



Formative Interventions for Healthcare Sustainability: A Developmental Design Agenda

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ABSTRACT

This chapter proposes a developmental design approach to build a long-term design research agenda to study and advise healthcare services towards meeting sustainability challenges. The study involved the application of systemic design tools in a participatory design workshop to create a formative understanding of the stakeholders, contexts and systemic interventions towards sustainability of healthcare systems. Healthcare services draw on vast logistics systems, generating waste streams and redundant uses, with a significant sustainability impact. Analysing the complex functions of any regional healthcare system reveals material flows and proscribed service interactions that reinforce continuing breaches of preferred sustainability levels. These flows are largely due to institutional arrangements defined far upstream of use and disposal. Yet, the actions and choices of healthcare consumers are becoming larger factors to consider in the overall environmental impact of healthcare systems. Patient-centred healthcare shifts a significant share of the responsibility of health outcomes on the consumer, including waste generated through home healthcare which is typically routed through municipal waste streams. Whether policies, healthcare services, or individual patient choices—nearly all actions in the healthcare system trigger actions with sustainability impacts. Healthcare’s complex systems are difficult to navigate individually, especially for non-experts. Although constant strides are being made towards making healthcare systems more sustainable, their complexity makes it difficult to verify the efficacy of interventions within the system and across the interconnected network of stakeholders and sub-systems.

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1 Introduction

Healthcare services are the source of significant unsustainable environmental threats. The increasing impacts of energy and material use, global supply chains and toxic waste streams of healthcare systems contribute to massive environmental impacts, including non-recyclable landfill waste, toxic chemical and plastics waste in land and water flows, and greenhouse gas emissions (Eckelman & Sherman, 2016). With an increasing demand for healthcare services from both modernizing and ageing populations worldwide, a vicious cycle of healthcare for individual patients at the cost of the health of entire populations is observed, causing moral and ethical tensions in the operation of health systems and the provision of health-related services in a responsible manner (MacNeill et al., 2021).

Recent events of the COVID-19 pandemic, increasing natural disasters around the world and an acknowledgement of climate change as a global challenge have escalated the conversations among healthcare policy-makers towards mitigating the environmental impacts of the healthcare industry (Ossebaard & Lachman, 2021). These conversations are translating to research on reducing emissions of healthcare systems, adopting less wasteful practices and finding a balance between economic and environmental sustainability (Sherman et al., 2020). Although these initiatives are encouraging and necessary for the transition to sustainable healthcare, they are predominantly piecemeal studies that are simplifying a complex problem (Arun Kumar, 2020, 2021; Arun Kumar & Wang, 2021; Kumar & Wang, 2019). It is unclear whether the individual initiatives are contributing meaningfully towards mitigating the impact on climate change, or are generating new problems which may be further degrading our environment, such as the practice of ‘green-washing’ that give public relations cover to policies that continue to exacerbate environmental degradation.

A complex systems approach is useful in creating a holistic understanding of healthcare system problems (Sturmsberg, 2020) and visualizing complex causes and effects across various networks of elements. A systems visualization, such as a synthesis map (Jones & Bowes, 2017), enables the participants to foresee the effects of probable interventions on the entire system, to take a more informed approach towards solution finding and resolution. This study used systemic design tools to engage participants with diverse backgrounds and interests to tackle a complex issue, visualizing their unique perspectives while inter-linking these perspectives to create a holistic understanding (Jones & Van Ael, 2022). In this case, the design study engaged diverse participants to discern how individual actions within sub-systems affects healthcare systems to envision intervention for high-leverage sustainable practices.

The study illustrates a systemic design approach to unveil the complexities in healthcare sustainability interventions. A participatory design workshop was conducted with design experts in healthcare and sustainability at a symposium using three different systemic design tools to map the stakeholders involved, the context of healthcare sustainability and potential leverage points for intervening in such complex systems. The workshop produced five representations that visualize the actors of the system, the context in which they operate, and the areas of intervention towards reducing the environmental impact of these systems.

