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Systemic Impact Mapping of Hospital Innovation: A Multi-level Perspective on Innovation Lab Processes

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Abstract— In an era of urgent societal needs and digital transformations, hospitals are under increasing pressure to adapt while delivering high-quality services amid constraints such as limited funding and workforce shortages. Innovation labs have emerged as spaces to foster bottom-up innovation, but their effectiveness in healthcare remains understudied. Using a case study approach, we explore the mechanisms driving hospital innovation lab strategies and their impact at different levels of the hospital system. Using impact mapping, we provide empirical insights into the role of innovation labs in hospital innovation focusing on the patient experience, the well-being of healthcare professionals, and sustainable hospital management.

Keywords—hospital innovation, innovation labs, impact mapping, multi-level, strategy

I. INTRODUCTION

In an era marked by societal transformations and rapid technological advancements, organizations, especially within healthcare systems, face mounting pressures to adapt to changing conditions while continuing to deliver high-quality services. These challenges are further exacerbated by limited public funding, a growing demand for services amidst a shortage of healthcare professionals, supply chain issues, and the ongoing digital transformation of health services [1]. Amidst these challenges, hospital management grapples with the imperative to innovate in order to remain resilient and responsive to evolving needs. Yet, the implementation of innovation strategies encounters obstacles not only from external conditions but also from internal dynamics. As a result, hospitals are undergoing a paradigm shift in management, leading to a greater understanding of the needs of their many stakeholders, including medical professionals, nursing staff, support services and logistics, hospital partners/suppliers, health authorities, and of course, patients and their families [2].

To address these needs, hospitals are increasingly turning to innovation labs - dedicated spaces equipped with resources and staff to foster bottom-up innovation initiatives [3]. These labs, known by various names such as fab labs, makerspaces, and living labs, serve as safe places for novel ideas to emerge and collaborative problem-solving efforts [4]. While innovation labs have long been prevalent in other sectors, their adoption within healthcare systems, particularly public hospitals, is a more recent phenomenon.

Scholars recognize the potential of hospital innovation labs in catalyzing digital transformations and nurturing innovation culture among healthcare professionals and hospital management [5]. However, questions persist regarding their effectiveness and impact. Due to their intermediary nature [6], innovation lab's operations may initially appear chaotic or coincidental, leading to skepticism about the value they bring [7]. Recent studies advocate for a systemic understanding of innovation lab impact [8], emphasizing their role in facilitating co-creation and prototyping while considering their effects across different levels of the organizational ecosystem [9], [10].

In this context, our research delves into the intersection of innovation labs and hospital management, seeking to understand how innovation lab processes inform hospital innovation. To address this question, we conducted a case study of the Hephaïstos FabLab at Bicêtre Hospital in France. With over five years of operation, this fab lab, situated within the procurement and logistics department, has emerged as a vital innovation hub within the hospital, providing prototyping, training, and problem-solving services to staff. Through our case study, we aim to depict the underlying mechanisms driving a hospital innovation lab strategy and pinpoint their impact across various levels of the hospital system. Our research offers empirical insights into the role of innovation labs in shaping hospital innovation, shedding light on the dynamics between innovation lab processes and hospital management systems.

The remainder of this paper provides an overview of hospital management systems and innovation lab processes in healthcare, followed by a detailed description of our research methodology and case study findings. We present a systemic view of hospital innovation lab impact, emphasizing the informing levels within the hospital system. Finally, we conclude with reflections on research perspectives and future directions in this field.

II. THEORETICAL BACKGROUND

A. Hospital Management System

In examining the potential outcomes of hospital innovation labs, it is imperative to understand the broader context of hospital innovation within the context of health systems. Hospitals, as integral components of healthcare systems, face multiple challenges in the midst of societal

changes and rapid technological advances. These challenges include resource constraints, escalating demand for services, and the need to adapt to digital transformations [2]. As a result, it is critical to understand hospital innovation as a systemic endeavor [6].

Within health systems, the need for resilience and adaptability has never been more pressing. The Organization for Economic Cooperation and Development (OECD) highlights the need for health systems to prioritize investments in workforce development, prevention strategies, and digital infrastructure. Furthermore, fostering trust-based governance and effective decision-making processes, supported by robust data collection and use practices, is essential for organizational resilience. In addition, collaboration among stakeholders across the healthcare ecosystem is essential to ensure timely delivery of products and services and to meet evolving healthcare needs [1].

