframing against a desirable future configuration, which is the operation through which innovation opportunities are identified in transition-oriented design (Goss et al., 2025). The opportunities examined in Section 6.2 are derived in this way,

from the composition of the causal structure, rather than from the ranking of loops the protocol did not complete.

Integrated into the causal structure, the prioritised pressures do not act on the constraints directly; they act through the organisational and cultural variables that head each chain. Group 1's pressures, the misalignment of clinical trial funding and the pressure for resource efficiency, bear upon the resources available for research and development, the variable through which that group's constraint is produced. Group 2's pressures act on strategic vision, with the instability of political visions and strategies depressing it and health education supporting it, and strategic vision is precisely the origin of that group's chain. Group 3's pressures divide: demographic ageing and geographic accessibility raise the demand for healthcare and thereby the need for equipment, increasing the frequency with which needs must be reported, while financial dependency depresses the availability of equipment and thence the system's responsiveness to operational needs. Financial dependency also bears upon the resources available for research and development, and constitutes the single point at which the three groups' accounts converge on a shared variable.

The pattern is consistent. Each pressure enters the regime where that group's causal chain originates, and its effect is mediated by organisational and cultural variables before it reaches the constraint the participants named. This is the structural claim the analysis supports: landscape pressures do not produce regime constraints directly, but do so through the organisational arrangements and shared beliefs that constitute the regime. The same external pressure would produce different constraints in a hospital configured differently; the pressures are not, in themselves, the explanation of the hospital's difficulties. The correspondence between the pressures each group prioritised and the chain that same group independently produced was not designed for; it emerged during consolidation, and its plausibility is what lends the integration its warrant.

The regime these findings describe is held in place by structural arrangements and shared cognitive dispositions rather than by technological deficits or resource shortfalls in any simple sense. The hospital does fulfil its social function; the discovery does not suggest otherwise. But it fulfils it through arrangements that reproduce the constraints its own actors identify. Budgeting is incremental and unsegregated, so research time is not protected; governance is fragmented, so systems do not interoperate; clinical acts are easier to monitor

than health outcomes, so incentives follow acts; responsibility is unclear and reporting is believed futile, so equipment needs go unmet. Each constraint is stable because the arrangement that produces it is also the arrangement through which the institution currently functions.

This is what the MLP describes as regime stability: a configuration sustained by rules, routines and the cognitive frames of the actors embedded within it, such that transition requires these to be destabilised rather than merely supplemented (Geels & Schot, 2007). The cognitive element is conspicuous in this material. Non-recognition of research, absence of strategic vision, and beliefs about the futility of reporting would not be removed by better technology or larger budgets. They are the routines through which the regime reproduces itself, consistent with accounts of participatory systems mapping in which shared routines and rules emerge as the mechanisms stabilising incumbent practice (Tourais & Videira, 2021). The landscape pressures bear upon this configuration in a manner that suggests intensification rather than relief: demographic ageing and geographic accessibility raise demand; financial dependency and the pressure for resource efficiency constrain provision; the instability of political visions erodes the strategic vision whose absence heads one of the chains. It is a reasoned inference, though not one the present data can demonstrate, that as these pressures intensify the constraints they feed will become more rather than less consequential; establishing this would require observing the regime over time, which a single cross-sectional workshop cannot provide.

Taken together, the sequence traced across this section demonstrates what the participatory process developed in this dissertation makes possible: the arrangements and beliefs through which the hospital's difficulties are reproduced, and the paths through which external pressures enter the regime, were rendered visible and available for collective examination. It is on this discovery that the reading against visions of the future hospital, presented in the next section, rests.

6.2.Reading the Discovery Against Visions of the Future Hospital

The conceptual framework developed in Chapter 4 positions the discovery of the present regime as the first stage of a longer process, in which a normative vision is developed and pathways are traced back from it to present conditions. Those stages fall outside the scope

of this study. What follows therefore does not construct a vision, but uses one drawn from the literature as a reference against which the dynamics surfaced by the discovery can be interpreted, and it is through this reading that the second research question is addressed: how the discovery produced by the participatory process contributes to identifying innovation opportunities aligned with visions of the future hospital. The logic of bringing present conditions and a desirable future into contact so that lock-ins and opportunities become visible is that of the double-flow reasoning of (A. I. Gaziulusoy et al., 2013). The vision employed here was not produced by the participants, and its status is that of a reference point rather than of a future they endorsed.

The vision is that of the smart hospital as conceptualised by Jovy-Klein et al. (2024), whose real-time Delphi study with thirty-nine experts organises the future hospital around four dimensions: artificial intelligence, sustainability, ecosystems, and human-centeredness. These dimensions recur, with different emphasis, across the future-hospital literature. Aliahmadi et al. (2024), in developing the notion of a Hospital 6.0, arrive through an expert Delphi at a future configuration defined largely by technological components: hospital-process smartization on a digital network infrastructure, service automation, AI-generated clinical suggestions, machine-learning analytics and connected patient monitoring. Their account gives detail to the artificial-intelligence dimension in particular, while foregrounding integration within the hospital rather than the inter-institutional ecosystem Jovy-Klein et al. (2024) emphasise. Taken together, the two describe a broadly consistent kind of vision for the future hospital: multidimensional, but constituted first and foremost through technology. The reading that follows is organised around the four dimensions of Jovy-Klein et al. (2024), whose scheme is the more differentiated of the two across non-technological dimensions and therefore the more searching lens for a discovery centred on organisational and cultural dynamics; the Hospital 6.0 of Aliahmadi et al. (2024) returns at the close, where its near-wholly technological character makes it the sharper illustration of the fit between vision and regime. Two features of the Jovy-Klein et al. (2024) study limit the weight its projections can bear. It records what experts expect rather than what has been observed, and it was conducted in the German health system, whose institutional arrangements differ from the Portuguese setting examined here. Its usefulness lies in the coherence of the future configuration it describes. The authors themselves treat the realisation of that future as uncertain, attributing the difficulty of transformation to shortages of financial and human

resources, deficits in digital skills, and the absence of supporting policy. The Hospital 6.0 of Aliahmadi et al. (2024) rests on a comparable evidentiary basis, as an expert consensus rather than observed implementation, and in a different national context again, so it too is read here as a coherent statement of a possible future rather than as a forecast.

Read against this vision, the discovery relocates the design challenge. Jovy-Klein et al. (2024) hold that smart hospitals must extend beyond their own boundaries to become constituent parts of wider healthcare ecosystems, and that this depends upon interoperability, since decentralised and isolated hospital structures lack the longitudinal data on which artificial intelligence depends. The hospital regime discovered here is isolated in precisely that way, and Section 6.1.4 traced the cause: fragmented system governance, itself produced by an inefficient management model and decentralised budgeting. The ecosystem dimension does not encounter a technological deficit in this regime. It encounters an organisational one, and interoperability cannot be installed because the fragmentation of systems is a consequence of the fragmentation of governance.

Artificial intelligence inherits that obstacle, since the data it requires are the data those systems fail to consolidate, and meets a second besides. Jovy-Klein et al. (2024) observe that artificial intelligence remains at an early stage in healthcare organisations, attributing this in part to the absence of strategic guidance for its implementation in care processes. The discovery places the absence of strategic vision at the head of Group 2's causal chain, where it permits monitoring and incentives to organise themselves around clinical acts rather than health outcomes. A hospital whose decisions are governed by the resources it happens to hold, and whose incentives reward the volume of acts performed, does not possess the strategic orientation that the adoption of artificial intelligence is said to require. The obstacle is not the technology but the decision logic into which it would be introduced.

The human-centered dimension meets the discovery at a third point. Jovy-Klein et al. (2024) project intensifying staff shortages and growing workloads, and anticipate new professional roles that would sustain patient-centred care at scale. The causal structure shows a hospital already unable to protect professional time: research time is unprotected because budgeting is incremental and unsegregated, time with patients is depressed by operational inefficiency, and professional satisfaction declines accordingly. Developing new roles and capabilities presupposes a capacity for professional formation that Group 1 named as the hospital's

purpose and then named the erosion of as its constraint. The sustainability dimension is the one on which the discovery offers least purchase, since the climate pressure Group 2 prioritised bears no traceable relation to the constraint that group examined.

Three design challenges follow, and each is located at the origin of a causal chain rather than at its endpoint. The first concerns system governance, whose fragmentation produces the non-interoperability that both the ecosystem and artificial intelligence dimensions presuppose. The second concerns budgetary segregation, whose absence leaves unprotected the research and experimentation time that the hospital's own actors named as eroded — the same time in which, in Jovy-Klein et al. (2024) terms, the digital skills a smart hospital requires would have to be developed. The third concerns the metrics through which performance is monitored, whose orientation toward acts rather than outcomes withholds the strategic orientation that technological adoption requires. Each of these is an organisational or cultural challenge, and each addresses a cause rather than a symptom. This is consistent with the argument of Goss et al. (2025) that designers working toward transition must connect the principles of a future system to the values, constraints and roles of present actors, rather than treating the mapping of the present as a neutral exercise preceding the imagination of the future.

Two cautions attach to this reading. The first concerns the institutional dimension, absent from the causal chains but conspicuous in the vision. Jovy-Klein et al. (2024) name the absence of supporting policy among the principal impediments to smart hospital transformation, and treat regulatory and data privacy questions as unresolved. The discovery conducted here cannot speak to these, since participants identified no institutional mechanism operating within the regime. A portfolio of design challenges derived from this discovery would therefore be silent on precisely the dimension the vision literature identifies as decisive. The second concerns the direction of fit. The smart hospital is a technologically constituted vision, and the constraints discovered here are not technologically constituted. This is true of both variants read here, and most sharply of the Hospital 6.0 of Aliahmadi et al. (2024), whose future configuration is almost wholly technological. A vision of that kind, introduced into the regime as discovered, would meet the organisational and cultural lock-ins the discovery describes before its technological components could take effect. It does not follow that the vision is inappropriate. It follows that its adoption would require prior

reconfiguration of the arrangements through which the hospital currently operates, and that innovation introduced without such reconfiguration would encounter the lock-ins the discovery describes. This is a claim about sequence rather than about desirability.

In answer to the second RQ, then, the discovery contributes to identifying innovation opportunities in two ways. It locates the points at which innovation must intervene for the visions of the future hospital to take hold, the three design challenges above, each situated at the origin of a causal chain rather than at its endpoint, so that intervention addresses the arrangements that reproduce the constraints rather than the constraints themselves. And it establishes the order in which change must proceed: the reconfiguration of governance, budgeting and measurement precedes the technological capabilities that depend upon them. This ordering is not only an inference from the present case. A. I. Gaziulusoy & Brezet (2015), drawing on earlier innovation scholarship, describe a semi-hierarchy among the sociotechnical dimensions in which institutional and social or cultural change generally precedes and conditions organisational and technological change. The sequence this discovery surfaces is thus consistent with what their framework would anticipate, rather than resting on this single application alone. What the participatory process adds to the visions found in the literature is thus not a new future, but the map of the present against which any such future must be read.

6.3.Participant Evaluation of the Protocol

Of the twelve questionnaire items, the ten retained after the exclusions described in Section 5.3 are reported here, grouped under the three constructs the evaluation was designed to assess. Responses are reported as frequencies with medians, in accordance with the analytical strategy set out in Section 3.3; the full item-level results are presented in the following Table 5.

Table 5. Participants evaluation of the workshop protocol (n = 7).

Construct and Item	SA (n)	A (n)	N (n)	Median
Clarity				
The objectives of the workshop were clear to me	5	2	-	5
The sequence of activities made sense from beginning to end	6	1	-	5
The instructions given at each stage were easy to understand	4	3	-	5
The time allocated to the activities was adequate	3	3	1	4
Facilitation helped keep the discussion focused and productive	5	2	-	5
Utility				
The workshop helped structure the problem more clearly and broadly	5	2	-	5
The activities made it possible to identify relations between internal problems and external pressures	6	1	-	5
The workshop helped move beyond immediate symptoms to explore deeper causes	6	1	-	5
Comprehension				
The themes discussed were relevant to the reality of the hospital	6	1	-	5
Taking part in this workshop increased my understanding of hospital dynamics	5	2	-	5

Note: SA = Strongly Agree (5); A = Agree (4); N = Neutral (3); D = Disagree (2); SD = Strongly Disagree (1). No respondent selected disagree or strongly disagree on any item. Two items from the original instrument were excluded because the activities to which they referred were not carried out.

Across the ten items, responses concentrated in the two highest points of the scale: no respondent selected disagree or strongly disagree on any item, medians were the maximum on nine of the ten items, and the single neutral response in the instrument was recorded on the item asking whether the time allocated to the activities was adequate, which also produced the weakest distribution of the ten.