The Systemic Design Toolkit, designed by Namahn and developed by Jones and Van Ael (2022), is a set of system modelling canvases designed for participatory workshops to engage participants from diverse backgrounds to address complex problems. The toolkit brings together the powers of systems thinking, human-centred design and service design approaches to support engagement with wicked problems, complex system interventions and development of higher level policy and practice across industries. Although the toolkit comprises over 40 canvases for a seven-stage methodology, this study was carried out in a condensed format, using three canvases, while developing a rich understanding of the system as well as potential interventions towards healthcare sustainability.

2 Design Agenda for Healthcare Sustainability

We recommend an incremental, developmental approach to making interventions in high-complexity contexts (Flach, 2012), within a long-term agenda towards stronger sustainability in consumer health and institutional healthcare. This early stage study reports on outcomes from a design workshop and content analysis, with continuing artefact development and literature analysis. In this exploratory phase of the study, we framed the workshop generative activities on defining actors, contexts and interventions to address critical environmental sustainability issues, such as consumer waste flows and sustainable product development and procurement. However, the participants in the workshop activities were not involved in follow-on analyses.

We find two contexts to account for a significant proportion of sustainability decisions accessible to service design: the patient as a consumer of healthcare services and the healthcare institutions as systems of healthcare provision. There are contexts in the total healthcare systems other than the individual patient and the hospital-level system, such as health policy, equipment suppliers and human-centred systemic design. But these two areas—the patient and hospital institution—widely differ in volume of material flows, types of waste, hazardous materials and single-use products. The consumer, patient, clinician and the hospital can all be seen as actors within a whole healthcare system for the purposes of sustainability transformation.

Healthcare sustainability has been approached from several perspectives, all of which are necessary to consider in a systemic view of healthcare. Pereno and Eriksson (2020) used a similar approach to explore the landscape of healthcare sustainability across multiple national and system contexts. Also acknowledging the significant complexity in this domain, they defined a variety of primary actor groups recruited for collaborative foresight approach, including health industries, health providers, managing authorities, universities and research centres, clusters, non-governmental organisations and healthcare networks, and professional consortia.

This study is structured to serve the aims of descriptive and normative research, using design action research to facilitate a series of learning cycles. The workshop and following activities establish the context to promote a longer term design agenda as a systems-change programme. We consider the agenda-formation process as a necessary stage of developmental design, and recommend a series of inquiries, learning cycles, and artefact cocreation and publication.

Based on the Warfield model of scientific programme development (Jones, 2018) a series of design engagements proceeds from the Lab (internal model development) to Studio (workshop cocreation of content) to the Arena (co-development within the healthcare industry), returning to the Lab for theory development, in a full developmental cycle of research. Tightly scoped research can contribute to the developmental design process, but in formative stages of agenda formation, an exploratory, interpretive research disposition is helpful, to err on the side of a comprehensive sweep of prevalent ideas in complex sustainability.

2.1 Towards Developmental Design

Design interventions and design research encounters can be considered as socially constructive performances that produce objects of design (Pedersen, 2007). These objects are produced by the participants in a given, defined design process and can be assumed to evolve with the project. The objects are the result of reflections on development of the knowledge attained towards and in the process of making the object, thus being outcomes of multiple tacit and explicit knowledge bases. One of the goals of the overall programme is to then relate these objects to the public and open dialogue for external input, particularly from those affected by the objects, in more of a reflective learning process rather than prototype testing.

The precedent of developmental evaluation was envisioned by Patton (1994) as an effective defining process for agenda formation. Developmental evaluation uses an action-research-oriented reflection cycle to make progress towards long-term goals through cooperative evaluation of interventions, as processes towards these goals (Patton, 1994). Patton has further developed the evaluation methodology in Principles-Focussed Evaluation (Patton, 2018) for complex social change programmes, and more recently as applied to global systemic problems such as climate change in the planetary Blue Marble Evaluation (Patton, 2021).

