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Dropping Pebbles: The ripple effect of designerly co-creation in steering sustainability transitions in hospitals

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Abstract: Steering sustainability transitions in complex organizations, such as hospitals, may benefit from iterative, situated, and participatory experimentation. Co-creation holds particular promise in this regard, acting as a "pebble" in the system that generates ripple effects towards sustainable change. However, its implications and methodologies within hospital systems, especially those grounded in design practice, remain underexplored. This paper investigates designerly co-creation through seven medical device design projects conducted by master's students in collaboration with healthcare professionals. Drawing on observations of co-creation processes and 14 interviews, the study identifies designerly co-creation as both an "incubation space" for sustainability innovations and a potential "catalyst for change" in staff behaviors, mindsets, competencies, and hospital procedures. The paper contributes to the growing body of knowledge on design for sustainability transitions by highlighting the evolving role of co-creation in steering change and generating impact within hospital contexts.

Keywords: designerly co-creation, sustainability transitions, hospital systems, healthcare

1. Introduction

The healthcare sector significantly contributes to the environmental footprint owing to its high energy consumption, CO_2 emissions, and the generation of both medical and general waste. This issue can be addressed by minimizing the environmental impact of the healthcare sector through the reduction of CO_2 emissions, material and resource usage, energy consumption, and waste generation, as detailed in the Green Deal Sustainable Care 3.0 agreement (Government of Netherlands, 2022). Hospitals are essential for advancing sustainability within the healthcare sector (Badanta et al., 2025), as they produce a significant amount of waste, which greatly contributes to environmental problems, such as increased pollution levels (Klangsin & Harding, 1998; Azevedo et al., 2025), owing to their resource-heavy infrastructure. Furthermore, the increasing dependence on disposable products (Klasen et al., 2025), along with infection prevention mandates, unsustainable

practices among hospital staff, supplier-related issues (Smale et al.,2025), staff shortages, and time constraints, all contribute to the growing volume of hospital waste streams. Recent studies from an academic hospital in the Netherlands indicate that each patient generates up to 17 kg of waste, 12 kg of CO_2-equivalent emissions, and consumes 300 L of water per day (Hunfeld et al., 2023). These studies indicate the urgency of steering long-term sustainability transitions in hospitals.

Meaningful change towards long-term sustainability transitions requires multi-level approaches that address social, environmental, and technological levels simultaneously (Loorbach et al., 2017), going beyond only technological solutions. By providing a long-term and systemic perspective, sustainability transition theories provide a framework to understand how large-scale societal changes toward sustainability unfold (Geels, 2004; Loorbach et al., 2017). These frameworks conceptualize how transitions can occur in a sustainable manner, but also how the associated complexities of these transitions are addressed systemically (Köhler, 2019).

Moreover, participatory methodologies, such as co-creation, offer frameworks for engaging with and experimenting within complex systems (Jones, 2018; Peet et al., 2024). When integrated with designerly approaches, these participatory methods enable diverse stakeholders to collaboratively envision, design, and experiment with alternative pathways for change (Gaziulusoy & Ryan, 2017; Hyysalo et al., 2019). This integration is particularly effective because design provides tools and mindsets that facilitate the creation of new values, technologies, practices, and lifestyles (Ceschin & Gaziulusoy, 2019), which can steer existing sociotechnical systems towards sustainability.

We approach hospitals as sites of transition. To engage with and experiment within the complex hospital system, we conducted designerly co-creation experiments. We propose that the designerly co-creation can function as a “pebble,” a small but deliberate intervention that initiates meaningful change within complex hospital systems. When such a pebble is “dropped into the hospital system” (see Figure 1), it generates “ripples” emerging from co-creation experiments that represent values and transformations. As these ripples expand and are amplified, they may foster hospitals’ long-term sustainability transitions.

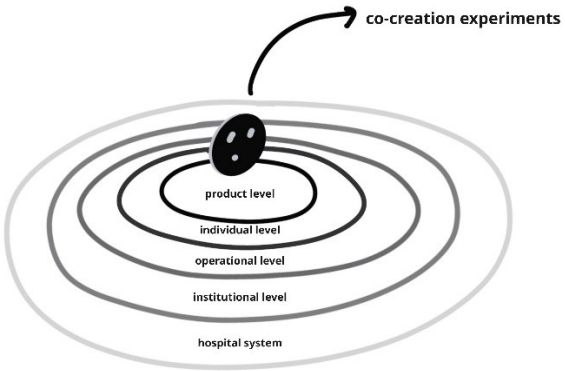

Figure 1 A diagram illustrating the pebble metaphor.