The uniform positivity of the responses sets the terms on which they can be read. Participants knew the facilitators, completed the questionnaire after investing two and a half hours in a session they had helped shape, and three of the ten did not respond. The pattern is consistent with a well-received protocol and equally consistent with social desirability. What follows establishes perception, not effectiveness.

On clarity, participants agreed that the objectives, sequence, instructions and facilitation were sound, with the time-adequacy item standing apart as noted. The open comments point the same way: two of the three participants who wrote anything wrote about time, one referring

to the time available for debating solutions, the other stating that more time had been needed for certain activities; the third found the introductory exercise uncomfortable. This convergence matters because it is corroborated independently. Section 5.2 records that the causal exercise ran short, that feedback loops were never identified, and that loop ranking was not attempted. Participants' ratings, participants' written comments, and the facilitators' own account of the session agree: the protocol, as designed, does not fit into two and a half hours.

On utility, participants agreed that the workshop helped them structure the problem more clearly, identify relations between internal problems and external pressures, and move beyond symptoms toward deeper causes. The second of these warrants comment. Section 6.1.5 established that participants did not themselves connect the landscape pressures to their causal chains; that integration was performed afterwards. Yet they report that the activities allowed them to identify such relations. The plausible reading is that the PESTEL exercise and the causal work together produced a felt sense of connection between the two levels without providing the means to record it, which argues for restoring the mapping step that time displaced rather than for treating the perception as mistaken.

On comprehension, participants agreed that the themes were relevant to hospital reality and that taking part increased their understanding of hospital dynamics. The first is notable given the group's composition: physicians, a nurse, economists, operations and research staff, and patients all judged the material relevant, suggesting the social function framing held a heterogeneous set of perspectives around a shared object rather than fragmenting them along professional lines.

These findings bear on the conclusions that can be drawn about the protocol. Section 6.1 established, from the outputs, that the protocol can support a discovery of the hospital regime. The evaluation establishes that those situated within the regime experienced the process as clear, coherent and productive of understanding, and that they recognised in it the movement from symptom to cause on which the discovery depends. A participatory instrument of this kind requires the engagement of actors embedded in the system it examines; had they found the process obscure or its themes remote from their working reality, the outputs analysed above would rest on a weaker foundation. The evaluation therefore supports the discovery claim from the participants' side, subject to two

qualifications: the protocol's scope exceeds the time allotted to it, and a self-report instrument completed by seven participants immediately after a session they helped shape can establish perception and nothing further.

6.4.Refinements for a Second Iteration of the Protocol

The evaluation, read together with the deviations recorded in Chapter 5, yields a set of refinements that a second iteration of the protocol should incorporate. Three follow directly from the evidence.

The first concerns duration. The convergence of participants' ratings, their written comments and the facilitators' record establishes that the protocol as designed exceeds a session of two and a half hours. A second iteration should either extend the workshop to a longer format or divide it across two sessions, so that the identification of feedback loops, their ranking, and the interrelation mapping can be completed collectively rather than displaced or performed analytically afterwards. This remedy mirrors the one proposed by Tourais & Videira (2021), whose participatory systems mapping workshop met the same difficulty and whose participants likewise requested more time per task, leading the authors to recommend extending the event to a full day or splitting it into two half-days.

The second concerns the interrelation mapping step specifically. The utility responses indicate that participants perceived relations between internal constraints and external pressures that the session gave them no means to record, and the plausibility of the author's post-session integration rested on a correspondence that emerged rather than one participants drew. Restoring this step to the session, with time protected for it, would convert a felt connection into a participant-generated one, and would allow the consolidated causal structure to rest more fully on the participants' own reasoning.

The third concerns the evaluation instrument. The questionnaire was prepared against the protocol as designed rather than as delivered, so that two of its items referred to activities that did not take place. A second iteration should align the instrument with the session actually run, or administer it in a form that adapts to deviations, so that every item can inform the evaluation. More broadly, establishing more than perception would require evaluation designs beyond immediate self-report, such as comparative application across multiple

sessions or assessment of the outputs by actors who did not participate in producing them; these directions are taken up in the following section.

A further, minor refinement concerns facilitation: one participant reported discomfort with the introductory exercise, suggesting that the opening activities should be reviewed for accessibility across participant profiles, particularly where groups combine professionals and patients.

These refinements are design knowledge in the sense of the first sub-question: they specify how the components and their enactment should evolve, without altering the protocol's underlying components or the principles that govern their sequencing, which the implementation left intact.

6.5.Limitations and Future Work

This study developed and instantiated a participatory workshop protocol for the discovery of the present hospital sociotechnical regime, and evaluated it through the outputs it produced and the perceptions of those who took part. While the results indicate that the protocol renders visible the arrangements and beliefs through which regime constraints are reproduced, several limitations should be noted, together with the directions for future research they open.

First, the participant group did not achieve the full stakeholder variety that participatory systemic design requires. Jones (2020) holds that complex systems must be understood through multiple perspectives, and that the diversity of actors engaged conditions what such a process is able to see. Regulators, policy-makers and technology suppliers were absent from the session, and this bears directly on a principal finding: no institutional cause appeared in any causal chain, despite the abundance of political and legal factors identified during the landscape exercise. Whether institutional pressure is genuinely experienced within the regime as organisational strain, or whether no one present was positioned to articulate it, cannot be determined from this study. Since institutions are constitutive of a sectoral system rather than incidental to it (Malerba, 2002), future applications should extend stakeholder selection deliberately toward policy-facing actors, which would allow this question to be resolved rather than merely posed.

Second, the session ran short of the time its design required. Feedback loops were not identified and loop ranking was not attempted, so participants produced causal chains rather than closed loops, the consolidated diagram represents those chains without establishing the reinforcing and balancing structures through which system behaviour would be expressed (Kim, 1992), and the design challenges of Section 6.2 were inferred from the composition of the causal structure rather than located through loop analysis. The refinements addressing this limitation are set out in Section 6.4; beyond them, repeating the workshop with the completed protocol would allow it to be established whether participants would draw the connections the author's consolidation proposes.

Third, the evaluation establishes perception rather than effectiveness, resting on a self-report questionnaire completed by seven of ten participants immediately after the session, with no disagreement recorded on any retained item. Beyond the instrument alignment addressed in Section 6.4, future evaluations might establish more than perception through comparative application across multiple sessions, or through assessment of the discovery outputs by actors who did not participate in producing them.

Fourth, several factors bear on the dependability of the consolidated diagram. No audio recording of the session was made, so the analysis rests on the photographed boards, canvases and notes rather than a verbatim record; the translation of the causal variables from Portuguese into English was performed by the author with LLM assistance rather than verified by a second translator; the classification of those variables into sociotechnical dimensions was undertaken by a single coder; and the consolidated diagram was not returned to participants for member-checking. A second coder, a verified translation, and member-checking of the diagram by participants together form the designated next step in validating it.

Fifth, the study is cross-sectional, resting on a single workshop. It describes the regime as its actors perceive it at one moment and advances no claim about transition pathways. The inference that intensifying landscape pressures will render the identified constraints more consequential is reasoned rather than demonstrated, and establishing it would require observing the regime over time. Nor can the study determine whether a different composition of participants would have produced different social functions, and therefore a different discovery, since the protocol elicits a framing without adjudicating between

framings. Longitudinal application, or repetition within the same institution at intervals, would allow the discovery to be tested against the regime's actual response to pressure.

Finally, only the discovery component of the conceptual framework was instantiated here. The framework developed in Chapter 4 describes a full transition-oriented process, comprising the definition of the social function, the identification and selection of stakeholders, the analysis of landscape pressures and regime dynamics, the development of a normative vision and the framing of system dynamics, and the design of transition pathways through backcasting and pre-mortem analysis. Extending the protocol to these remaining phases, and testing it empirically, is the principal task this study leaves open. Such an extension would address directly the aim that motivates the framework: not how the present regime may be discovered, but how the hospital sociotechnical system may be transitioned toward a desirable future configuration. The present study contributes an initial methodological step toward that end, and considerably more work is required before the framework as a whole can be regarded as validated.

6.6.Research Contributions and Implications

The literature reviewed in Chapter 2 established a convergence between sociotechnical transition theory, systemic design and participatory approaches, alongside a persistent gap between them: theoretical frameworks for understanding transitions are well developed, but practical instruments through which stakeholders may collectively surface and frame systemic challenges remain scarce. Ceschin & Gaziulusoy (2016) call for tools connecting local innovation activity with system-level change; Wilkerson & Trellevik (2021) call for methods situating innovation problems within wider societal contexts; A. I. Gaziulusoy & Brezet (2015) call for the integration of transition theory with design practice; and Jones (2020) calls for participatory systemic design in complex fields such as healthcare. This study responds to those calls in a specific and bounded way.

The principal contribution is methodological. The dissertation develops a participatory workshop protocol that translates concepts from sociotechnical transitions, social function fulfilment and participatory systems mapping into an executable process for collective discovery, and instantiates it in a real hospital context with stakeholders drawn from professional and experiential positions within the system. In the terms of DSR, the artifact

is a method, supported by facilitation scripts, templates and canvases (Hevner et al., 2004). Its contribution is not that it produces an account of the system, which any structured enquiry might, but that it produces an account of a particular kind: one in which the difficulties actors experience are traced to the arrangements and beliefs that reproduce them, and in which external pressures are shown to enter the regime through those same arrangements.

A second contribution is empirical. The application of the protocol yielded a discovery of a hospital regime in which the causes of the constraints participants identified are overwhelmingly organisational and cultural rather than technological or material. Technology appeared in the causal chains as a consequence of fragmented governance rather than as a source of difficulty, and no institutional cause appeared at all, despite the prominence of political and legal pressures in the external field participants described. Whether the latter reflects the regime or the composition of the group cannot be settled here, but the finding is itself informative: it indicates that actors embedded in the hospital perceive institutional pressure without identifying institutional mechanisms internal to their own practice.

A third contribution follows from reading that discovery against the vision of the smart hospital. The design challenges the discovery surfaces are located at the origins of the causal chains rather than at their endpoints, and they are organisational and cultural in character. This carries a practical implication for hospital managers and innovation teams: technological adoption introduced into the regime as discovered would encounter the arrangements that produce the constraints it is meant to relieve, and would therefore address symptoms whose causes lie elsewhere. The sequence matters, and reconfiguration of governance, budgeting and measurement precedes the technological capabilities that depend upon them.

Finally, the study carries an implication for the design of participatory processes of this kind. The framing of the hospital's social function, performed before any difficulty was examined, determined what participants subsequently regarded as significant: the pressures they prioritised and the constraints they selected were framed by the purpose they had declared. Three groups working from three conceptions of the hospital produced three accounts that diverged accordingly. For practitioners designing such processes, this indicates that the

framing step is not preparatory but constitutive, and that the plurality it surfaces should be treated as an output of the method rather than as a failure to converge.

7. Conclusion

This dissertation set out to address a gap between the theory available for understanding sociotechnical transitions and the practical tools through which stakeholders might collectively discover the dynamics of a present regime and locate where innovation could take hold, a gap that is especially pronounced in the hospital sector. In response, it developed a participatory workshop protocol for the discovery of the current hospital sociotechnical regime, grounded in a five-phase conceptual framework derived from the literature, and applied it in a workshop that brought together a diverse group of stakeholders connected to the hospital sector, evaluating it through the outputs it produced and the views of those who took part.

The first research question asked how a participatory process can be designed to support the discovery of the dynamics of a hospital sociotechnical system, as an instrument to facilitate innovation. The study answers it with the artifact itself: a workshop protocol that operationalises the discovery component of the conceptual framework as the Participatory Systemic Discovery framework, grounding the analysis in the social function the system delivers, assembling the stakeholder variety that function requires, situating internal constraints within the external pressures acting upon the system, and tracing those constraints to the mechanisms that reproduce them. Its application demonstrated what such a design makes possible: the arrangements and beliefs through which the hospital's difficulties are sustained, and the paths through which external pressures enter the regime, were made visible and available for collective examination. In answer to the sub-question, this design rests on six components, from the framing of the social function to interaction mapping, sequenced by four principles, and the single instantiation indicated that each contributed as intended, with the evaluation returning the refinements a second iteration should incorporate.

The second RQ asked how the discovery produced by this participatory process contributes to identifying innovation opportunities aligned with visions of the future hospital. The discovery contributes by locating where innovation must intervene for such visions to take hold, three design challenges concerning system governance, budgetary segregation and performance measurement, each situated at the origin of a causal chain rather than at its endpoint, and by establishing the order in which change must proceed, with the

reconfiguration of governance, budgeting and measurement preceding the technological capabilities that depend upon them. What the process adds to the visions found in the literature is not a new future, but the map of the present against which any such future must be read.