The developmental approach is intentionally incremental, following insights from learning from each step to the next towards long-term impact, i.e., from learning in event one (systemic design workshop) that drives event two (deeper analysis and publication), then event three (synthesis map) and so on.

Design practices customarily orient towards improvements in effective delivery, as implementation is a known weakness in design practice. We might note that in instructional design, an adjacent concept is found in the proposals for formative design (Frick & Reigeluth, 1999), but this has also not been applied towards longer term constantly progressing design or research agendas.

There appears to be no direct analogy or equivalent in design methodology. It is different than iterative evaluation cycles, or learning journeys, because those practices are not ‘forward intervening’ to change their subject domain, as in design. We do not conceive of developmental design as iterative construction towards an optimized outcome, but as an expansion of learning that builds an open agenda of proposed interventions that can be developed and tested, even independently from our proposed platform. Developmental evaluation does provide support for constructing research agendas, in terms of defining new problems of interest and possible interventions and outcomes.

The beginning and end of a designed artefact are open and not limited to the project. Design is related to user appropriation and hence the process must be open to appropriation as well (Krippendorff, 2005). This appropriation is reflective in nature and any change occurring to the context affects the relationship between the artefact and the user. The reflective practice of practitioner fields such as management and design, as described by Schön (2017), suggests that a key action of reflection in and on practice involves the evaluation of effectiveness of action, echoing the values of developmental evaluation. Furthermore, the use of research for the improvement of practice and this cyclic process of reflection in and on practice creates a base for the focus on developmental design as a method of reflection *through* practice. This aspect of reflection through practice, as in Research through Design, (Jonas, 2007) is not typical in evaluation, and is an important component of developmental design—the design of artefacts as a reflective practice towards the long-term research, development and intervention in complex systems.

3 Methods and Approach

A two-hour workshop was conducted with 19 participants and two facilitators via remote facilitation, as an accepted workshop in the 10th Relating Systems Thinking and Design Symposium (Jones & Arun Kumar, 2021). The workshop was facilitated by the authors, involving brief topical presentations via a Zoom conference call and the participants used systemic design tools displayed as image files on the Miro online whiteboard platform. The Zoom call and the chat log were recorded and the outcome from the workshop was recorded and analysed ex post.

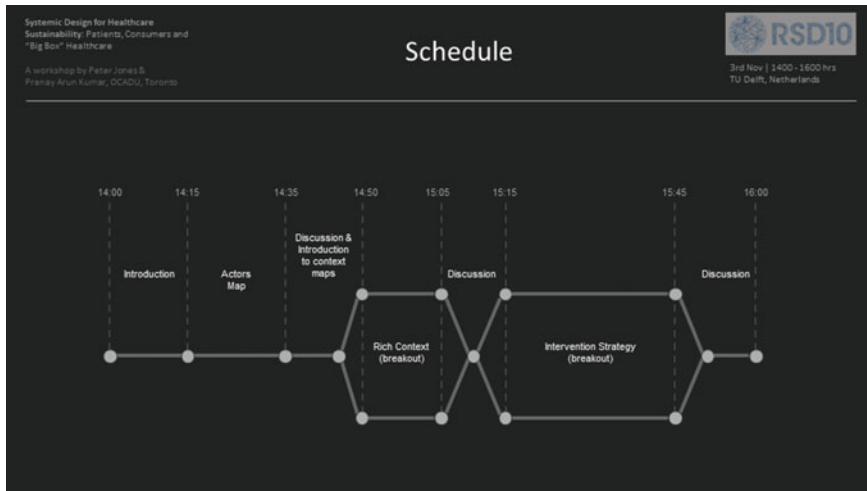


Fig. 1 Workshop schedule and structure. *Source* Author's own figure (2022)

The workshop was conducted in three phases (Fig. 1) using three systemic design tools to frame the actors of the problem (Actors map), to frame the context of the problem (Rich Context map) and to explore solution areas within this defined system (Intervention Strategy).