A systems view of hospital innovation involves a holistic understanding of the interconnected components within the hospital ecosystem. Hospitals are complex organizations with multiple interactions among stakeholders, work processes, and outcomes [11]. Adopting a systems approach enables the identification of improvement opportunities and the optimization of the effectiveness and efficiency of the hospital system [12]. This approach goes beyond technological advances to encompass service organization, internal communications, logistics, and human resource management, enabling the implementation of integrated solutions that improve patient experience, quality of care, and economic performance [5], [10].

Moreover, adopting a systems vision encourages collaboration and cooperation among health system stakeholders [13]. It facilitates the creation of partner networks, promotes knowledge sharing, and encourages the exchange of best practices. This collaborative ethos fosters the emergence of innovative and sustainable solutions, while mitigating conflict and maximizing benefits for the healthcare system as a whole [14]. By taking a multilevel approach and recognizing the interconnectedness of different forms of innovation and the actors involved [15], hospitals can effectively improve their performance and deliver better care. In practice, hospital innovation takes place at four different levels [16] (see Fig. 1.):

- **The patient and family level:** This level focuses on meeting the needs and expectations of patients and their families, improving the quality of care, and optimizing the overall healthcare experience by taking into account individual preferences and experiences [17], [18].
- **Healthcare professionals level:** Key stakeholders, including physicians, nurses, therapists, and other healthcare professionals, work together to improve clinical practices, develop innovative treatment approaches, utilize advanced medical technologies, promote continuing education, and foster interdisciplinary collaboration to deliver superior patient care [19].
- **Hospital organization level:** At this level, innovation initiatives target internal processes and operations within the hospital. Efforts are directed at optimizing resource allocation, streamlining workflow efficiency, automating administrative tasks, and

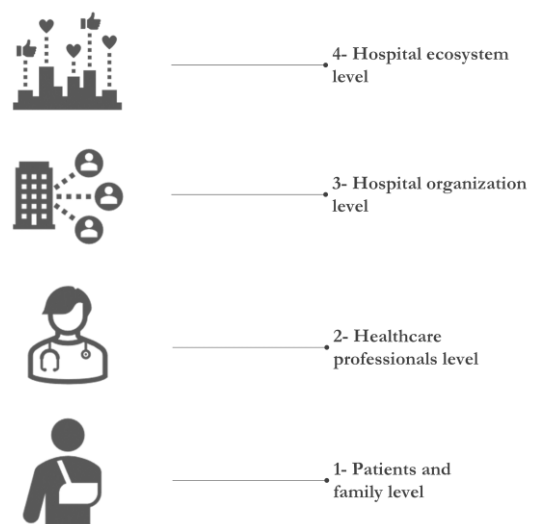


Fig. 1. Hospital system

implementing integrated information systems to support caregivers and management staff [11], [12].

- **Hospital ecosystem level:** Collaboration extends beyond the hospital walls to include partnerships with other hospitals, suppliers, research organizations and health authorities. This collaborative network fosters knowledge sharing, resource sharing, and implementation of innovative practices across the healthcare system, with a focus on meeting diverse user needs and addressing systemic challenges [1].

B. Innovation lab processes in Hospital Management

Innovation labs are emerging organizational forms that exhibit distinct characteristics, including both tangible and intangible resources that facilitate innovation processes in multi-stakeholder settings such as hospitals [4]. Tangible resources, including physical infrastructures and management practices, play a critical role in enabling the provision of specialized services tailored to stakeholder needs [20]. Moreover, innovation labs' collaborative and flexible governance structures foster an environment conducive to experimentation and co-creation [21]. The design and localization of these labs are equally significant aspects contributing to their efficacy within the systems they are embedded in. Situating them in neutral and unconventional spaces promotes creativity and encourages participants to think beyond traditional frameworks [22]. This approach fosters an innovative atmosphere distinct from the traditional hierarchical structures prevalent in hospital settings [3].

Intangible resources, such as the "lab culture" and organizational behavior, are key characteristics of innovation labs. Collaborative and adaptive work practices foster a culture of openness and experimentation [23]. Innovation labs serve as multifunctional spaces for creating, incubating, and implementing projects aimed at addressing complex challenges [24]. They offer a safe environment for experimentation and collaboration, enabling participants to explore novel solutions to pressing problems [10]. These spaces also serve as nodes for interaction, exchange, and network building among diverse stakeholders [25]. By facilitating knowledge sharing and collaboration, innovation labs enable the formation of partnerships and alliances that are essential for driving systemic change in hospital management practice [5]. They also serve as learning environments,

providing opportunities for skill development and capacity building among hospital staff [12]. Participants gain insights into innovative approaches to problem-solving and decision-making through hands-on experiences and experiential learning activities [26]. This means that innovation labs are important for transforming representations and thinking frameworks, challenging existing paradigms, and fostering a culture of continuous improvement [13]. They contribute to the evolution of management practices towards more adaptive and responsive models [26].