This paper investigates the role of designerly co-creation in steering short- and long-term sustainability transitions in hospitals by exploring the values it generates. In this paper,

designerly co-creation refers to co-creation guided by design practices such as prototyping, user and product journeys, as well as process and context mapping. These co-creation processes were centered on medical device design projects carried out by master's students in the faculty of industrial design, in collaboration with healthcare professionals. Through the co-creation experiments, we initiated, guided, and observed within the real complexity of hospital settings, which helped us uncover the immediate values of implementing designerly co-creation in hospitals. Through these experiments we engage directly with the real-world healthcare system and observe its dynamics in practice. While addressing these challenges, seven co-creation processes were embedded within three hospitals in the Netherlands to experiment with how co-creation operates in practice. Through 14 follow-up interviews with healthcare professionals and master's students, we captured the immediate values that co-creation generates. Building on these empirical insights, we then speculate on how these values may create ripple effects that contribute to long-term sustainability transitions.

2. Background

Sustainability transitions rely on the emergence of "cracks, tensions, and windows of opportunity" within existing regimes (Köhler et al., 2017, p. 8), which often arise through niche innovations (Geels, 2002; Rip & Kemp, 1998). We position designerly co-creation practices in hospitals as niche-level, localized experiments where alternative practices can emerge. These micro-level experiments are not only valuable in themselves but may also reveal cracks and tensions within existing hospital organizations, potentially opening windows of opportunity for broader systemic change over the long term. Thus, our approach aligns with the Multi-Level Perspective (Geels, 2002; Rip & Kemp, 1998), which provides a conceptual foundation for understanding where and how sustainability transitions can begin.

2.1. Multi-Level Perspective

Multi-Level perspective (MLP) proposes that transitions occur across three analytical levels: (1) niches, which act as protected spaces where radical innovations are developed and tested; (2) socio-technical regimes, the existing structures and rules that stabilize current systems and lead primarily to incremental change; and (3) the socio-technical landscape, comprising broader external forces and societal trends that influence these systems from the outside. These niches provide spaces for experimentation and the development of alternative practices, technologies, and social arrangements that can challenge and eventually transform established regimes (Geels, 2002; Loorbach, 2017).

2.2. Role of Design in Sustainability Transitions

Design offers distinctive tools, mindsets, and approaches for enabling sustainability transitions. Within design practice, the emerging field of Design for Sustainability Transitions (DfST) (Ceschin & Gaziulusoy, 2019), and particularly the Transition Design (TD) (Irwin, 2020) framework, provide a powerful approach for addressing complex systemic challenges such as those found in healthcare. TD enables practitioners to identify existing systemic problems and to conceptualize interventions aimed at fostering more sustainable futures (Jarrell et al., 2025). The TD framework advocates for driving systemic change through "reframing the present and the future, designing interventions, and waiting and observing" (Irwin, 2020, p.

32). This model promotes iterative and reflexive practices, understanding the current system, envisioning desirable futures, developing and implementing design interventions, and then observing and learning from the system's responses (Irwin, 2020). Such approaches inherently involve participatory and collaborative processes such as co-creation which enable diverse stakeholders to collectively envision and enact pathways towards sustainability.

2.3. Co-creation

Co-creation represents a concrete way in which design can operate within complex contexts such as hospitals. Co-creation (Sanders & Stappers, 2008) is a broad term referring to collective creativity shared between two or more people, encompassing both material and intangible domains. It is defined as an umbrella term that includes co-design and co-production as specific instances of co-creation (Sanders & Stappers, 2008; Vargas et al., 2022). Although the terms are often used interchangeably, co-design refers to collaboratively working on design development processes, while co-production involves prototyping solutions with relevant stakeholders in a participatory manner (Bird et al., 2021; Sanders & Stappers, 2008; Masterson et al., 2022; Messiha, 2023). In this paper, co-creation refers to a collaborative process that unfolds within a defined timeframe, involves a heterogeneous group of stakeholders, and fosters creativity towards ideas, products, services, and interventions.