Before engaging participants in the mapping exercise, the facilitators provided a brief introduction to the workshop, the context of healthcare sustainability being addressed, and the use and relevance of systemic design tools for this workshop. Each phase involved an introduction to the tool as well as to the method of using the tool, followed by facilitating participants to use the tools effectively and concluded with a guided discussion on the mapping experience as well as answering queries from participants on the tools and processes.

The first phase, the identification and mapping of actors and stakeholders using the Actors map, was conducted with the entire group participating together on the same map image. The remaining two phases were conducted by organizing participants into two groups, one focussing on the patient as a consumer of healthcare services and the other on healthcare systems as service providers. The objective of breaking the team into two groups was to enable participants to have a more focussed approach towards context and intervention identification within either the micro-perspective of the individual's agency in complex problem-solving or the macro-perspective of the systemic and institutional agency. Participants were asked to choose from the two groups they preferred, depending on their interests.

For each of the three phases, the participants used electronic sticky notes to add elements on the maps, and then linked the elements with each other and defined these relationships between elements. Participants were also free to change their sticky notes and change their positions if they felt there was a more appropriate position, based on discussions with the facilitators and other participants.

The methodology described above had four objectives: 1. to introduce the participants to systemic design tools as methods to engage with complex problems; 2. to allow the participants to leverage diverse academic and professional backgrounds and contribute to rich dialogue with nuanced perspectives towards a problem that was elusive but palpable; 3. to identify points of intervention within healthcare and health systems for influence and impact and 4. to progress from tangible and infrastructural issues towards identifying and elucidating the moral and ethical tensions in healthcare sustainability.

4 Analysis and Findings

We report on three classes of findings of interest for the discussion. The findings from the data generated by participants were analysed as content relevant to informing both expected or near-term sustainability practices. The use of a rapid system analysis method was perceived as valuable and effective for the purpose of collective learning and design. The workshop process yielded effective interaction from a self-selected group of participants that suggests the utility of the interactive design tool-driven process.

The participants of the workshop had diverse professional backgrounds including expertise in systemic design, service design, clinical medicine, mental health, sustainability, product management, industrial design, design education and other related fields. Most, if not all of the participants were new to the use and application of systemic design tools, even though many were designers and could relate to the explanations of the tools provided by the facilitators. The participants could be classified primarily as ‘tourists’ according to the Design Journeys (Jones & Van Ael, 2022) methodology, i.e. interested novices to systemic design with ideas to contribute. The workshop generally served as an introduction to systemic design tools for most participants as well.

A total of five maps were generated over the period of two hours through the workshop (Figs. 2, 3, 4, 5 and 6). Participants were told to use sticky notes of a single colour on a map, to ensure that their contribution to the mapping process was identifiable, even though the annotations were anonymous. The high number of notes and diversity in colours used indicated engaged participation in the workshop.

4.1 Actors Map

The Actors map (Fig. 2) was used as the first tool to identify the ranges of stakeholders (actors and actants) associated with the system as identified by the participants. These actors ranged from individuals such as patients and caregivers, to institutions and organizations such as ministries of health and universities. These candidates were positioned on the Actors map depending on the participants' perceived understanding of the knowledge the actor possessed of healthcare sustainability and their ability to influence decision-making within the system. Within the 15 minutes provided for this exercise, the participants managed to identify stakeholders in all four quadrants of the map at various levels of power and influence. The participants were also able to create links between stakeholders where a suitable relationship was identified, even though they were not able to flesh out the relationships between the stakeholders within the allotted time.



Fig.2 Actors map produced from the workshop. Source Author's own figure (2022)

4.2 Rich Context Maps

The second phase of the workshop involved developing the *Rich Context map*. This tool is used to define the sociocultural and business contexts of a complex situation. The Rich Context served two purposes in the workshop, to collect responses associated with the contextual categories to define system features and to be able to compare sustainability issues between the patient and healthcare system contexts. The Rich Context identifies long-term trends in a system (e.g., ageing and longer lifespans), the current practices in healthcare systems (e.g., self-care based on online resources before consulting clinicians) and niche innovations which are influencing changes in the system (e.g., bio-plastics for medical equipment). The relationship between the trends, practices and innovations provided a clearer understanding of the context in which the system was being studied. In this case, the set of participants divided themselves into two groups, one focussing on the consumers of healthcare (Fig. 3), and the other on service providers of healthcare as agents of healthcare sustainability (Fig. 4).