However, despite the growing body of literature on innovation labs, there are significant challenges and complexities associated with these initiatives. Innovation labs may encounter managerial tensions and loss of support due to sudden changes in leadership [7]. Several instances of innovation labs ceasing operations have demonstrated the fragility of these structures [27], occasionally leading to significant tensions and even causing frustration among stakeholders [28]. Although innovation lab initiatives do not need to achieve financial sustainability, they represent significant investments in terms of funding, time, and the emotional commitment of the teams and decision-makers involved [29]. Therefore, it is essential to gain a direct understanding of these challenges and develop tools to assist in structuring clear impact strategies.

III. RESEARCH METHODS AND DATA

This research aims to improve our understanding of the specific domains in which innovation lab processes contribute to hospital innovation and how they inform clearer impact strategies. More specifically, building on the work of [10] regarding the evolution of projects and services provided by a hospital innovation lab, this research adopts an interpretive perspective to illustrate the primary sources of impact of innovation lab initiatives in hospital contexts through a multi-level analysis of the driving forces behind lab operations.

A. Case Description

A case study [30] was conducted on the Hephaïstos FabLab at the Bicêtre Hospital in France. This lab functions as an innovation service for the hospital, providing problem-solving, prototyping, digital skills development, and knowledge sharing services (see Fig. 2.). It operates as a distinct support unit with cross-disciplinary connections to healthcare and support functions within the hospital. Any hospital staff member can submit a project or participate in a brainstorming session, and the FabLab is designed to improve the lives of hospital users, including patients and staff, by encouraging a collaborative approach to the resolution of problems.

The FabLab team consists of individuals with a diverse set of skills ranging from technical support to design methodology, all with an educational approach and proximity to the hospital space. The physical space of the FabLab is located within the main hospital building and is designed to be open and accessible to all hospital staff, with the team also providing on-site support to other hospital units. The FabLab utilizes user-friendly technology and provides guidance and support on modeling and prototyping to users of all profiles. It has been operating for over five years and has become increasingly integrated into the hospital's daily functioning, offering innovation project services to a wide range of users.



Fig. 2. Examples of Hephaïstos FabLab projects. Left: adaptable board for walking frames. Right: Therapeutic educational tools “Explain diabetes to me”.

B. Data Sources and Collection

The data collection included the analysis of archival materials related to past projects, initiatives, and activities of the Hephaïstos FabLab. This included documents, reports, project proposals, and other relevant materials that provided insights into our case operations. Additionally, the research team held periodic meetings between March and September 2022 to review lessons learned from past projects and gather post-implementation feedback. An intern from the FabLab facilitated these meetings, taking notes and processing raw data. Additionally, in February 2023, the FabLab operational team participated in a focus group session structured as a collaborative workshop to elicit insights, experiences, and perspectives on our case characteristics. In-depth discussions were held to triangulate, reinterpret, and make sense of the collected data, facilitating the identification of key themes and patterns.

C. Data Analysis

The data analysis followed the impact mapping method outlined by Adzic [31]. The guidelines provided by Wyse [32] were used to conduct the focus group with team participants and steer the data analysis and triangulation process. Impact mapping is a crucial component of impact studies [33], providing a visual framework to understand goals, anticipated outcomes, and facilitate collaborative decision-making. This approach involves bringing together stakeholders from various backgrounds, including business, technology, and design, to collaboratively construct an impact map. During this process, participants discuss the goal, involved parties, desired effects, and deliverables or indicators, while also identifying underlying assumptions. Once the map is finalized, decision-makers can use it to establish a shared strategy, identify priority scenarios, and determine subsequent actions. Using this method, we identified the fundamental elements of our case, including its purpose (why), stakeholders (who), impact (how), and key indicators (what), to gain a comprehensive understanding of its implications (see Fig. 3.).