Although the idea of co-creation can be traced back to the 1970s (Ehn, 1988), emerging from early calls for greater workplace democracy and participatory approaches, its application in healthcare remains relatively limited, especially for navigating sustainability transitions. Co-creation practices in healthcare is valued mainly due to their capacity to bring together multiple stakeholders, such as patients, medical professionals, hospital staff, and vendors, and to provide equal opportunities for people with different types of knowledge such as experiential, institutional and professional knowledge (Peet et al., 2025; Smale et al., 2025). In recent years, healthcare professionals and researchers have increasingly advocated for co-creation adoption, recognizing its potential to address complex and interdependent challenges including sustainability (An et al., 2025; Lauritz et al., 2023; Smale et al., 2025), changing healthcare regulations (Tschumi & Mayer, 2023), and integration capacity for interdisciplinary teams designing medical devices (P. Kaygan & H. Kaygan, 2025). However, there are many barriers to setting up co-creation activities in hospital settings, including limited stakeholder engagement, restricted access to knowledge and funding, weak relational connections, hospital culture, local conditions and policies (Longworth et al., 2024). In patient-healthcare professional collaborations, the most common form of co-creation in healthcare, additional barriers include patient diversity and shifting agency, unclear distribution of power and responsibility, risk of undervaluing professional expertise, the challenge of balancing standardized practices with contextual priorities, and a resistant healthcare culture (Batalden et al., 2015).

Co-creation processes incorporate creative and designerly methods that offer a concrete way to work with wicked problems (Rittel & Webber, 1973), within complex settings such as hospitals. Recently, there has been growing interest in employing designerly co-creation practices in the healthcare sector. Some recent studies (An et al., 2025; Jarrell et al., 2025) have combined a Transition Design perspective with co-creation activities. These approaches

aim to facilitate impactful innovations and guide sustainability transitions within healthcare settings. These studies, by conducting designerly co-creation practices in healthcare have shown methodological promise (An et al., 2025; Jarrell et al., 2025). For example, Jarrell et al. (2025) conducted a full-day workshop in the healthcare setting with hospital staff, patients, families and social service providers. Another recent study created a practical co-creation model to address public health issues (An et al., 2025). This model includes "co-conception, co-envisioning, co-making, and co-mapping stages to come up with systemic level health interventions" (An et al., 2025, p.8).

First steps towards understanding the potential of co-creation in hospitals have been taken. However, there remains a lack of understanding regarding the short and long-term impact of co-creation experiments on steering the sustainability transitions of hospitals. In order to address this gap, this study investigates whether co-creation creates short term value that may contribute to sustainability transitions in healthcare. We employ a value framework for multistakeholder designerly collaborations that addres complex societal challenges (de Koning & van der Bijl-Brouwer, 2024) to comprehend the impact of co-creation experiments on addressing sustainability challenges in hospitals. The value framework identifies five categories of values: innovation value, network value, identity value, learning value, and commercial value, which are created and perceived in creative collaborations for social innovation. When the value framework (de Koning & van der Bijl-Brouwer, 2024) is applied to this study, the values are defined as follows: innovation value refers to the generation of new ideas or solutions through medical device design and sustainability interventions facilitated by co-creation. Network value refers to the interactions among participants and the values that emerge from these interactions. Identity value captures the values generated in relation to participants' professional identities. Learning value refers to the knowledge and skills acquired through co-creation.

3. Methodology

The study's aim was to understand the role of co-creation in fostering sustainability within hospitals, by focusing on the short- and long-term value of such co-creation practices in driving sustainability transitions. The study employed a constructivist qualitative research approach (Constantino et al., 2008; Flick, 2018) to explore the different types of value (de Koning & van der Bijl-Brouwer, 2024) that were generated through designerly co-creation in hospital contexts. We set up seven co-creation processes centered around seven medical device design projects addressing sustainability challenges in hospitals (see Table 1). Designerly practices such as prototyping medical devices, mapping processes and contexts were central to the co-creation sessions. The methodological approach combined direct observations of the co-creation sessions with qualitative data gathered from 14 follow-up semi-structured interviews involving healthcare professionals who participated and master's students who acted as facilitators.