The Systemic Design Toolkit suggested the participants could conduct secondary research to identify the trends and practices before attempting the *Rich Context map* (Jones & Van Ael, 2022). However, in this study, participants had to draw on their expertise on the subject to suggest the trends, practices and innovations. In the *patient-centred rich context* (Fig. 3), we could see a dense contribution in *long-term trends* and *current practices* within the culture and practices quadrants, while the *emerging niche initiatives* area showed very few contributions. Within the *current practices* ring, the participants seemed to indicate a low relevance of economic structures to the ensuing long-term trends, with a relatively low contribution of annotations to the *economic structures* quadrant. The niche initiatives suggested by the participants indicated stronger correlations with culture and routine behaviour than with institutional or economic structures.

In the *healthcare services-centred rich context* (Fig. 4), there was a dense contribution to *long-term trends* supported by perceived current practices in the prevalent economic structures and routine behaviours of these organizations. The few niche initiatives identified also link primarily to culture and routine behavioural practices.

The Actors and the Rich Context maps helped frame the system within which this study operated. The framing of this system involved identifying the stakeholders and their influence and power in the system, as well as the long-term trends, current economic, institutional, cultural and behavioural practices and new innovations disrupting the system. These two phases of the study provided a frame of reference to identify suitable interventions towards making healthcare systems sustainable.



Fig. 3 Rich Context map, patients as consumers in healthcare sustainability. *Source* Author's figure (2022)



Fig. 4 Rich Context map, healthcare system sustainability issues. *Source* Author’s figure (2022)

4.3 Intervention Strategy Maps

The third exercise of the workshop involved the *Intervention Strategy tool*, designed to elicit leverage points for change towards desired outcomes (in this case, sustainable healthcare). Participants stayed with their previous teams, focussing either on patient-centred interventions or on healthcare system interventions. Two maps were developed as mentioned above (Figs. 5 and 6). While the first two phases framed the system for its context and stakeholders, this phase focussed on identifying suitable interventions to navigate the context towards sustainability innovations in both domains.

In both the intervention maps, a seemingly uniform contribution can be observed across the 12 leverage points and many links between the elements have