In the following, we present a multilevel perspective that serves as a basis for developing a systemic representation of

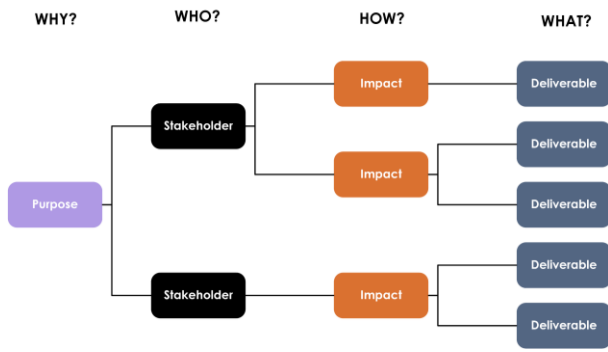


Fig. 3. Impact mapping method

the impact of the processes carried out by a hospital innovation lab.

IV. RESULTS

A. Pinpointing the sources of impact: the who, how and what

The results of our case study revealed eleven different action levers and thirty-three associated indicators. These levers and indicators were influenced not only by the activities observed in our case, but also by valuable insights gained from focus group discussions with the FabLab team (see Fig. 4.). These discussions helped us pinpoint the underlying motivations, observed outcomes, and future expectations of team members (refer to Annex A). This understanding was instrumental in constructing a collective interpretation of our case activity, which in turn facilitated the triangulation process with archival data and observations. This a detailed examination of the FabLab's goals, target stakeholders, and methods for effecting organizational change enabled us to identify the primary impacts and the range of stakeholders involved at different levels of the hospital, including patients, healthcare professionals, managers, suppliers, and others (refer to Table I). A further overview of each lever is provided below.

- a) **Improve Caregiver-Patient-Family Interaction:** Our case contributes to enhancing interactions between caregivers, patients, and their families, fostering a supportive environment within the hospital. For instance, activities involving patients and/or their families and the number of patient beneficiaries per hospital serve as indicators of this impact.



Fig. 4. Results from focus group with the FabLab team

- b) **Empowerment of Healthcare Professionals:** The FabLab facilitates the development of digital and design skills among healthcare professionals, empowering them to innovate and address complex challenges in patient care. Indicators such as the number of employees by department and hospital, project publications in the Wiki, and professionals involved in the lab activities reflect this empowerment.
- c) **Use-Driven Design:** Adopting a user-driven approach, this case focuses on developing tools and solutions that directly address the needs and preferences of healthcare workers and patients. Key indicators include the average project development time, number of tools developed, user tests carried out, and users involved.
- d) **Workplace Well-being:** By providing access to innovative tools and resources, the FabLab promotes workplace well-being among hospital staff, contributing to a positive work environment and improved job satisfaction. Measures like the satisfaction rate of the lab users and the rate of adoption of developed tools gauge this impact.
- e) **Stimulate the Innovation Mindset:** Our case fosters a culture of innovation within the hospital, encouraging staff to explore new ideas, experiment with technologies, and collaborate on innovative projects. Metrics such as the number of Pop-up Workshops held, Ateliers Minute, and awareness-raising or promotional activities organized indicate this stimulation.
- f) **Process Optimization:** Through its projects and initiatives, the FabLab contributes to optimizing processes within the hospital, streamlining workflows, and improving efficiency in various departments and specialties. Indicators like the number of departments impacted per year, specialties impacted per year, hospitals impacted per year, and projects by type of request highlight this optimization.
- g) **Administrative Agility:** The FabLab's agile approach to problem-solving and project management enables the hospital to respond quickly to changing needs and priorities, enhancing administrative efficiency and effectiveness. Metrics such as the frequency of requests from the same department, response rate by project type, and rate of time saved compared with a standard procedure reflect this agility.
- h) **Frugality:** By promoting cost-effective solutions and resource optimization, the FabLab helps the hospital reduce expenses, maximize value, and achieve financial sustainability. Indicators including total project costs by department, average HR costs per project, and rate of cost reduction compared to market demonstrate this frugality.
- i) **Source of Recognition:** Through its innovative projects and collaborations, this case enhances the hospital's reputation and visibility, earning recognition from stakeholders within the healthcare community and beyond. Measures like the number of scientific publications and communications, non-

scientific publications including projects, and students/apprentices/interns received signify this recognition.

- j) **Co-creation Interface with Suppliers:** Our case serves as a platform for collaboration with external partners, including suppliers and vendors, fostering co-creation and innovation in product development and service delivery. Metrics such as the number of collaborative projects with external partners and partnerships illustrate this co-creation interface.
- k) **Hospital Innovation Practices Federation:** Our case also facilitates knowledge exchange and collaboration with other innovation labs and hospital networks, contributing to the dissemination of best practices and the advancement of innovation in healthcare. Indicators like the number of exchanges with other innovation labs and active hospital innovation networks showcase this federation.