Taken together, these answers show that a rigorous, shared discovery of the dynamics of the present hospital, of the kind the protocol produces, is both achievable and a necessary foundation for sound reasoning about how the system might change. The present study contributes an initial methodological step toward the transition of hospital sociotechnical systems, and the extension of the protocol to the prospective phases of the framework is the principal task it leaves open.

Contribution to the United Nations Sustainable Development Goals

The 2030 Agenda for Sustainable Development (United Nations, 2015) sets out seventeen Sustainable Development Goals (SDGs) that together describe a shared agenda for economic, social and environmental progress. This dissertation contributes most directly to SDG 3, Good Health and Well-being, which aims to ensure healthy lives and promote well-being for all at all ages (United Nations, 2026). It is in this setting that the framework was operationalised, and although the same approach could in principle be applied to other systems and other goals, its contribution here is grounded in the health sector, where it was developed and tested.

The dissertation takes as its object the hospital's ability to fulfil its social function, treating and preventing disease and contributing to the health of the population, and develops a way for the actors who make up a hospital to diagnose, together, what stands in the way of that function. By testing this framework in a real hospital, the work provides an instrument that can improve the hospital's ability to deliver quality health to its patients, since a shared and rigorous understanding of what constrains the present system is the necessary first step toward improving it. This speaks to the concern of SDG 3 to deliver good health under growing pressure, in line with targets on access to quality essential health services, on reducing the burden of chronic disease, and on the health workforce.

Taken together, the dissertation supports these goals by offering a practical way to diagnose a complex health system and to spot, within it, the opportunities for innovation through which its transition toward a more sustainable and effective delivery of care might begin.

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9. Annex A: Inclusion & exclusion criteria

Table A.1- Inclusion & exclusion criteria and screening-log summary

Code	**InclusionCriteria**
I1	Relevant to healthcare systems or directly applicable to healthcare system transformation.
I2	Explicit future-oriented, systemic, or transition-oriented perspective.
I3	Addresses healthcare as a complex socio-technical or systemic phenomenon.
I4	Includes a substantive design or systems method/framework (e.g., systemic design, systems mapping, foresight, backcasting).
I5	Provides sufficient methodological, conceptual, or empirical detail for data extraction.
Code	**ExclusionCriteria**
E1	Lacks a relevant healthcare system transformation or future-oriented systemic focus.
E2	Design or systems approaches are only mentioned superficially.
E3	Focuses narrowly on a specific technology or intervention without broader systems or transition perspective.
E4	Insufficient methodological, conceptual, or empirical detail for synthesis.

Annex B: Concept matrix

Table B.1 - Concept matrix of the 24 included studies

References	Concepts Covered / Contributions of the Paper	Future Research
(Bornes, 2023)	The paper proposes a methodology for sustainable interaction design that makes designers consider how an interactive system is embedded in and affects a wider sociotechnical system, to avoid narrow solutions and rebound effects. It adapts systemic design methods to interaction design and centers on building a "quali-quantitative" causal-loop–based model that mixes qualitative and quantitative variables to represent system dynamics and feedbacks. This model is co-created with stakeholders as a hand-made, participatory map to support discussion and scenario comparison rather than prediction, offering practical guidance on defining boundaries, choosing variables, and involving actors at different stages	- Future research should develop systemic sustainability methods for interactive systems beyond artefact efficiency. - Further work should adapt systemic design principles to HCI and interaction design. - More case-based studies are needed to refine and validate the modelling approach. - Research should assess the long-term socio-technical effects of design interventions. - Qualitative and quantitative modelling should be further integrated as a decision-support tool in sustainable HCI.

(Ceschin & Gaziulusoy, 2016)	The paper shows how DfS has shifted from improving single products to enabling radical socio-technical transitions, arguing that sustainability is a property of whole systems, not individual artefacts. It proposes a framework of four innovation levels (product, product–service system, spatio-social, socio-technical system) and positions "design for system innovations and transitions" as a strategic, vision-led design activity that uses transition theories to transform how societal needs are met over time. This directly supports how different design approaches (products, PSS, social innovation) can be combined to link local innovations to regime-and landscape-level change.	- Future research should develop concepts and tools that connect small-scale innovations with broader system-level change. - Further work should examine how other DfS approaches can contribute to system innovation and transition processes
(A. I. Gaziulusoy et al., 2013)	The paper introduces a systemic "double-flow" scenario method that combines forward (explorative) and backward (backcasting) scenarios to link product development decisions with long-term socio-technical sustainability transitions. It treats sustainability as a system property and uses participatory workshops where stakeholders map environment-society–economy relations, identify sustainability risks and social functions, then co-create sustainable future visions and scenario maps that reveal innovation pathways, lock-ins, and leverage points over short, medium, and long-term horizons. This helps companies align product, service, and organizational innovations with broader transition goals.	- Future research should refine the balance between the method's practical efficiency and the depth of insight it generates. - Further work should test the method across a broader range of sectors and contexts. - The scenario method should be improved to better connect company planning with long-term sustainability objectives. - Research should further develop the double-flow logic to connect present conditions with future pathways that are both feasible and socially acceptable

(Geels & Schot, 2007)	This paper refines the MLP and proposes four typical sociotechnical transition pathways—transformation, reconfiguration, technological substitution, and de-alignment/re-alignment—each defined by how landscape pressures, regime dynamics, and niche innovations interact over time. It clarifies the roles of niches (micro-level radical innovations), regimes (meso-level structures of rules, actors, infrastructures), and landscapes (macro-level trends and shocks) and shows that transitions are not always niche-driven but can also emerge from regime adjustments or landscape-driven destabilization. It provides a clear vocabulary and structure to map transitions by distinguishing regime, niche, and landscape variables and by using the four pathways (and possible sequences between them) as templates to interpret different transition logics and associated opportunities.	- Future research should further refine the typology of transition pathways to deepen understanding of sociotechnical change. - More work is needed on how landscape dynamics shape transition processes and system innovation. - Research should examine how incremental, radical, and system innovations interact in regime transformation. - Further studies should clarify the role of agency and causal mechanisms in transition processes.

(Wilkerson & Trellevik, 2021)	This paper proposes "systems sustainability-oriented innovation" (SSOI), a process that combines design thinking with systems mapping to produce richer, more systemic problem definitions for sustainability-oriented innovation. It argues that user-centred design thinking alone tends to define problems too narrowly, and shows how inserting a short, participatory systems-mapping step (CLDs around a key variable) early in the double-diamond enlarges boundaries, surfaces feedback loops, and makes multidimensional (environmental, social, economic) dynamics explicit. Through business and educational cases, it demonstrates that this combined approach helps heterogeneous stakeholders co-create a shared systems view, identify leverage points, and connect individual user perspectives with wider societal and temporal scales, directly supporting the goal of mapping complex problem spaces and revealing innovation opportunities before ideation.	- Future research should expand design thinking beyond user-centred perspectives to engage broader socio-material systems. - Further work should examine how systems mapping and design thinking can be combined to strengthen problem definition in SOI. - There is a need for methods that situate innovation problems within wider societal contexts. - Research should assess the value of systems mapping as a communication tool across multidisciplinary organisational settings.
(Malerba, 2002)	This paper defines a "sectoral system of innovation and production" as the set of products plus all the heterogeneous agents (firms, users, suppliers, regulators, universities, financiers, etc.) and their market and non-market interactions, structured by a specific knowledge base, technologies, inputs, demand, and institutions. It proposes a framework where sectoral systems are analyzed through key building blocks—knowledge and learning regimes, technologies and demand (and their complementarities), interaction networks, institutions, and processes of variety creation and selection—that co-evolve over time and differ strongly between sectors. It offers a way to conceptualize "the hospital/healthcare sector" as a	- Future research should examine how sectoral institutions emerge through both intentional design and unintended interaction effects. - More detailed case-based studies are needed to explain the evolution of sectoral systems. - Research should investigate how sectoral demand conditions shape firms' competencies, behaviour, and organization.

	sectoral system, helping mapping relevant actors, knowledge bases, demand structures, institutional rules, and innovation patterns (e.g., Schumpeter Mark I vs II) that shape regime stability, lock-ins, and the space for system-level innovation opportunities.	- Further work should develop taxonomies of sectoral systems based on their elements, structures, and dynamics. - The appropriate level of analysis for agents, functions, products, and their interrelations should be further clarified
(Melles et al., 2021)	The paper defines human-centered design (HCD) in healthcare as a systemic approach built on three key characteristics: deeply understanding people and their needs, engaging stakeholders early and throughout, and explicitly addressing interactions across micro, meso, and macro levels of sociotechnical care systems. It structures HCD via the Double Diamond, stressing thorough exploration of the problem space (e.g., ethnography, patient journeys, stakeholder mapping) before solution development and using tools like co-creation and interaction prototyping to ensure new products, services, or procedures fit real care contexts. For the topic, it underlines that the framework should be coupled with HCD practices that surface latent needs and stakeholder perspectives and that scenario work must consider how future hospital configurations affect patients, teams, and organizations, not just individual touchpoints or technologies.	- Future research should strengthen the evidence base for HCD within clinical contexts. - Further work should broaden accepted methodological standards and evidence criteria in healthcare innovation. - Research should address the practical challenges of implementing HCD, especially stakeholder engagement and communication.

(Persson et al., 2025)	This paper proposes a practical workshop framework that integrates foresight (normative scenarios, backcasting, pre-mortems) with the multi-level perspective on sustainability transitions to help diverse actors explore lock-ins and potential transition pathways in socio-technical systems. Using four 2045 sustainable food scenarios and regime dimensions (science, markets, industry, policy, technology, culture), participants collaboratively mapped events needed to reach each scenario and barriers that could derail it, then post-analysis coded these against Geels' transition pathway typology (transformation, reconfiguration, de-/re-alignment, technological substitution) to characterize plausible pathways and reveal where multiple pathways and risks may co-exist.	- Future research should test the integration of foresight and transitions approaches in sectors beyond food systems. - More work is needed to understand how diverse actors shape collaborative transformation processes. - Research should develop practical tools that support stakeholder dialogue within integrated MLP-scenario processes. - Further studies should examine how incremental technological shifts contribute to sustainability transitions. - Research should investigate the barriers and enabling conditions that shape progress toward normative futures.
(Goss et al., 2025)	The paper shows how designers can frame complex system dynamics so that near-term design interventions align with long-term transition visions, based on research-through-design work on reducing food waste in the Dutch food system. Starting from a predefined future system vision, it develops and tests design activities and artifacts that explicitly link desired future dynamics to current actors' values, constraints, and power, instead of neutrally mapping the present. The key contribution is a framing framework that jointly specifies (1) future-oriented system principles, (2) evolving organizational roles, and (3) shifts in	- Future research should develop more effective ways of framing system dynamics to identify innovations that support sustainability transitions. - Further work should clarify the organizational roles stakeholders can play in transition processes. - Research should examine how changes in behaviour and capabilities can inform

	people's behaviours and capabilities (social practices), and operationalizes this via tools like actor readiness profiles and multi-level value templates so designers can navigate micro/meso/macro scales and now–near–far futures in a coherent way.	transition-oriented design decisions. - Long-term future visions should be further developed to better align short-term innovation with systemic change.
(A. I. Gaziulusoy & Brezet, 2015)	The paper provides a framework for linking firm-level design and innovation to long-term sustainability transitions by combining sustainability science, transition theory, and design for sustainability. It frames sustainability as a dynamic system property and connects four design levels (product improvement, product redesign, function innovation, system innovation) to different time horizons so companies can run short-term projects that support long-term regime change. For the topic, the main contribution is the idea of "social function fulfilment": design around how the function is delivered, through new configurations of artefacts, infrastructures, policies, norms, and user capabilities, so concrete design briefs and scenarios explicitly contribute to transitioning the healthcare provision system as a socio-technical system.	- Future research should develop theories and practical approaches that connect micro- and meso-level DfS practices with wider systemic change. - More work is needed to integrate sustainability science, transition theory, and design perspectives into a prescriptive framework for companies. - Research should examine how companies can act as proactive agents in system innovation and transition processes. - Further studies should explore how firms manage tensions between short-term business demands and long-term transition requirements. - Integrating insights from sustainability science and system innovation research could strengthen understanding

		of how design supports broader systemic transformation.
(Jovy-Klein et al., 2024)	The article uses a real-time Delphi with 39 experts to forecast how "smart hospitals" will develop from 2027 to 2042 across four dimensions: artificial intelligence, sustainability, ecosystems, and human-centeredness. It projects widespread AI use in core processes (including multimodal data and systems medicine), hospitals acting as ecosystem data hubs, home treatment becoming standard, and growing attention to energy-efficient, climate-aware operations, alongside severe staff shortages, changing roles, and new digitally skilled professions that must keep care human-centered. This paper is important for healthcare transitions, it contributes a structured, time-phased vision of the future healthcare provision system with concrete projections and dimensions that can be treated as a target regime when building scenarios, specifying social function fulfilment, and designing interventions that align with this smart-hospital trajectory.	- Future research should examine specific smart hospital technologies, such as nanotechnology and AI-enabled robotics, in more detail. - More work is needed on ethical and regulatory issues, especially data privacy, bias prevention, and compliance in AI use. - Comparative studies across countries such as the United States and Israel could clarify different pathways of smart hospital development. - Research should also explore how different types of healthcare facilities evolve into smart hospitals with varying levels of sophistication and local adaptation.