3.1. Study context

This study was conducted at three hospitals in the Netherlands. The projects were carried out with healthcare professionals, addressing healthcare challenges under the ESCH-R consortium (Huijben et al., 2025). The medical device design projects (see Table 1) were

executed by master's students for their graduation theses and used to facilitate co-creation processes. The authors, as design researchers and healthcare professionals, were involved in sensitizing, guiding, and facilitating the implementation of both design projects and co-creation experiments. Their activities included embedding themselves within hospitals, connecting students with healthcare professionals, supervising students' master's projects and co-creation experiments, and conducting interviews and observations. Currently, little is known about how designerly co-creation can be employed in hospital settings, making it challenging to implement within the real complexity of a hospital environment. We adopted an experimental approach to examine co-creation in hospitals, focusing on three aspects: (1) the challenges experienced during implementation by facilitators (master's students); (2) the perceived value of both the process and outcomes by participants; and (3) joint reflection, conducted in separate sessions with participants and facilitators. While five projects (Project 1-5)included structured co-creation sessions, two projects (Project 6- 7) included unstructured co-creation sessions. Following their processes provided methodological insights.

Table 1 Overview of medical device design projects and co-creation sessions.

Project title	Project Description
Project 1 Towards greener pulse oximetry: Product design enabling a seamless transition towards more sustainable pediatric pulse oximetry	*Focus:* Reusable alternatives of pulse oximeter, a device measuring blood oxygen levels. *Objective*: Promoting use of reusable pulse oximeter. *Co-creation aim:* Co-creation session aimed to better understand challenges and barriers towards using reusable alternatives. Seven healthcare professionals participated in this session.
Project 2 Sensing a sustainable future: A Holistic Approach to Pulse Oximetry Product and System Design	*Focus:* Pulse oximeter, a device measuring blood oxygen levels. *Objective:* Reducing medical device waste in hospitals by designing a reusable alternative to pulse oximeter. *Co-creation aim:* Identify interventions addressing product-related and systemic barriers to reuse in hospitals. Three healthcare professionals participated.
Project 3 Rewiring for Sustainability: A Circular Approach to the Redesign of ECG Lead Sets	*Focus:* ECG cables and lead sets, used to measure heart signals. *Objective:* Reducing medical device waste in hospitals by designing re-usable ECG Lead Sets. *Co-creation aim:* Revisit problems related to use of reusable ECG sets and generate systemic interventions to tackle with them. Five healthcare professionals participated.
Project 4 Grasping Circularity in Endoscopy: A Hybrid Redesign of Biopsy Forceps	*Focus:* Biopsy forceps used to collect tissue samples from inside the body. *Objective:* Reduce single-use medical device waste in hospitals by designing partly reusable biopsy forceps. *Co-creation aim:* Develop product service-system strategies to enable use of partly reusable biopsy forceps. Five healthcare

	professionals participated.
Project 5 Reducing Drug Waste in Pediatric Intensive Care: Mapping Hotspots and Exploring Reduction Strategies	*Focus:* Medication preparation systems in a hospital. *Objective:* Reduce drug waste in hospitals. *Co-creation aim:* Generate sustainability interventions to decrease medication waste in hospital. Ten healthcare professionals participated.
Project 6 Beyond the Bottle: Design approaches to sustainable infant bottle feeding	*Focus:* Infant milk bottle (used to safely store formula and feed newborns) *Objective:* Designing a product-service system concept for infant bottle feeding to reduce resource use. *Co-creation aim:* Unstructured co-creative sessions were to explore problems regarding milk bottle preparation and generate sustainability interventions. Two healthcare professionals participated.
Project 7 Circular Care: Improving the Environmental Impact of Infusion Bags in Hospitals	*Focus:* Infusion bags (medical containers used to deliver medications into a patient's bloodstream through an intravenous (IV) line. *Objective:* Improving the environmental impact of infusion bags in hospital by designing recyclable infusion bags. *Co-creation aim*: Unstructured co-creation sessions were used to understand the barriers to recycling infusion bags. Two healthcare professionals, a waste processor company and a compound manufacturer participated.