TABLE I. SOURCES OF IMPACT: THE WHO, HOW AND WHAT

Stakeholders (who)	Action levers (how)	Indicators (what)
1. Patients and relatives	a. Improve caregiver-patient-family interaction	Number of activities involving patients and/or their families
		Number of patient beneficiaries per hospital
2. Healthcare professionals	b. Empowerment of healthcare professionals	Number of employees by department and hospital
		Number of project publications in the Wiki
		Number of professionals involved in FLH activities
	c. Use-driven design	Average project development time
		Number of tools developed
		Number of user tests carried out
		Number of users involved
	d. Workplace well-being	Satisfaction rate of FLH users
		Rate of adoption of FLH-developed tools
	e. Stimulate the spirit of innovation	Number of Pop-up Workshops held
Number of Ateliers Minute		
Number of awareness-raising or promotional activities organized		
3. Hospital organization	f. Process optimization	Number of departments impacted per year
		Number of specialties impacted per year
		Number of hospitals impacted per year
		Number of projects by type of request
	g. Administrative agility	Frequency of requests from the same department
		Frequency of requests by hospital

		Frequency of requests by type of request
		Rate of time saved compared with a standard procedure
		Response rate by project type
	h. Frugality	Total project costs by department
		Total project costs per hospital
		Average HR costs per project
		Rate of cost reduction compared to market / savings or expenditure avoided
	i. Source of recognition	Number of scientific publications and communications
		Number of non-scientific publications including projects
		Number of students/apprentices/interns received
4. Hospital ecosystem	j. Co-creation interface with suppliers	Number of collaborative projects with external partners
		Number of partnerships
	k. Hospital innovation practices federation	Number of exchanges with other innovation labs
		Number of active innovation labs or hospital innovation networks

B. Articulating a systemic vision: the why

While we have outlined the what, the how, and for whom of our case initiatives, it's equally crucial to understand the underlying motivations driving these actions. Our case demonstrates a collective ambition aimed at positively influencing the operations of Bicêtre Hospital, enhancing the experiences of its staff, patients, and service providers alike. Three guiding principles have emerged as leitmotifs, completing the systemic vision of our case impact (see Fig. 5.):

- i. Creating a welcoming and reassuring hospital environment to promote patient well-being - *The patient experience*
- ii. Developing ergonomic and organizational innovations to improve working conditions for care staff - *The well-being of hospital professionals*
- iii. Contributing to the introduction of an innovative approach to hospital resource management to ensure optimal and sustainable use of equipment and staff - *Hospital management*

The significance of a systemic vision lies in establishing shared intentions and levers for action, aligning around a common purpose, and facilitating adaptability and readjustment. By understanding the larger scope of actions taken, stakeholders involved in a hospital innovation lab initiative can anticipate, coordinate, and adapt to change more easily, thereby maintaining coherence and maximizing impact. Importantly, the ability to provide a holistic view of all key sources of impact can enable the envisioning of