(Pereno & Eriksson, 2020)	This paper contributes by showing that sustainable healthcare transitions are shaped by interactions among multiple stakeholders rather than by isolated organizations. Their study is especially relevant because it identifies key actors, relational dynamics, and transition strategies, while also demonstrating the value of participatory workshops and systemic design for mapping complex healthcare systems and revealing innovation opportunities.	- Future research should extend to the European sector and compare sustainable healthcare across different countries and health systems to inform long-term policy. - More work is needed on knowledge-building strategies and tools for the wider international dissemination of sustainable healthcare issues. - Research should further explore Nordic and European scenarios to support cross-border markets, collaboration, and governance in sustainable healthcare. - Further studies should examine how sustainable healthcare strategies can scale across different political, institutional, and socio-economic contexts.

(Tourais & Videira, 2021)	This paper contributes by offering a participatory systems mapping framework that can be transferred to complex healthcare contexts to identify sociotechnical dynamics, barriers, and opportunities for innovation. The authors show that iterative stakeholder engagement through interviews, workshops, and co-created causal loop diagrams helps build a shared understanding of problems, align different perspectives, and reveal feedback loops that can inform transition pathways and systemic innovation strategies.	- Future research could build on the systemic overview developed in the study to inform the design of transition experiments in specific organizational or sectoral contexts. - More attention is needed to emerging risks, including public health issues that became especially visible during the Covid-19 pandemic but were not deeply explored in the workshops. - Further studies should expand CLDs with additional variables and causal links to improve understanding of sustainability transition dynamics. - Research should investigate niche-regime and landscape-regime interactions more deeply to uncover underexplored causal relations and feedback loops.

(Pereno & Barbero, 2020)	The paper proposes a systemic design approach for the sustainable transition of regional and urban systems, arguing for an integrated vision that combines social, environmental, cultural, political, and economic dimensions to identify innovation opportunities in complex environments. It shows how design tools that support learning processes, multi-stakeholder networks, foresight visions, and green niche innovations, together with the active involvement of diverse stakeholders, can inform participatory systemic transition strategies and frameworks integrating backcasting and system mapping for identifying innovation opportunities in different contexts.	- Future research should further develop integrated approaches that connect social, environmental, cultural, political, and economic dimensions in territorial sustainability transitions. - More work is needed on design tools that support learning processes and multi-stakeholder network building in socio-technical system innovation. - Further studies could examine how foresight-oriented design tools help stakeholders envision desirable futures and support territorial transition processes. - Research could also explore the complementarities and synergies among different systemic design tools for supporting sustainable urban and regional transformation

(Bibri, 2018)	This paper develops a framework for strategically planning intelligent, sustainable systems by integrating urban development, sustainability principles, and technological innovation, conceptualizing them as complex adaptive systems that parallel the hospital as a sociotechnical system. The author positions backcasting as a central normative method for addressing wicked problems, enabling researchers to transcend regime constraints, align advanced digital infrastructures with societal goals, and ensure that immediate design decisions remain oriented toward the long-term transformation of healthcare environments.	- Further work should adapt backcasting frameworks to the specific topic, purpose, scope, and complexity of each research project. - Future applications should account for practical constraints such as time, resources, stakeholder dependencies, and power relations. - Research should continue exploring different backcasting approaches across urban sustainability domains rather than assuming a single universal framework. - Backcasting studies may benefit from combining backcasting with complementary futures methods, such as forecasting, depending on the context.

(Hekkert et al., 2007)	The paper argues that innovation systems drive technological change and that static, structure-focused analyses fail to capture their dynamics. It proposes seven "functions of innovation systems" — entrepreneurial activities, knowledge development, knowledge diffusion, guidance of the search, market formation, resource mobilisation, and legitimacy creation — that describe the processes a system must fulfil to develop and diffuse a technology, and shows how these functions reinforce one another in virtuous or vicious cycles that build or erode momentum for change. For the review, it offers a dynamic, function-based lens for diagnosing why sociotechnical transitions accelerate or stall.	- Further theoretical and empirical study of innovation-system dynamics at both macro and micro levels. - Policy-oriented research on systemic instruments that strengthen weak functions or remove blocking mechanisms. - Empirical work on how momentum and virtuous cycles build, to learn how to steer the direction of transitions.
(Rouchitsas et al., 2025)	The paper contribution lies in the development and application of a transdisciplinary framework that integrates systems thinking, design thinking, and futuristic thinking. This framework is specifically designed to address the complex challenges of designing sustainable sociotechnical systems and offers novel approaches to understanding and solving these problems.	- Future research should examine how transdisciplinary frameworks can be applied in real-world settings with practitioners and other stakeholders. - Longitudinal studies are needed to understand how participation in this kind of framework affects research and design practices over time. - Further research should explore how such approaches can be incorporated into education and curriculum development. - More work is needed on metrics that assess the broader and long-term sustainability impacts of complex systems

(Aliahmadi et al., 2024)	This paper contributes by proposing Hospital 6.0 as a conceptual model that connects hospital transformation with Industry 6.0 and frames future healthcare as increasingly shaped by digitalization, automation, AI, machine learning, IoT, and smart post-discharge support. Its main contribution is the identification of eight core Hospital 6.0 components and their organization into a single framework, offering a structured view of how next-generation hospitals are imagined. The paper also adds methodological value by validating these components through a three-round Delphi process, in which all eight elements reached expert consensus and approval. The study is useful because it presents a technology-led vision of healthcare transformation focused on efficiency, monitoring, personalization, and clinical decision support, even though it does not provide a deeper sociotechnical transition analysis.	- Future research may explore more alternatives for controlling sick people in a continual manner. - Future research should address the difficulty of predicting future developments in healthcare. - Future research may further examine how continual control can help predict other possible problems in the patient's future. - Future research may explore how personalization and customization can be better applied in hospital care.
(Toni et al., 2024)	This paper contributes by showing the likely innovation pathways through which future healthcare transformation may happen, rather than only describing a vision of future hospitals. It identifies emerging business models, digital infrastructures, and investment directions that help explain how patient-centered and more connected	- Extend the analysis to other countries to compare healthcare innovation trajectories and emerging business models across different national contexts.

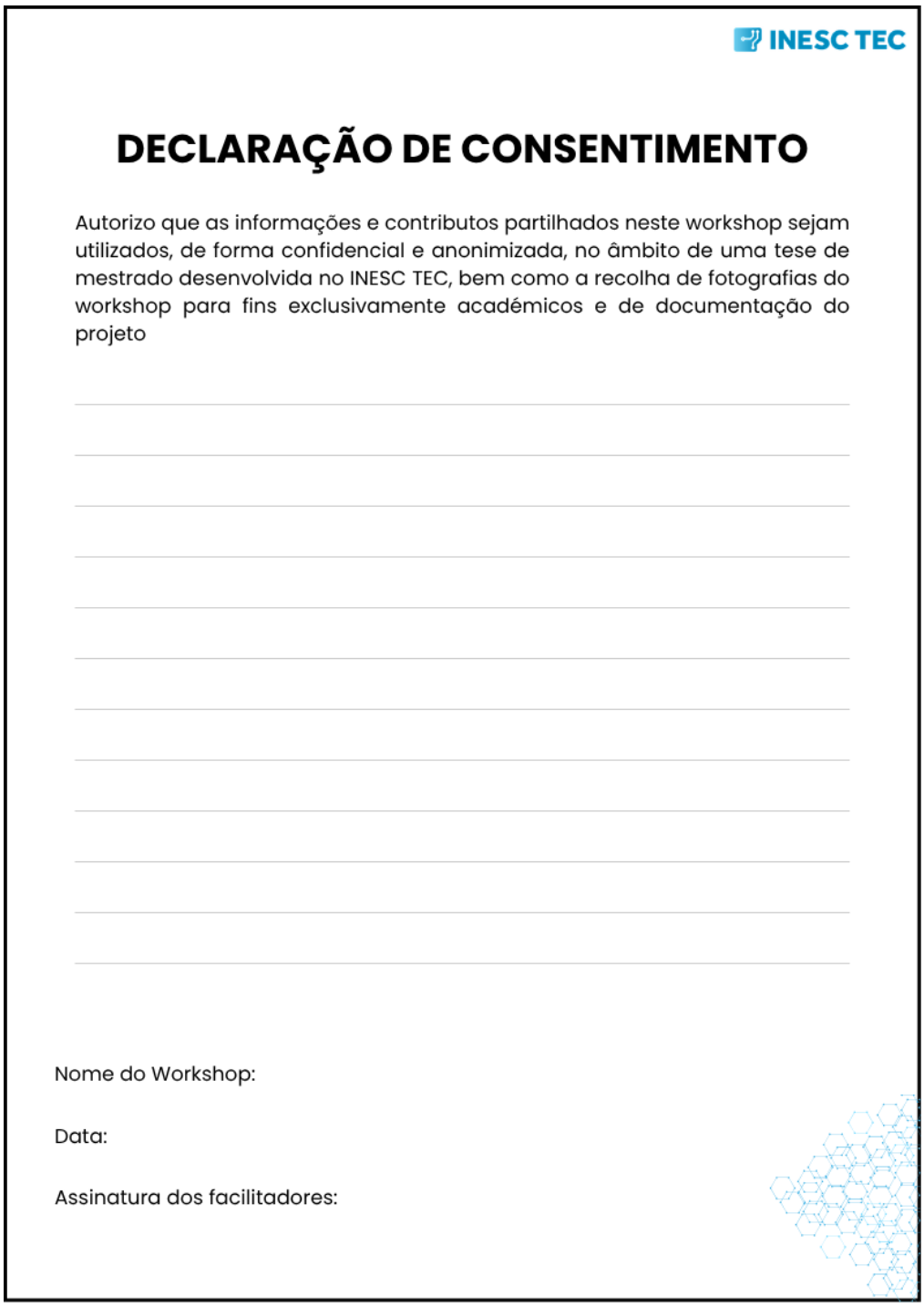
	healthcare systems may develop. It is a useful complement to the hospital future-vision papers with a more grounded view of the sector's next innovation pathways, especially around data integration, telemedicine, remote monitoring, and new coordinating actors in the system	- Complement the qualitative scenario approach with quantitative methods to describe possible futures more systematically. - Apply the same methodological approach to other sectors influenced by major public investment programs. - Examine how more standardized and integrated data infrastructures can support patient-centered care across organizations and territories. - Further investigate the role of telemedicine, remote monitoring, and shared digital platforms in reducing fragmentation and improving continuity of care.
(İ. Gaziulusoy & Öztekin, 2019)	This paper provide a conceptual bridge between design and sustainability transitions. The authors show that design can be understood as part of broader sociotechnical change, which is useful for framing innovation in healthcare as systemic rather than isolated. The paper also highlights the design's strategic role in transition processes through stakeholder engagement, scenario work, and pathway development. These contributions are relevant because they support the use of participatory and systemic methods to identify	- Study design's roles and agency in transition projects more closely, beyond niche pilots and experiments. - Use transition projects and consortiums as case studies to connect design theory and practice with sustainability transitions. - Explore how approaches like design for conviviality, resilience, and co-habitation can strengthen DfST.

	innovation opportunities and understand change in complex settings such as hospitals.	- Future work should focus on empirical testing, methodological development, and practice-relevant tools that can support and refine DfS transitions.
(Mok & Gaziulusoy, 2018)	The authors develop a transition-oriented design framework that connects strategic design with sustainability transitions theory in a more operational way. Rather than treating design only as a tool for visioning future systems, the paper shows that design can also help identify obstacles in niche-regime interactions and shape interventions that respond to emerging problems across different time horizons. Its relevance lies in the way it clarifies the role of design within sociotechnical transitions. The paper argues that design can contribute by locating intervention points, making future contingencies more tangible, and supporting iterative action that links short- and medium-term decisions with longer-term transition goals. This is particularly useful because it offers a concrete way to understand design not simply as a creative practice, but as a strategic practice for guiding systemic change.	- Further research should explore aquaculture practices that reduce nutrient emissions and address internal niche tensions that slow transition progress. - More work is needed on the limits of ASC certification and how certification dynamics may affect competition in the sector. - Future studies should examine reverse salients more closely and identify where strategic design can intervene effectively. - Applying the MLP can help clarify regime structures and assess the transformative potential of niche innovations. - Strategic design research should focus on interventions that respond to foreseeable problems while supporting near-term transition goals.