3.2. Data collection

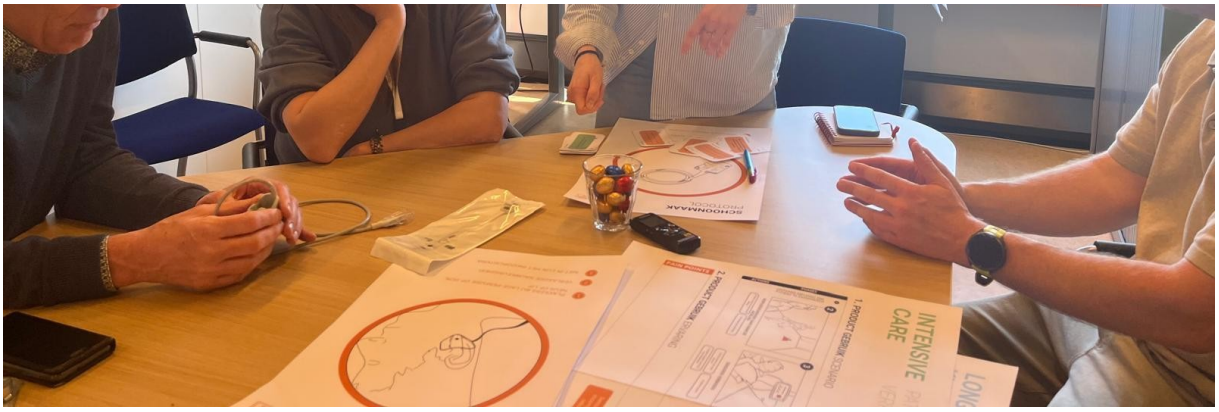

Figure 2 Co-creation session in Project 1.

In addition to following the process of the seven medical design projects, we conducted 14 semi-structured interviews with master's students and healthcare professionals, including medical personnel, procurement officers, technical staff, infection prevention specialists, and logistics personnel as well as through direct observations of the co-creation sessions (see Figure 2). The purpose of these interviews was to understand how the sessions unfolded, what kinds of values participants perceived, and how they believed the co-creation sessions

contributed to addressing sustainability challenges within the hospital. The interviews lasted between 20-60 minutes. The hospital context was intentionally selected because it allowed for exploratory, low-risk experimentation. Working with master's students created a safe-to-fail environment, and the embeddedness of the setting enabled manageable yet meaningful engagement with real healthcare challenges.

Table 2 Interview list

Project	**Role/Expertise**	**Code**
Project 1	Facilitator/ Design student	F1
	Participant/ Sustainability expert	P1
	Participant/ Infection preventionist	P2
	Participant/ Medical technician	P3
Project 2	Facilitator/ Design student	F2
	Participant/ Procurement Staff	P4
Project 3	Facilitator/ Design student	F3
	Participant/ Nurse	P5
	Participant/ Technician	P6
Project 4	Facilitator/ Design student	F4
	Participant/ Nurse	P7
Project 5	Facilitator/ Technical Medicine student	F5
	Participant/ Infection preventionist/Nurse	P8
	Participant/ Pharmacologist	P9
Project 6	Facilitator/ Design student	NA
Project 7	Facilitator/ Design student	NA

The 14 semi-structured interviews were transcribed using software named Otter and analyzed through two-cycle thematic analysis. In the first cycle, open coding (Clarke et al., 2018) identified emergent themes from participants' experiences, providing insights on hospital culture and organization. The second cycle used both inductive and deductive coding (Braun & Clarke, 2006). Inductive coding identified context-specific values from the hospital setting, while deductive coding was guided by the value framework of de Koning & van der Bijl-Brouwer (2024) to understand observed value types. This process enabled understanding how designerly co-creation practices generate and mediate different forms of value within complex healthcare environments and their contribution to long-term sustainability transitions in hospitals.

4. Findings

Our aim was to identify immediate values produced and their potential impact on sustainability transitions, and examine limitations when designerly co-creation encounters hospital settings. Data revealed four value types: innovation value, network value, identity value, and learning value. However, commercial value was identified due to the projects' educational focus.

4.1. Innovation Value

Innovation, in general, is highly valued within the hospital context (P4). Innovation value emerged through both the medical device design and the new creative, visual and collaborative way of working. The prototypes of these devices played a critical role in two ways. The first role of the prototypes was generating practical insights and demonstrating that sustainability can be implemented at the level of physical medical devices. Second, during co-creation, the prototypes acted as "boundary objects" (Star & Griesemer, 1989) and facilitated immediate collaboration among diverse stakeholders, which is considered an innovative way of working in the hospital context (P1). P2 emphasized that the resulting physical examples also have the potential to serve as proofs of concept, showing hospital staff that sustainable products and systems can be designed, thereby increasing the credibility and perceived implementability of sustainability strategies rather than leaving sustainability as an abstract concept.