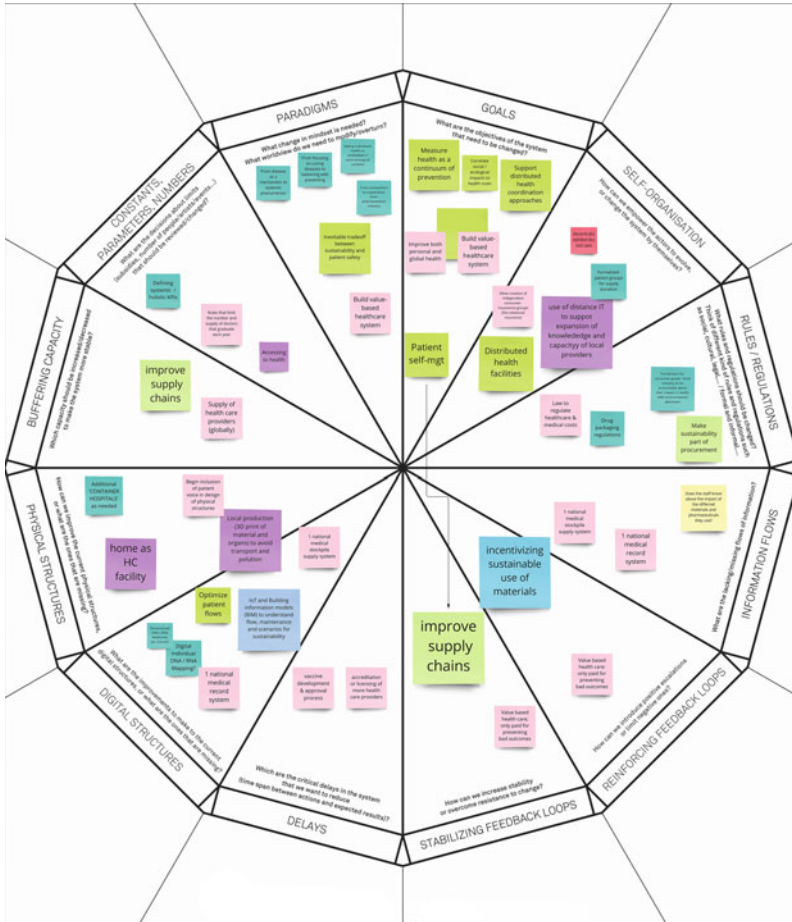


Fig.6 Intervention Strategy map, healthcare system sustainability issues. *Source* Author’s figure (2022)

5 Discussion

The use of systemic design tools for complex problem interventions gives stakeholders and designers structured approaches towards high-level problem-solving. Yet the use of these methods and the process of designing system interventions have various factors to consider for maximum efficacy. In this section, we discuss some of the factors that influenced the output from the workshop conducted, and the relevance of these factors for future participatory design workshops using systemic design tools.

5.1 Cognitive Factors in Participation

It is important to note that the expected lack of experience in using systemic design tools served two different purposes in this study. Firstly, the lack of prior knowledge of the tools allowed diverse interpretations of the mapping process, with participants using their own justifications and reasoning for placing elements in the map. The prior knowledge of such tools tends to promote the intuitive formation of strategy among users which limits their ideas and the openness to method-use approaches, whereas a lack of such intimation allows a more playful and exploratory approach, eliciting a broader range of ideas, which is a valuable outcome of using the systemic design tools. However, the lack of experience also left some participants apprehensive of contributing freely to the mapping process. This was observed through regular inquiries in the chat and during discussion periods of the workshop, when participants would verify the most appropriate position for a certain annotation with the facilitators and how they could justify their meaning by location before placing the label in position. Some participants were also left questioning the relevance and value of their ideas to the maps, which limited their contributions. There was a lack of comfort in the ambiguity and diversity of ideas for some participants.

Each of the maps represented a first iteration of mapping for the workshop and was designed to be completed in 15–20 minutes to accommodate for the duration of a two-hour workshop. The aim of the exercise was to explore the breadth of ideas and cross-pollinate diverse perspectives on the system across disciplines and areas of interest to compare and explore the salient issues in healthcare sustainability. This study should not be confused with a clear identification of system boundaries or solution sets, and rather should be observed for the rich discourse provided through the maps, which can be a resource for more targeted navigation towards future solutions for healthcare sustainability.

5.2 Ecological Factors for System Mapping

The first iteration of the maps helped provide the widest diversity in ideas and perspectives on the system, and acted as a sounding board for exploration of relationships between elements and their value in intervening in the system. If the context of this study was that of a structured project working towards interventions in a predefined system, this exercise could be continued through multiple iterations, resolving the focus of the project and elaborating the nuances of the network of elements and the relationships between the elements to arrive at suitable solutions that may responsibly disrupt the system with a granular understanding of the effects of the disruption across the system.

However, the maps generated in this study have a wider use as triggers for researchers, practitioners and policy-makers developing projects on healthcare sustainability. As part of the developmental design approach described earlier, the findings from the workshop will be translated to a synthesis map, which would

serve as a design artefact for further reflection and progression towards co-design of systemic interventions with stakeholders (from studio to the arena and back to the lab). The authors subsequently presented the synthesis map and research agenda to the subsequent RSD11 symposium, in 2022.