(Barbero & Pallaro, 2017)	This paper contributes by showing that systemic design offers a practical way to address the complexity of healthcare as an interconnected sociotechnical system rather than as a set of isolated problems. It is especially relevant because it combines holistic diagnosis, problem framing, and iterative intervention in a way that helps reveal concrete opportunities for innovation in hospital settings. It also highlights the value of integrating qualitative and quantitative data, stakeholder participation, and human-centered design when mapping healthcare dynamics and identifying pathways for change.	- Future research should examine how the output-input principle can be applied to special healthcare waste to reduce treatment costs and improve resource recovery. - More research is needed on how design disciplines can support sustainable development in healthcare. - The potential of systemic design to address the complexity of healthcare challenges should be explored further.
(Jones, 2020)	The study frames systemic design as a future-oriented approach that combines systems thinking with design practice to intervene in complex social and sociotechnical systems. It is especially valuable because it moves beyond isolated problem solving and instead supports the identification of high-leverage innovation opportunities through mapping, anticipation, and systemic intervention. A particularly important contribution is its emphasis on stakeholder variety and participatory design. Jones argues that complex systems must be understood through multiple perspectives and that meaningful change depends on engaging diverse stakeholders in co-creating system models, transition pathways, and actionable decisions.	- Future research should strengthen the integration of design and systems practice. - More work is needed on participatory systemic design across complex fields such as healthcare and public policy. - Anticipatory methods and leverage-point analysis should be developed further.

(Geels 2004)	The paper broadens the focus from sectoral systems of innovation to socio-technical systems, so that the production, use and diffusion of technology are studied together as part of how technology and society evolve side by side. It separates three linked dimensions: the system itself, the actors who sustain it, and the rules or institutions that guide them , and frames socio-technical regimes as the "*deep structure*" holding these together. To explain how one system gives way to another, the author sets out a MLP in which transitions happen when niche, regime and landscape dynamics align. It gives the review a foundational lens for how transitions hold steady and then shift.	- Test and apply the MLP across more empirical cases. - Adapt the framework to sector differences, allowing for different transition pathways. - Study co-evolution across whole systems, not just a few of their parts.

Annex C: Informed consent and ethics documentation;



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DECLARAÇÃO DE CONSENTIMENTO

Autorizo que as informações e contributos partilhados neste workshop sejam utilizados, de forma confidencial e anonimizada, no âmbito de uma tese de mestrado desenvolvida no INESC TEC, bem como a recolha de fotografias do workshop para fins exclusivamente académicos e de documentação do projeto

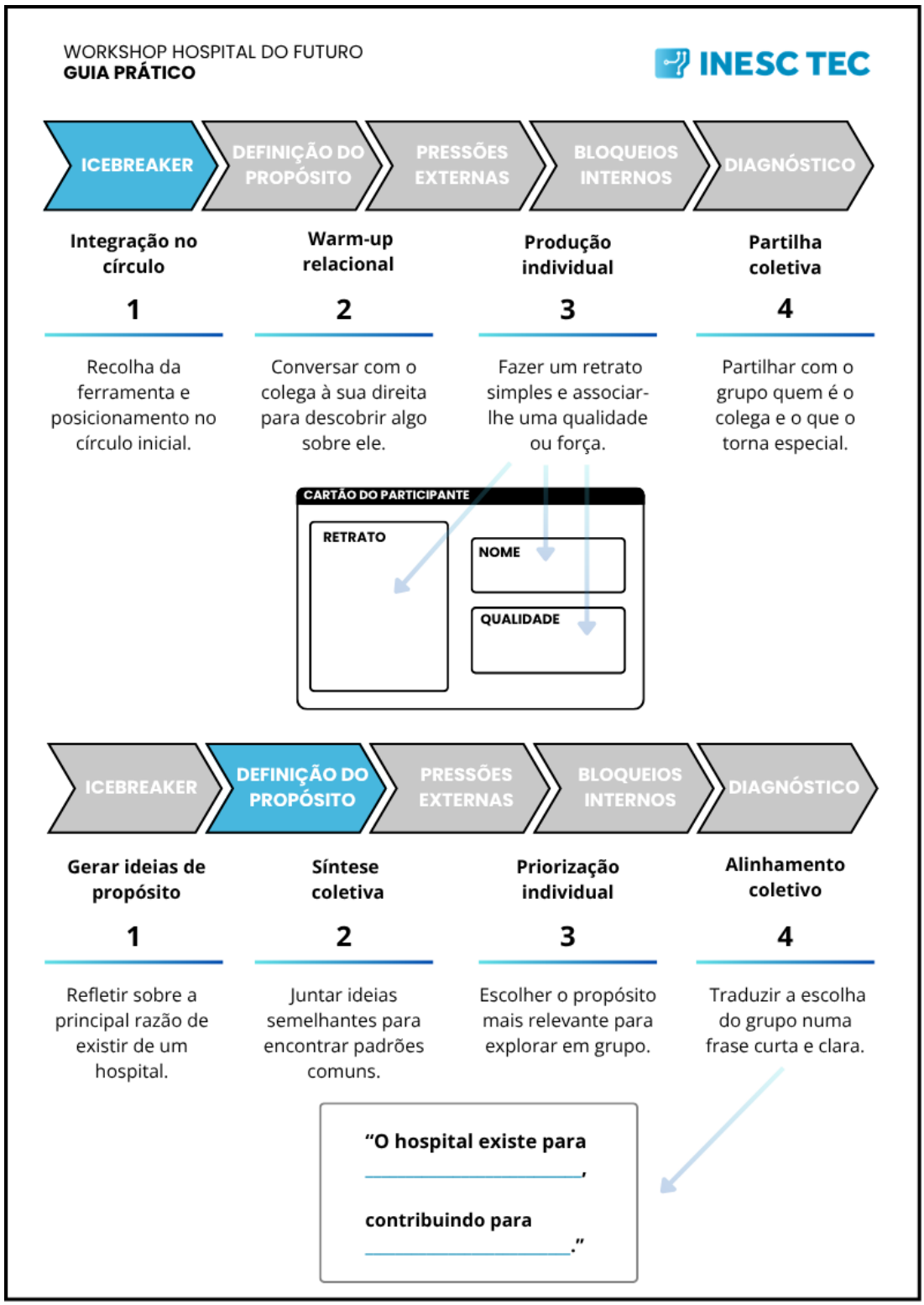
Nome do Workshop:

Data:

Assinatura dos facilitadores:

Figure C.1 - Informed consent and ethics documentation presented before the workshop activity.

Annex D: Workshop Session Activity Guide

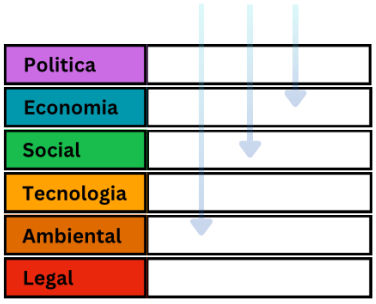


ICEBREAKER | DEFINIÇÃO DO PROPÓSITO | **PRESSÕES EXTERNAS** | BLOQUEIOS INTERNOS | DIAGNÓSTICO

Mapear Pressões

1

Identificar tendências e fatores externos que influenciam o hospital.



Priorização Individual

2

Selecionar as pressões que podem ter maior impacto no propósito do hospital.

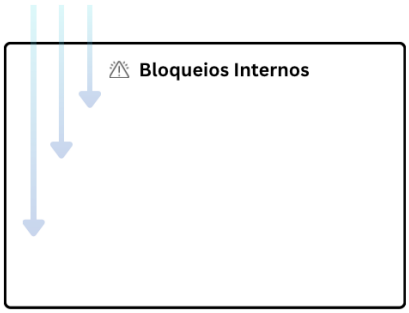
Pressões externas: Fatores externos ou tendências sobre os quais o hospital tem pouco controlo direto, mas que afetam a sua capacidade de cumprir o seu propósito.

ICEBREAKER | DEFINIÇÃO DO PROPÓSITO | PRESSÕES EXTERNAS | **BLOQUEIOS INTERNOS** | DIAGNÓSTICO

Identificar bloqueios

1

Listar os principais obstáculos internos ao bom funcionamento do hospital.



Síntese coletiva

2

Organizar os bloqueios por temas e clarificar o seu significado.

Priorização individual

3

Escolher os bloqueios mais urgentes ou mais impactantes para explorar na fase seguinte.

Bloqueio Interno: Obstáculo dentro do hospital que dificulta o cumprimento do seu propósito.

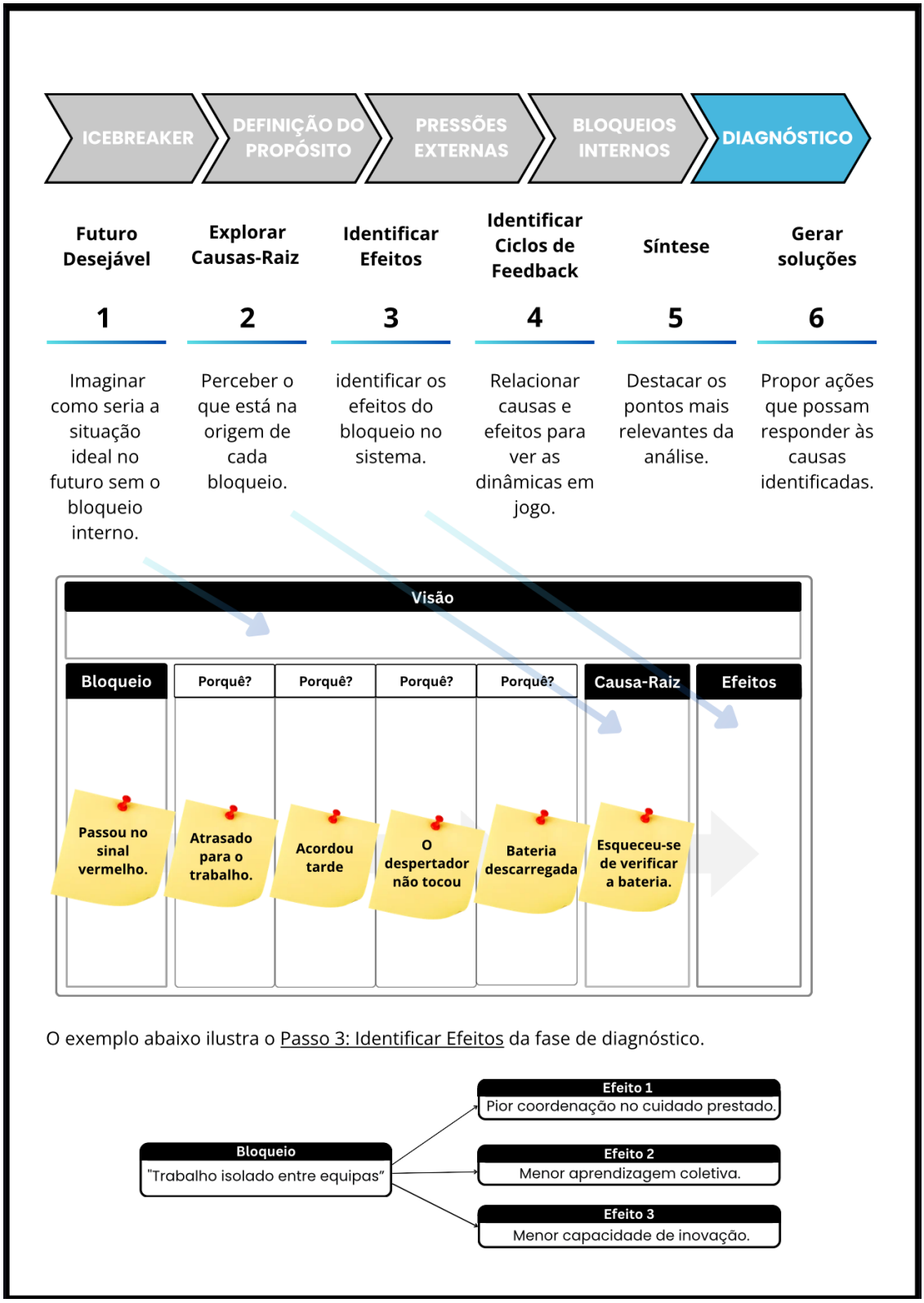


Figure D.1 - The activity guide followed during the session, setting out each stage and step of the workshop, explanations and the tools used.