As the co-creation processes were largely organized around developing new products, systems, or sustainability interventions, these spaces inherently fostered novelty. P7 stated that collaboration with master's students, as novice designers, provided them with "out-of-the-box solutions" to existing problems in the hospital setting. The novelty of the product solutions was mostly attributed to the master's students, while the participants primarily contributed by reflecting on the implementability of these product-related solutions as well as providing context-related knowledge.

Generating implementable solutions with the highest potential impact is highly valued in hospitals (P5). Involving experts from the field increased both the variety and feasibility of the proposed solutions. Although manufacturing medical products in the short term can be challenging, participants appreciated the opportunity to share their opinions early in the medical R&D process. According to F3, the involvement of procurement staff enabled others to develop more holistic and, therefore, more feasible solutions that considered the entire supply chain. During the co-creation, both implementable and non-implementable ideas emerged; however, all remained at the concept-development stage. Moreover, we observed that designerly co-creation also provided a new way of working and thinking towards sustainability in the hospital context: "not only the product but as a method co-creation will stay with us" (P2). Both the products themselves and the collaborative process fostered innovation value and enabled the integration of disciplines around a shared problem which leads us to reflect on network value.

4.2. Network Value

The co-creation approach brought together diverse stakeholders, including procurement staff, nurses, infection prevention specialists, sterilization unit members, and medical doctors. This often clashes with the traditional ways of working in hospitals. P2 highlighted the "sequential working culture", in which staff follows a set order: individuals in one

department complete their tasks and then hand over the project to the next department. In contrast, coming together in the same room was perceived as a more "efficient way" to work (P5, P1, P2). Given the hospital's prevailing "silo culture" (P1), the co-creation proved particularly valuable for fostering cross-departmental dialogues.

> "I work here, but most of the time when people try to make changes, they go to each stakeholder separately and talk to them about what we think from our expertise. But we are never all in the same room together like we were in co-creation." (P3)

We observed that the co-creation also facilitated the formation of new connections among participants. Engaging with colleagues they had not previously interacted with and collaborating on a particular challenge, strengthened this sense of connection. As P1 noted, the co-creation session offered a rare opportunity for diverse stakeholders, such as nurses and procurement staff, to interact and collaborate.

Collective energy fostered solution-oriented thinking to address sustainability challenges during co-creation. Some participants were already aware of their roles in sustainability, which helped create collective momentum around the question, "What can we do?". F4 highlighted that the idea generation process among participants became more positive and solution-oriented when they engaged in dialogue together during the activity. Combined with identity and learning values, this fostered the energy necessary to advance sustainability.

Lastly, the processes were predominantly facilitated by master's students from a technical university. This was perceived as a valuable networking opportunity for collaboration between technical universities and healthcare institutions, as it introduces new ways of thinking and facilitates knowledge sharing among these institutions at a broader level.

4.3. Identity Value

Participants engaged in the co-creation process in ways that reflected their professional identities. Each participant "brought their own expertise" to the co-creation, presenting their perspective as a representative of their respective professional domain. P3 approached the co-creation sessions as an opportunity to articulate why certain technical decisions determine the selection of a particular product, and also to recognize other experts' perspectives. Others saw co-creation as an opportunity to ensure that their rules and perspectives were included. P2 and P8, as infection prevention staff, were concerned with maintaining authority over their respective domains. They emphasized that their participation from the start of the project would ensure that relevant protocols were respected.

> "I participate in the implementation of a new workflow or product to be more involved from the beginning, like in this project. Otherwise, when the project is almost finished, we have to say no because it's not hygienic enough." (P2)

P1 and P5 perceived the co-creation sessions as a platform to influence and initiate sustainability change early on in the process, reflecting a more proactive, change-oriented identity. This ensured that they were able to contribute to sustainability discussions and influence decisions to incorporate their sustainability agenda. Meanwhile, some participants

(P6) described their primary motivation as supporting the students by sharing their professional expertise, framing their participation around mentorship and contribution.

4.4. Learning Value

The co-creation setting created a safe-to-fail environment in which most participants openly shared their knowledge. The master's students also contributed to this exchange by bringing in the research they had conducted around the problem within the department. Healthcare professionals that joined the co-creation process were also curious about how other departments operate and how products are used in different settings (F1, P3). The learning value generated by the co-creation differs from person to person, not only based on their role or expertise but also based on personal characteristics such as curiosity.