5.3 Domain Knowledge Factors

This study serves as one of the first holistic explorations of the nuances of making healthcare systems sustainable. Most studies on this subject by the scientific community have typically relied so far on hypothesis testing, generating specific evidence towards defining the problem or a specific solution, which has been the *modus operandi* in scientific research (MacNeill et al., 2020; Sherman et al., 2019). This deductive reasoning model leaves little room for exploratory, complexity or visual approaches to the discovery of saliency and critical patterns in complex systems. By visualizing the complexity of the systems involved, new opportunities can be unearthed through collaborative mapping, such as with the tools used in this study, to provide multi-level, multi-perspectival insights into complex problem contexts (Jones & Bowes, 2017). This study reflects not only the complexity of the problem at hand, but also the diverse perspectives generated by an interdisciplinary set of participants towards a common goal, one that is difficult to structure and theorize purely through mathematical modelling. Although with enough data, these systems can also be modelled with clear quantitative results, at this stage the system is yet to be comprehensively defined for further analysis, towards which this study provides one piece of the puzzle.

The placement of the annotations within each map and the overall density of contributions in various sections of each map can be attributed to various factors. In the Actors map (Fig. 2), all participants were contributing simultaneously and had no restrictions on how to contribute. The predominant contributions of actors with a perceived higher knowledge of the system and varying levels of power or influence in the system (top-right and bottom-right quadrants) could be a reflection of the background and expertise the participants brought to the exercise.

In the two Rich Context maps and the two Intervention Strategy maps however (Figs. 3, 4, 5 and 6), there were other factors at play. Firstly, the participants were asked to pick between the patient-centred map or the healthcare-services-oriented map, and the number of participants on each map were not equal. The quantity of annotations on each map may be a reflection of the number of participants, the knowledge of the system possessed by the participants and the interest to participate (which may vary with interest and fatigue of individual participants). In the Rich Context maps (Figs. 3 and 4), participants were asked to start by identifying major trends (inner circle) in the landscape, then to define current practices in the dominant regime (middle ring) and end with emerging niche initiatives (outer canvas), as suggested by Multi-Level Perspective theory (Geels, 2005) and in the tool itself (Jones & Van Ael, 2022). The time periods for each of these three sections were not strictly monitored and the lower contributions to niche initiatives

could be partly attributed to a smaller time devoted to this section, or a lack of knowledge of actual innovations in the four quadrants (Institutional, Economic, Cultural, Social). The low contributions in some cases could also be attributed to taking time to learn a new tool and use it, as discussed earlier.

The diagrams provided above have been left in their original state as produced by the participants in the workshop, to indicate the process and original outcomes. Further work has since been done to refine the maps, and present them as a cohesive exploration of stakeholders, contexts and intervention strategies for healthcare sustainability, potentially as a synthesis map with relevant literature and bibliographic sources for future reference. The maps and their diverse perspectives offer a window of opportunity for exploration of ideas towards healthcare sustainability at various scales and contexts.

6 Conclusion

The value of this project as a developmental approach is to promote a design agenda for healthcare sustainability at the industry level. Developmental design uses a series of interventions and analyses to develop a continuing discourse with the intention of finding and engaging with stakeholders, who will be discovered over a period of time as feedback and priorities are returned into formative development of a design agenda. Like developmental evaluation, the long-term nature of complex system projects requires a staged series of analyses and artefacts that are all aligned towards a long-term outcome. It can be seen as a mode of designing within systemic design.

The impacts of environmental degradation and climate change are creating normative business and service challenges for the healthcare industry. The intensification of public health demands, as witnessed during the COVID-19 pandemic emergency measures produced billions of single-use non-biodegradable masks and syringes. These challenges require new approaches to understand and frame problem contexts, as well as our proposals for effective intervention. This study analyses and proposes interventions in healthcare systems from a macro-perspective (healthcare service systems) and a micro-perspective (the role of patient-consumers) as potential agents of change. The study illustrates the opportunities for developing new research and intervention avenues through a participatory design workshop involving design experts in healthcare and sustainability, and the role of systemic design tools in visualizing complexities of systemic problems. The study is part of a long-term project to engage with the problem of healthcare sustainability in a climate-conscious world through developmental design to elicit innovation across system and service levels in healthcare.

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