Annex E: Workshop materials

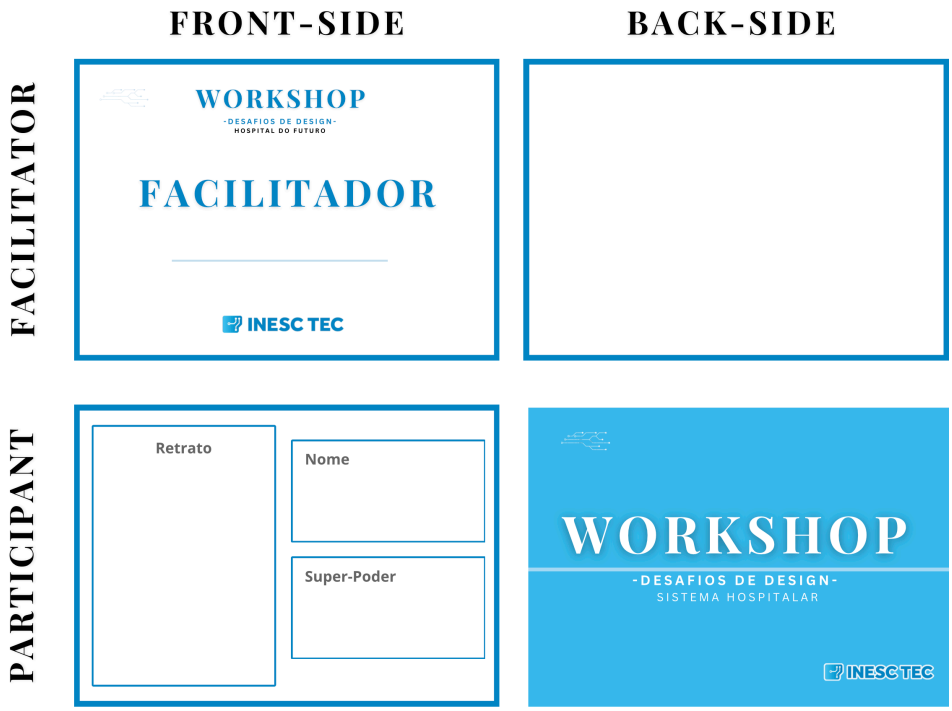


Figure 10 - Participant identification card (blank template).



Figure 11 - Purpose brainstorming template (blank), used to elicit participants' conceptions of the hospital's social function prior to the formulation of the group statements.

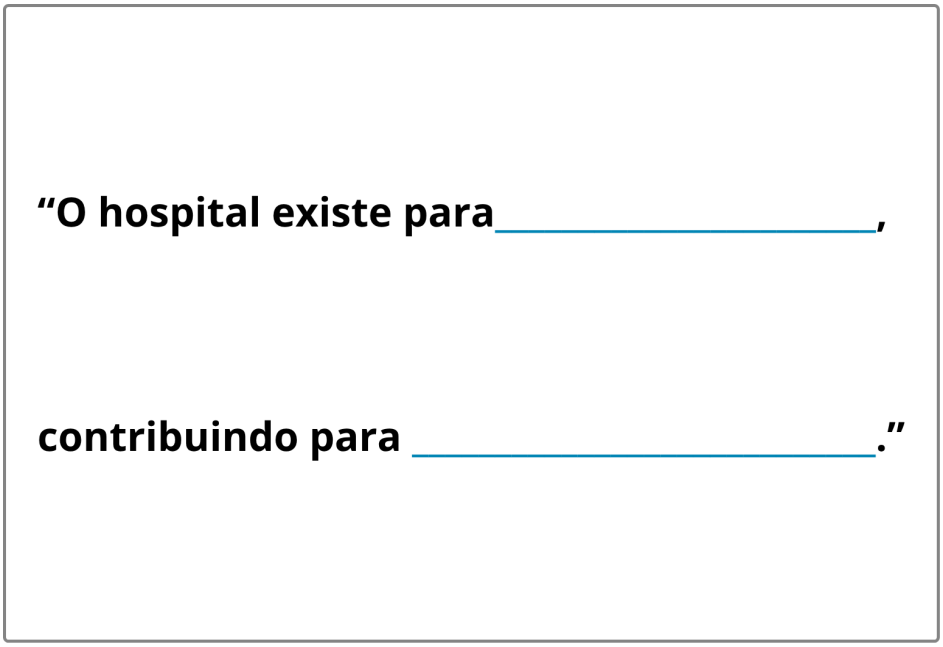


Figure 12 - Social function statement template (blank).



Figure 13 - PESTEL template for eliciting landscape pressures (blank). In the workshop session, the tool was translated into Portuguese and therefore appears as "PESTAL".

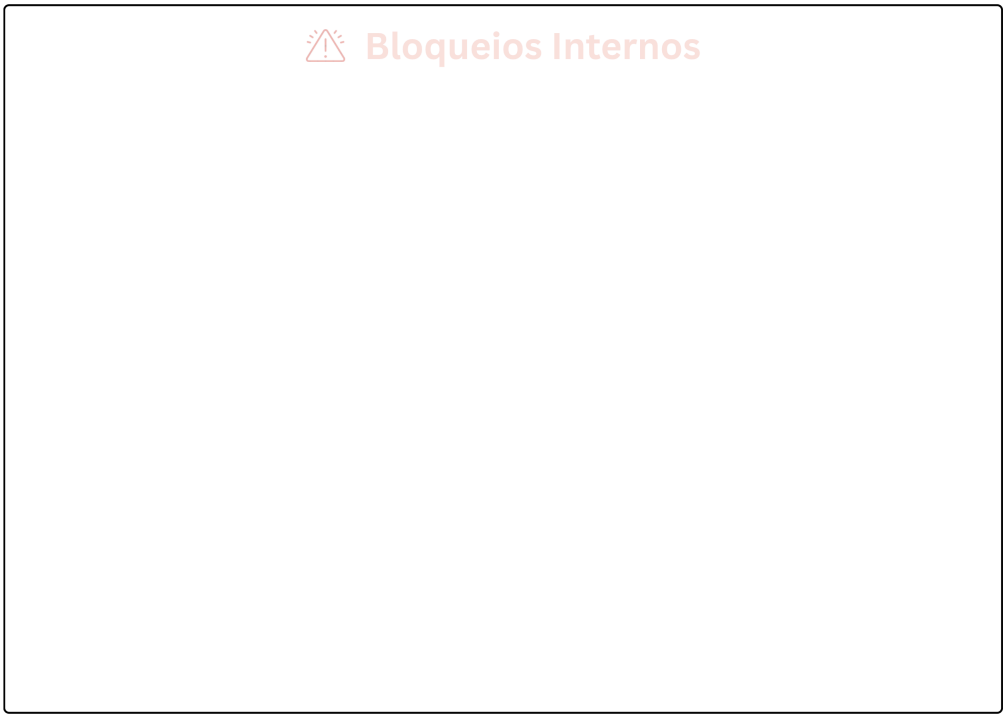


Figure 14 Template for capturing internal constraints, on which participants performed the brainstorming activities

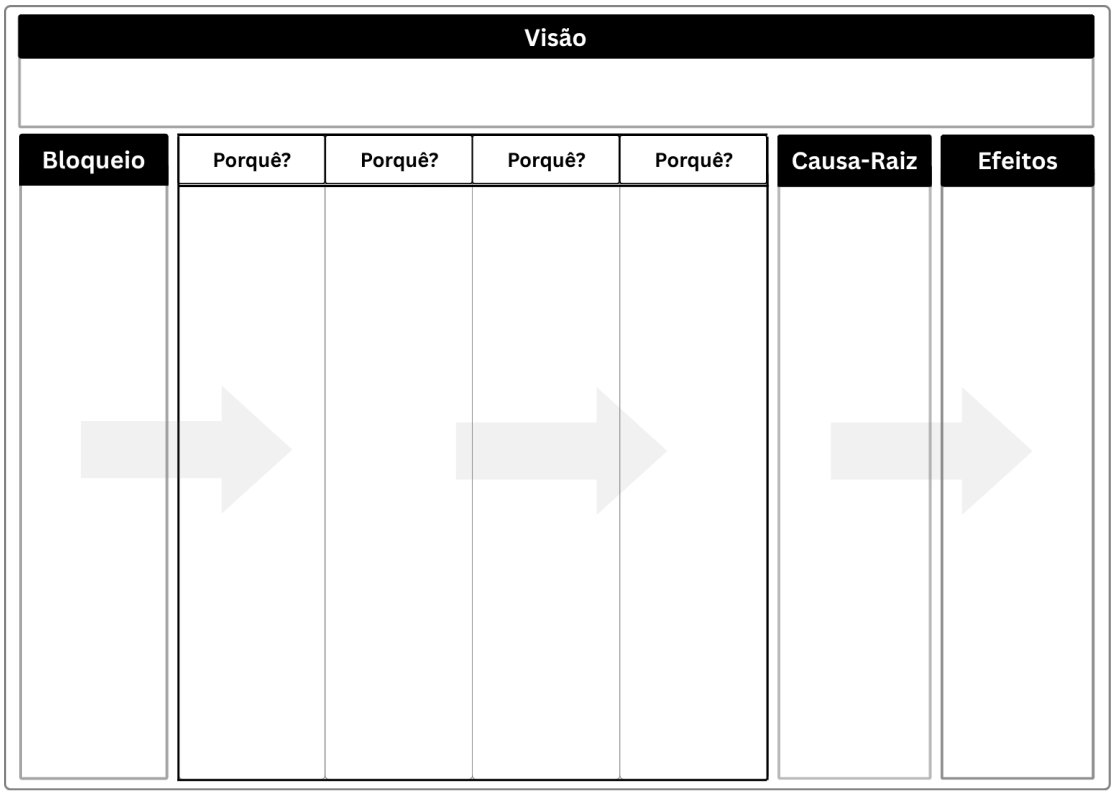


Figure 15 - Causal mapping canvas (blank).

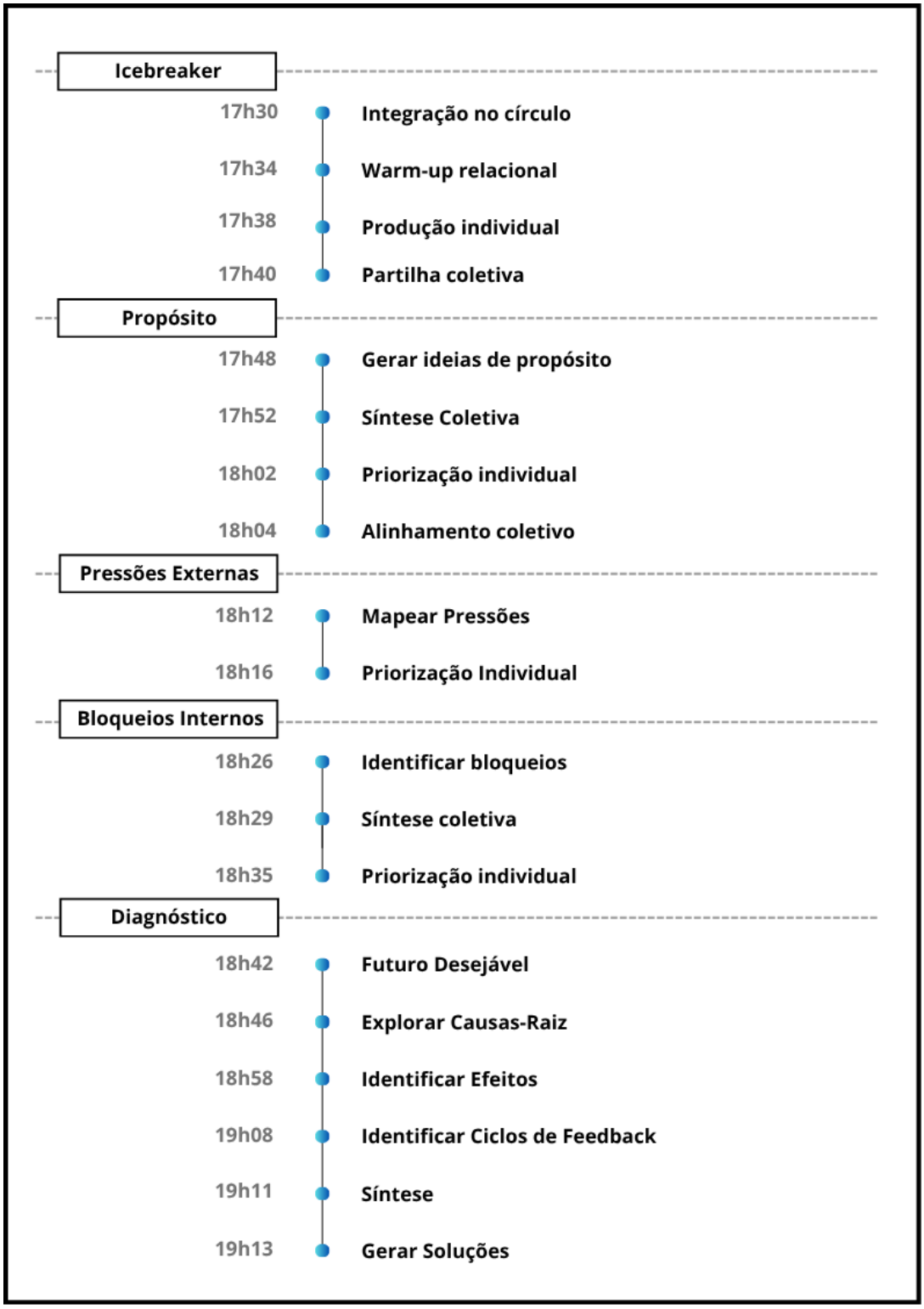


Figure 16 - Time structure of the workshop sessions.