The hospitals we worked with have a decentralized organizational culture, meaning that each department functions as an individual unit with its own practices. This makes it challenging to develop a holistic understanding of the entire system or of specific procedures, as information is scattered across departments. The amount of waste is generally unknown in the departments (P8, P5) and must be obtained through procurement records (F2) or collected through observations and interviews (F1). P3 explicitly stated that they gained knowledge from each other during the session.

> "We were together with a nurse. She gave a lot of insights into the use of the sensors and explained why certain things are important during their application, such as attaching, detaching, and disposing of them. I think that's the strength of that co-creation session, you also hear how other departments view the subject." (P3)

The co-creation process also provided participants with insights into current practices and procedures within specific departments, especially in discussions about where the environmental hotspots in processes are (P5). The learning value may lead to increased awareness of sustainability issues (P8); however, this needs to be supported through the implementation of the generated ideas (P5), as the impact of awareness alone may diminish over time (F2).

5. Discussion

This study explored designerly co-creation centered on designing medical device projects in hospital settings. The goal was twofold: to demonstrate potential for enhancing hospital sustainability through new product design and foster engagement around sustainability. We found these co-creation experiments enabled meaningful experimentation and a situated understanding of sustainability, creating four interrelated forms of values (de Koning & van der Bijl-Brouwer, 2024). Positioning these processes as niche experiments in line with the MLP from transition studies (Geels, 2002; Rip & Kemp, 1998;), we posit they hold potential to disrupt existing systems and generate long-term impacts by influencing behaviors, awareness, and mindsets towards sustainability (see Figure 3).

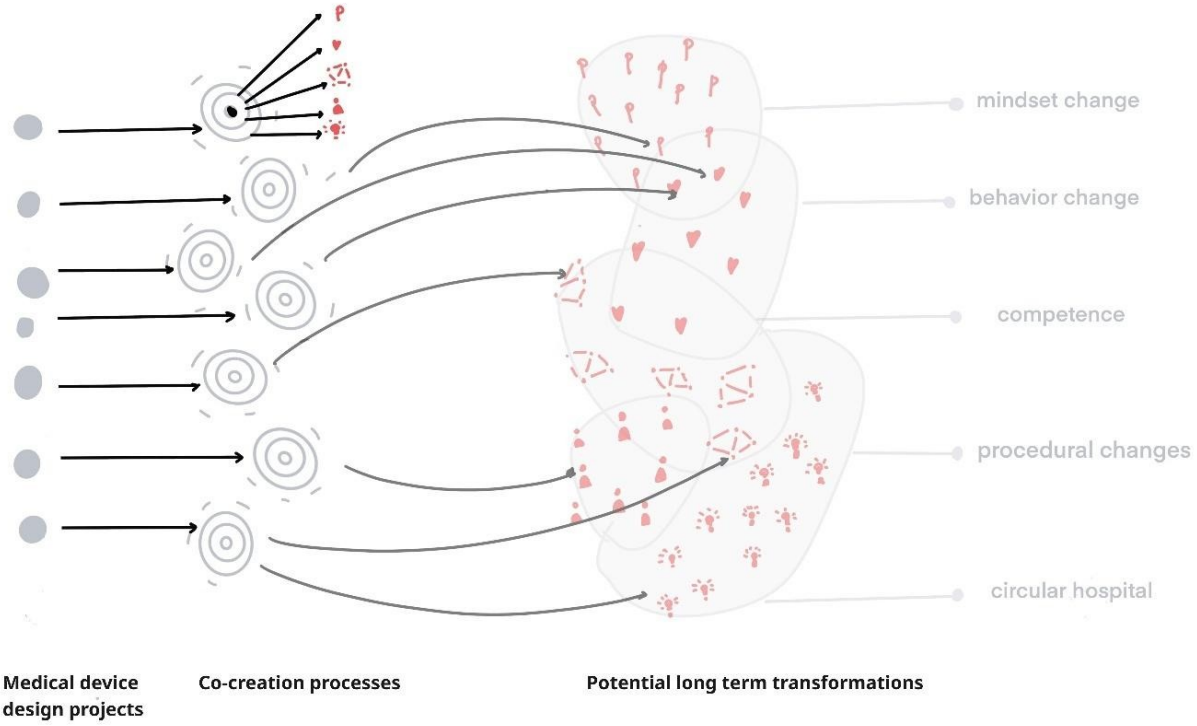

Figure 3 A model visualizing the ripple effect

In this section, we discuss two intertwined roles of designerly co-creation in hospitals and their relationship to sustainability transitions. The first role, grounded in our findings, concerns how co-creation generates immediate sustainability insights and values within hospitals. For the second role, we speculate how such practices may contribute to broader sustainability transitions by influencing mindsets, behaviors, and hospital organizations.