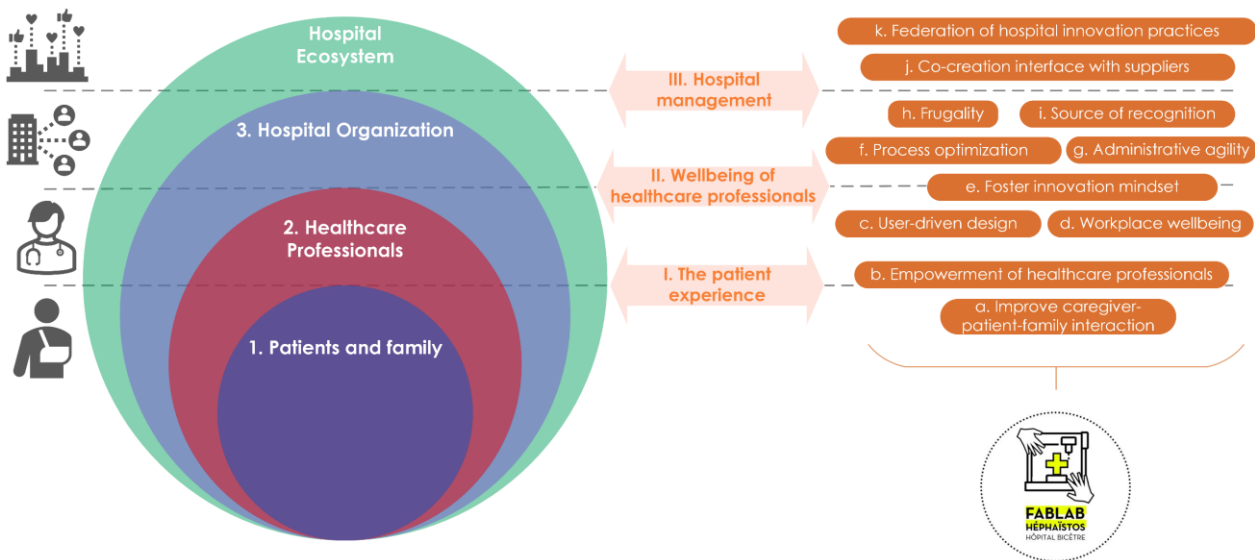


Fig. 5. Systemic vision of impact sources

additional impact scenarios that may need to be prioritized, updated, or rethought. This is particularly valuable in emergent organizations, such as innovation labs, where strategies are also emergent. In this way, impact mapping becomes an instrumental approach for triggering reflective and interpretative processes that promote the renewal or reinforcement of ongoing actions.

C. Discussion and limitations

This study contributes to the growing understanding of the role of innovation labs in addressing systemic challenges. By providing a systemic scope of these initiatives, we aim to bring clarity to what can often seem like chaotic and complex endeavors.

Our study offers a fresh perspective on the impact assessments of grassroots innovation initiatives. As empirical data on innovation labs continues to grow, there is an increasing interest in developing tools to assist in outcome assessment. Our research stresses the importance of not only focusing on ex-post assessments but also aiding in the construction of collective impact and indicator mapping. This approach allows for the design and application of more effective evaluation instruments [34].

Systemic visions of innovation lab activity can foster collaboration. By elucidating an innovation lab's action levers across organizational levels, potential synergies with other labs and stakeholders can be uncovered. This clarity facilitates network emergence and knowledge dissemination [25]. In the specific context of a hospital innovation lab, such as the Hephaïstos FabLab, distinctive challenges arise. Questions about enhancing the diffusion of the lab's results and the extent to which a separate fabrication unit should be established within the hospital were raised while the study was conducted. This hypothetical shift from the original FabLab ethos, which prioritizes knowledge sharing and experimentation, could transform the hospital into a producer or supplier, thereby testing the boundaries of such structures' vocational roles.

We recognize the exploratory nature of our study and the limitations associated with it. Our study primarily focused on

the FabLab team's perspective. Future research could examine the hospital users' perceptions of our case impact in greater depth. Additionally, tracking innovations and projects could provide valuable insights into the adoption of FabLab's outcomes. Despite these limitations, we believe our empirical work offers novel and detailed insights into the strategic management of hospital innovation lab processes, hospital management, and healthcare professional empowerment.

V. CONCLUSION AND PERSPECTIVES

In conclusion, this study addresses a critical gap in the literature regarding the impact of innovation labs, particularly within the challenging and evolving context of healthcare and hospital systems. The research was motivated by the recognition that while innovation labs have gained prominence, their specific contributions and effectiveness within healthcare settings remain inadequately understood.

Our empirical investigation aimed to provide insight into this phenomenon by focusing on the Hephaïstos FabLab at Bicêtre Hospital in France. The study offers insights into the structuring of impact strategies in emergent organizations, using impact mapping as a complementary approach to mainstream impact assessment methods. The significance of these findings lies in their potential to inform decision-making processes and drive positive change within healthcare management and service delivery. By understanding the impact levers and key stakeholders involved in innovation lab initiatives, healthcare organizations can better navigate the complexities of their environment and develop their innovation capacity.

Continued research efforts are necessary to explore and refine our understanding of innovation labs in healthcare contexts. Replication studies and comparative analyses with other cases will be essential for uncovering the particularities and commonalities of these organizations and further elucidating their impact trajectories.

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- Setting up machines and projects
- Open, documentable Wiki
- Micro hab
- FabLab open days
- More pop-up workshops in departments
- Conviviality
- Daily discussions = trust
- Signage projects

- Hospital FabLab training program
- Collaboration with partners (manufacturers)
- Collaboration with other FabLabs/Designers
- Publications
- Visits to operating theatres and departments
- Getting closer to the field