Annex F: Social Function Brainstorming Outputs



Figure 17 - Completed purpose brainstorming output: the purposes participants associated with the hospital, clustered into five themes.

Annex G: Full landscape-pressure sets;

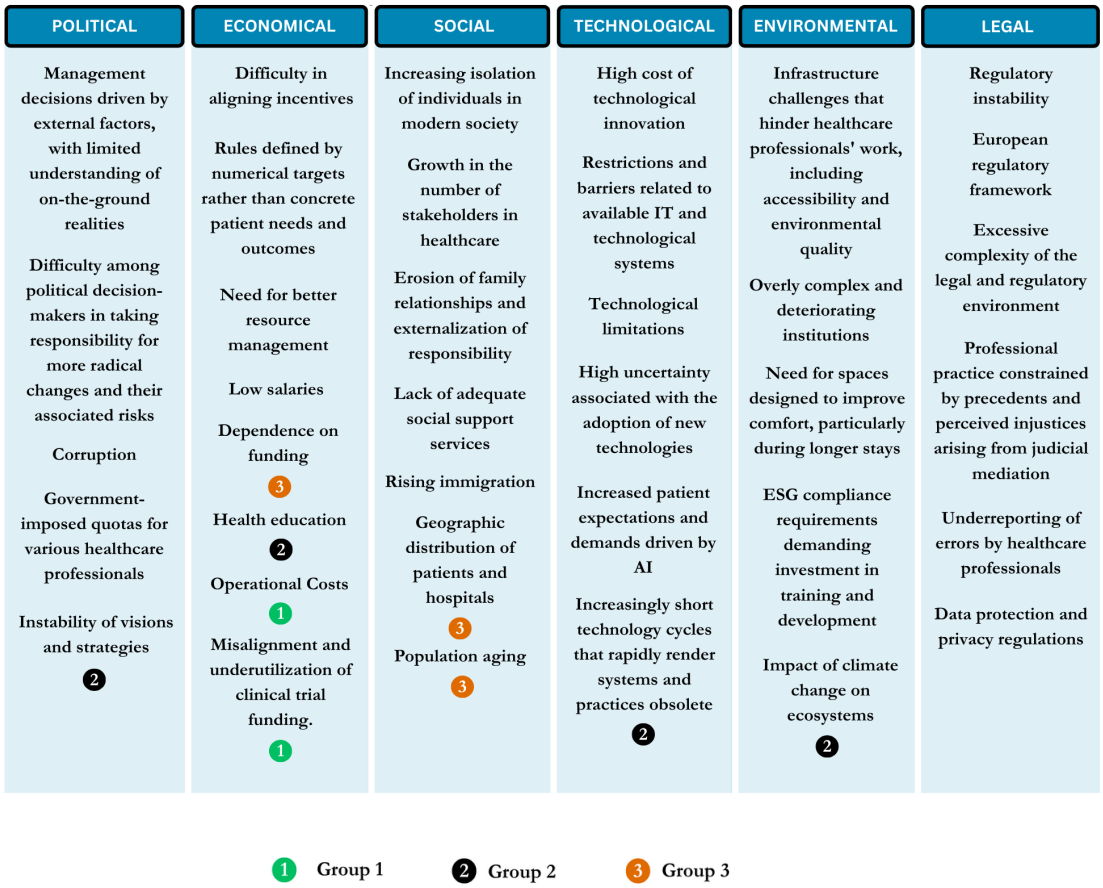


Figure 18 – Full set of landscape-pressures identified by the participants (translated to english).

Annex H: Full internal-constraint sets;

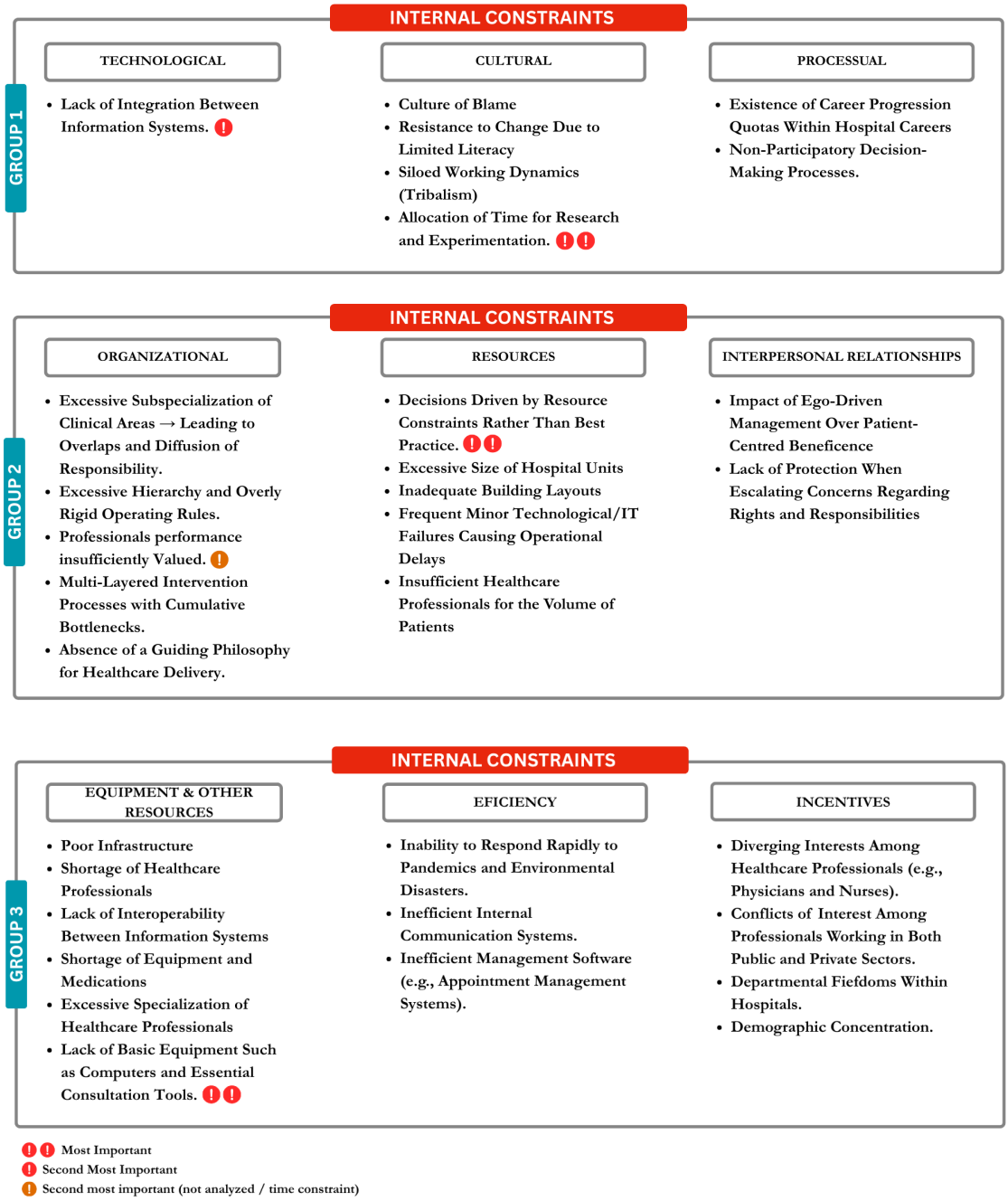


Figure 19 – Full set of landscape-pressures identified by the participants (translated to english).

Annex I: The four Causal Chains;

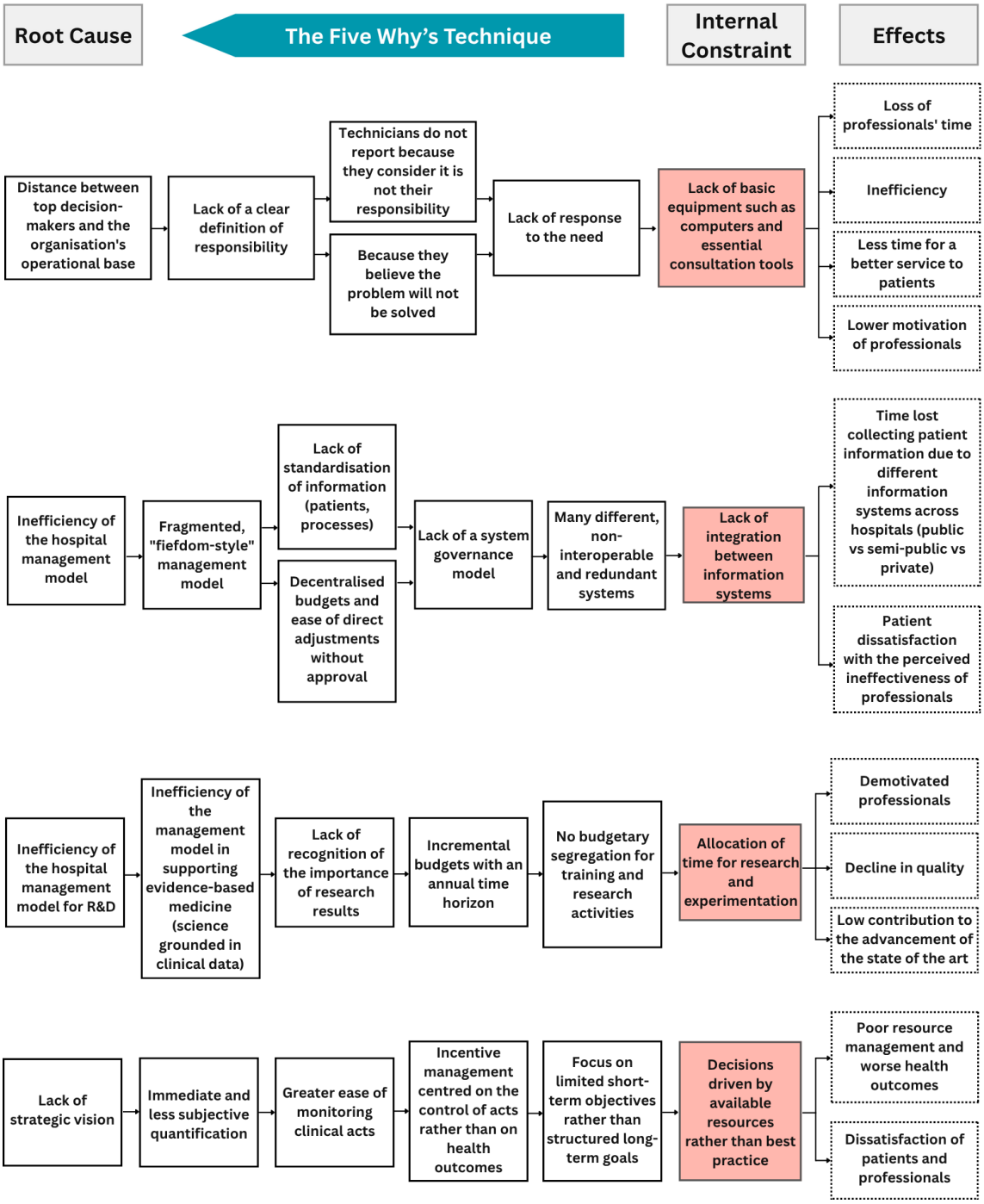


Figure 20 – Representation of all the casual chains produced by the participants (translated to english).