5.1. Co-creation as "Incubation space" for sustainability innovations

The functioning of co-creation processes as niche experiments of a new way of working and using, designing, and producing products serves as "incubation for innovation" (Geels, 2002; Rip & Kemp, 1998;). The conducted experiments generated practical insights regarding co-creation and sustainability that we discussed through four interrelated forms of value: innovation, network, identity, and learning (excluding commercial value). Our findings indicate that the combination of values generated through designerly co-creation enhanced the credibility and perceived feasibility of sustainability efforts within the hospital. However, co-creation remains largely abstract without tangible outcomes and continuous engagement with real hospital challenges. The visibility of tangible and intangible outcomes of co-creation is essential to sustain motivation and safeguard the credibility of sustainability in hospitals. Co-creation also contributed to a democratizing effect (Peet et al., 2025), as participants began to recognize and value diverse forms of expertise, helping to challenge traditional hierarchies of knowledge, which fostered professional recognition, cross-disciplinary learning, and new collaborations. Similar to Smale et al. (2025), the co-creation processes brought together diverse expertise, fostered mutual understanding, and enhanced

participants' sense of ownership, while trust-building was constrained by the short-term nature of the co-creation process.

5.2.Co-creation as "Catalysis for change"

Based on our findings of what people said that they valued and learned, we speculate that co-creation has the potential to act as a "catalyst for change" (Mulder, 2018), initiating mindset and behavioral change at the individual level, as well as competence development (Wiek et al., 2011), such as collaboration, strategic thinking, systems thinking, and futures thinking. At present, co-creation practices often clash with existing hospital routines and logics; however, participants consistently recognize the value of the new working modes, developed concepts, and interprofessional connections that were created. For large-scale and long-term transformation to occur, a fundamental shift in behavior, ways of working, and goal orientation, moving beyond efficiency and cost-driven values, is necessary.

Designerly co-creation can serve as an experiment for these emerging ways of working, testing new forms of collaboration, and decision-making within the hospital system. However, if it remains at the experimental level, the effect may be fragile. The effect might remain fragile because of (a) lack of methodological understanding, (b) lack of groundwork, (c) lack of implementation, and (d) lack of support from institutional and regulatory bodies. To translate these experimental practices into enduring habits and amplify the impact of these experiments, supporting alignment, understanding, and agreement among stakeholders are required (Masterson et al., 2024). We need to make conflicts visible and create tangible outcomes such as implementing sustainability interventions, developing medical devices, generating environmental impact, and scaling up to broader organizational levels within the hospital. To achieve this, we need more co-creation and longer processes to understand the interlinked effects. This requires continuous cycles of experimentation, learning, and implementation (Irwin, 2020) through co-creation and integrated models that support these cycles (An et al., 2025; Irwin, 2020). Otherwise, co-creation risks remaining an isolated exercise and a designated experiment only.

Co-creation without tangible outcomes or institutional impact risks falling short of its transformative potential. These efforts must be supported by sustained implementation and an embedded approach grounded in real hospital practice. As hospital staff are already time-constrained, external actors, such as design students and researchers, can support the implementation of these practices; however, dependency on external actors could create uncertainty about achieving intended outcomes. We acknowledge that such uptake, amplification, and institutional embedding remain speculative at this stage.

6. Conclusion

Given its dual role as both an incubation space and a catalyst for change, this study highlights the potential of designerly co-creation to support hospitals' shift towards sustainability. Designerly co-creation generated four types of value: innovation, network, identity, and learning, which can foster sustainability in hospitals, though these findings are limited to the study's specific experimental context. When amplified, these values collectively highlight the potential for a shift towards more sustainable healthcare systems by promoting awareness,

behavioral and mindset changes, enhanced competencies, and procedural improvements. Realizing this potential requires ongoing experimentation, continuous engagement, institutional support, and the integration of co-creation into broader organizational frameworks.

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7. References

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