Annex J: The consolidated CLD

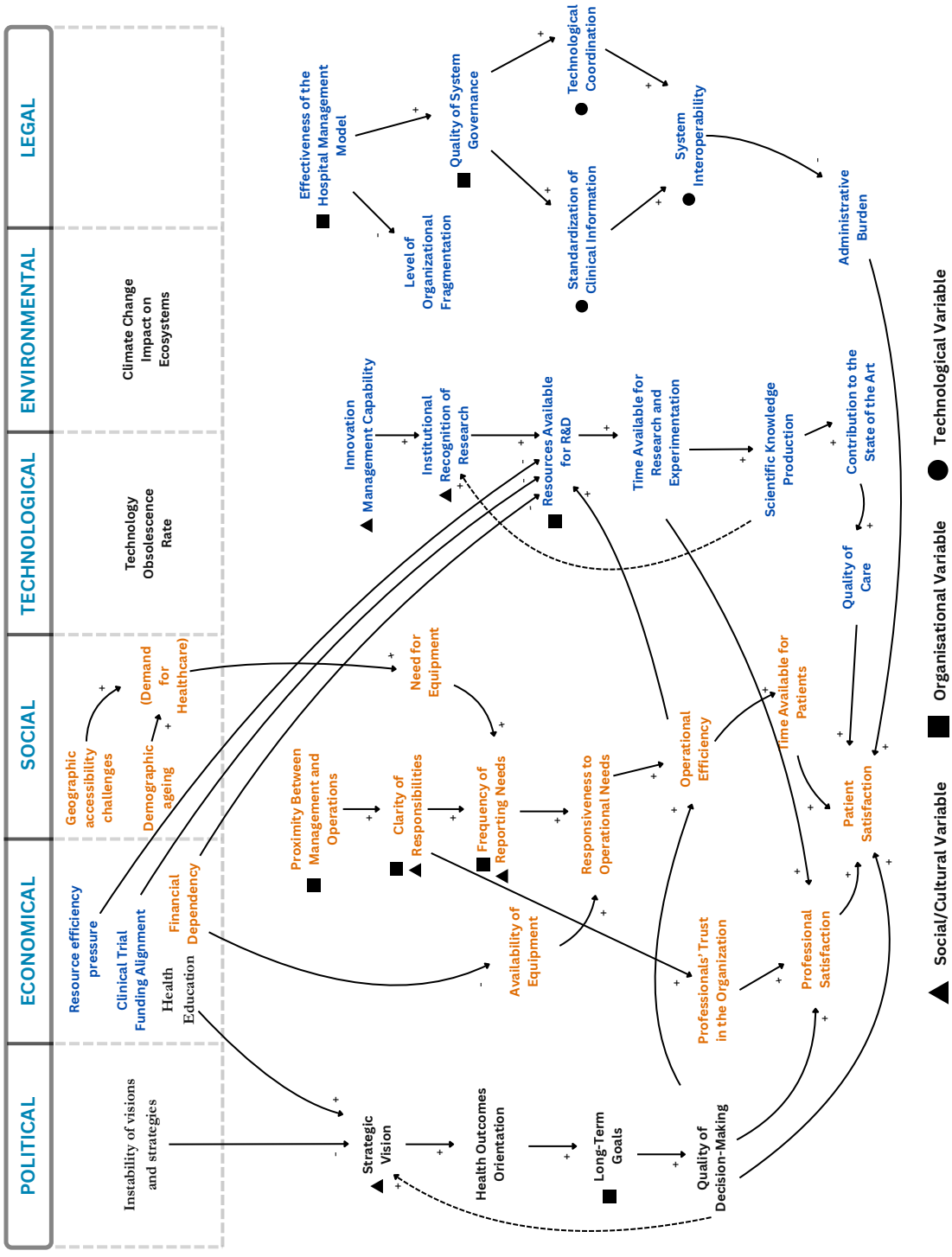
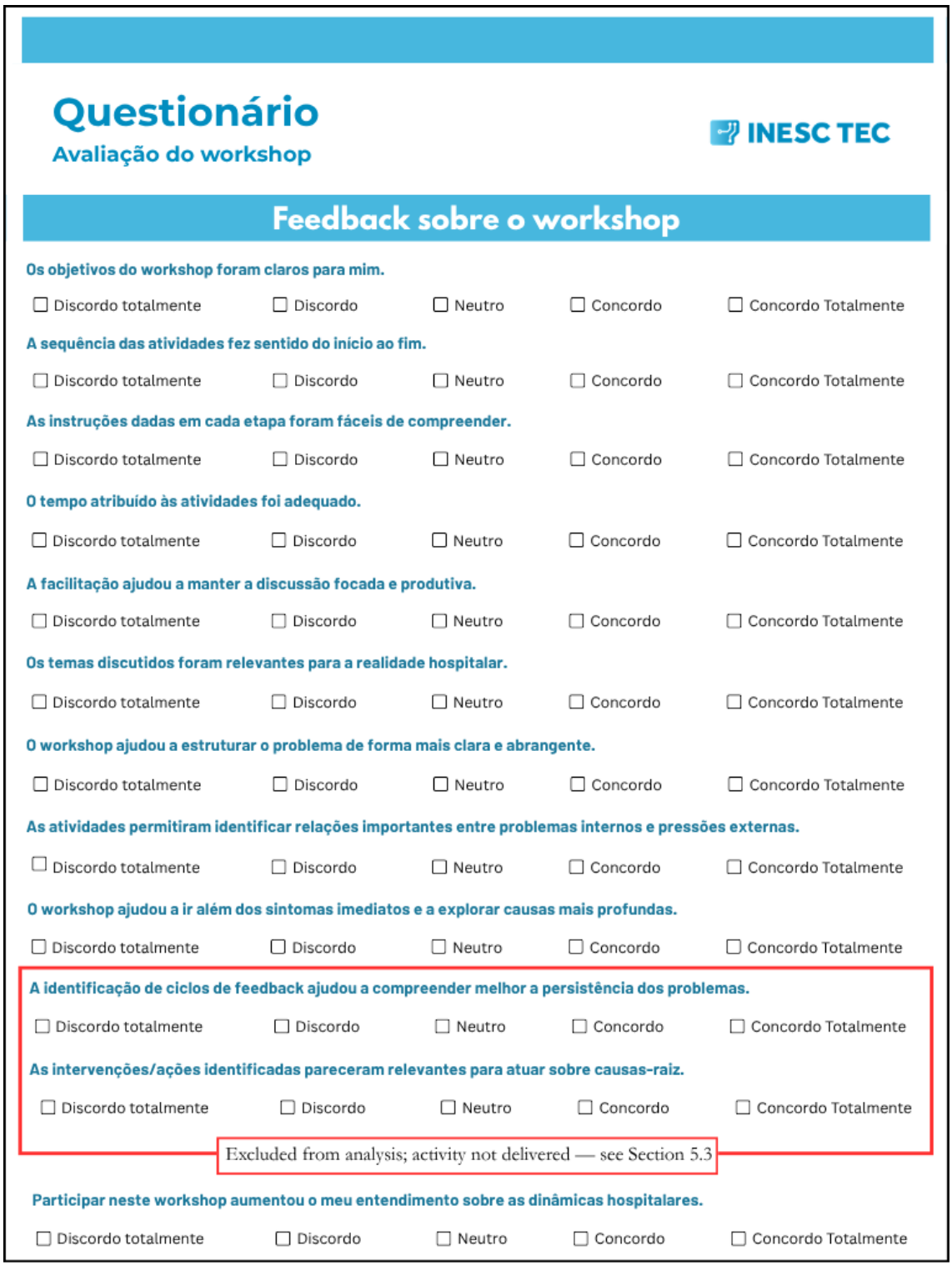


Figure 21 - The consolidated CLD at legible scale;

Annex K: Questionnaire



Questionário

Avaliação do workshop

INESC TEC

Feedback sobre o workshop

Os objetivos do workshop foram claros para mim.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

A sequência das atividades fez sentido do início ao fim.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

As instruções dadas em cada etapa foram fáceis de compreender.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

O tempo atribuído às atividades foi adequado.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

A facilitação ajudou a manter a discussão focada e produtiva.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

Os temas discutidos foram relevantes para a realidade hospitalar.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

O workshop ajudou a estruturar o problema de forma mais clara e abrangente.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

As atividades permitiram identificar relações importantes entre problemas internos e pressões externas.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

O workshop ajudou a ir além dos sintomas imediatos e a explorar causas mais profundas.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

A identificação de ciclos de feedback ajudou a compreender melhor a persistência dos problemas.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

As intervenções/ações identificadas pareceram relevantes para atuar sobre causas-raiz.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

Excluded from analysis; activity not delivered — see Section 5.3

Participar neste workshop aumentou o meu entendimento sobre as dinâmicas hospitalares.

☐ Discordo totalmente ☐ Discordo ☐ Neutro ☐ Concordo ☐ Concordo Totalmente

Figure 22 - The questionnaire used to evaluate the perception of the participants.

Annex L: Organisational Map of the Reference Hospital

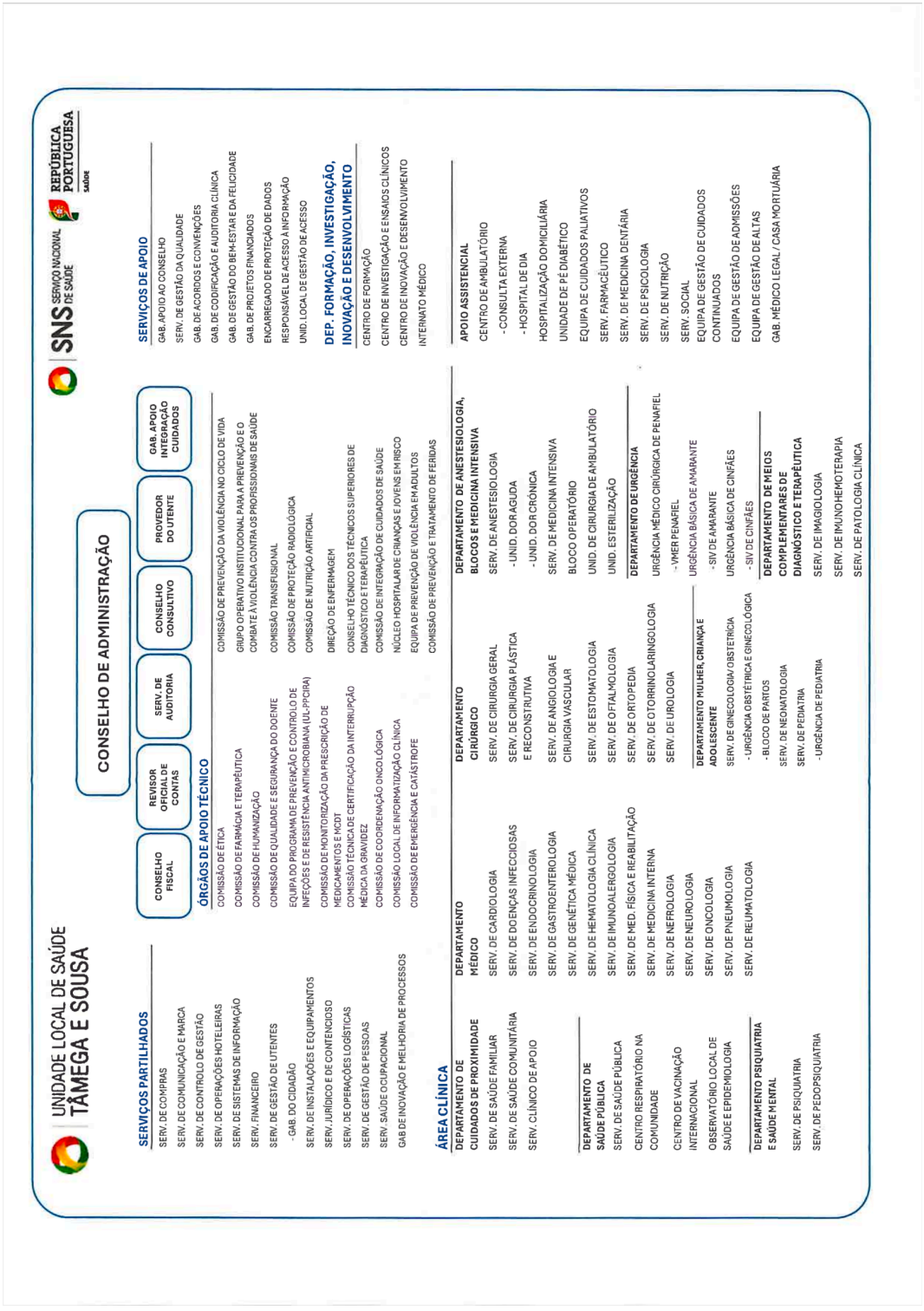


Figure 23 - Organisational chart of the *Unidade Local de Saúde de Tâmega e Sousa*, used as a reference to identify the professional roles and perspectives relevant to stakeholder selection. (Unidade Local de Saúde do Tâmega e Sousa, 2025)

Annex M: Statement on the Use of Generative Artificial Intelligence

In accordance with academic guidelines on the responsible use of Generative Artificial Intelligence (GenAI), the author declares that GenAI tools, namely ChatGPT and Claude, were consulted during the preparation of this dissertation. Their use was confined to reorganising and structuring the argument, improving the clarity and readability of text originally authored by the author, and supporting translation between Portuguese and English. All material produced or refined with the assistance of these tools was critically reviewed, verified, and validated by the author, who assumes full responsibility for the final content of this work. GenAI was not employed to generate original research findings, to produce references, or to replace the author's own analysis and interpretation of the empirical material.