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Exploring Systems Thinking and Systemic Design: Insights from a Summer School Experiment Addressing Urban Health Crises

Koen De Wandeler[1]*and Adrian Yat Wai Lo[2]
[1] KU Leuven Faculty of Architecture, Paleizenstraat, Brussels, Belgium
[2] Faculty of Architecture and Planning, Thammasat University, Pathum Thani, Thailand
* Corresponding author email: koen.dewandeler@kuleuven.be
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Abstract

This paper relates urban healthcare crises to the global challenges of overshoot and collapse and suggests systems thinking as an innovative approach towards addressing these amalgamated crisis situations. We begin by reviewing what systems are and how they are structured and behave, highlighting how systems thinking can identify high-leverage interventions and systemic design to achieve effective change. Subsequently, we illustrate how these system concepts were applied in an international, multidisciplinary summer school between European and Southeast Asian partners in collaboration with the World Health Organization's (WHO) Technical Science for Health Network (Téchne). Examining how ventilation, temperature, humidity, and daylighting control strategies enhance Infection Prevention and Control (IPC), the initiative developed ideas and designs for a multiple disease treatment center that would provide isolation units and create a safe care environment for patients, families, and communities. The design process was informed through consultation with three physically and socio-economically diverse neighborhoods across the Bangkok Metropolitan Region to gain a richer understanding of the varied experiences and approaches in managing the COVID-19 disruption. Leveraging WHO guidelines, students adopted a systemic design approach to develop innovative solutions that could withstand natural hazards and used local materials and natural ventilation to prevent airborne infection and control indoor temperature. In conclusion, we propose a novel working model linking specific stages of systemic thinking and systemic design into a generalized, iterative urban and healthcare design framework that will be further refined as part of specific electives at the KU Leuven Faculty of Architecture and joint summer schools in 2023, 2024 and beyond.

Keywords

Systems thinking; Systemic design; Urban crises; World Health Organization (WHO); Multiple disease treatment center; Climate and disaster resilience

1. Introduction

Our research initially set out to examine the roots of urban crises in general and propose possible solutions and best practices. Inspired by concerns about urbanization, poverty alleviation, depletion of natural resources, and climate change, we intended to examine how the expansion of urban areas affects the carrying capacity of the human habitat and explore how systems thinking can contribute to addressing complex urban crises. More specifically, we were seeking to critically examine the role of architects, designers, and urban (ADU) professionals in their engagement with other stakeholders and with the practice of planning, designing, building, and managing the built environment in the face of urban crises (De Wandeler, 2019; De Wandeler, 2020). Westmann et al. (2022) concluded that newly emerging urban crises including climate change and pandemics are interlinked with other crises, such as economic and racial issues, cannot be solved in isolation, and must be examined using both a complex systemic and interdisciplinary approach. These studies emphasize the need to address urban crises by strengthening economic, social, and environmental resilience in urban systems, whereby 'systems' are defined as 'an interconnected set of elements that is coherently organized in a way that achieves something' (Meadows, 2008, p. 11).

The COVID-19 pandemic thoroughly disrupted our intended research on urban crises in several ways, not least of which rendering face-to-face collaboration between international partners, and more importantly, fieldwork, extremely difficult. Yet with these challenges came new opportunities as the pandemic re-focused our work to more specifically, but not exclusively, examine urban healthcare issues. This re-orientation greatly benefitted from our collaboration with WHO Téchne, the Technical Science for Health Network[1] and was reflected in the theme of a two-week international multidisciplinary summer school that resulted from a partnership of KU Leuven Faculty of Architecture (FAR), Thammasat University's Faculty of Architecture and Planning, a.k.a. Thammasat Design School (TDS), the Polytechnic of Turin (Italy), and Téchne. Drawing on the lessons learnt from the pandemic, the summer school sought to explore ways to develop more resilient and flexible health structures.

Held in Bangkok from 16 to 30 July 2022, the initiative gathered a multidisciplinary group of 23 under-graduate and post-graduate students in architecture, science, technology, engineering, urban design and public health, coming from Belgium, Cambodia, Myanmar, Thailand, and Vietnam. The objective of this paper, then, is to integrate the concepts of systems thinking and systemic design, thereby providing a novel approach to promote innovation in the design of Infection Prevention and Control (IPC) strategies and structures, as driven by the immediacy of the COVID-19 pandemic, but also in the longer term, to help address the broader economic, social, and environmental resilience issues associated with the general urban crises as discussed in the previous paragraphs. More specifically, systems thinking and systemic design are linked to develop a novel design framework that can be employed to encourage more creative and innovative designs in addressing urban crises. Application of this design framework is illustrated through a creative summer school approach that included a multidisciplinary, international group of students, faculty, and healthcare practitioners who developed physically based and programmatic IPC interventions for local communities in urban and peri-urban Bangkok, Thailand.

[1] WHO created Téchne in April 2020, 'in response to Member States' need for guidance and assistance in addressing technical aspects and structural challenges related to their COVID-19 response activities', Regrouping ADU professionals and public health practitioners from several institutions globally, the network 'prepares for and responds to acute public health events with urgent and customized support' (WHO, 2023).

1.1 Theoretical Framework

1.1.1 COVID-19 as a Disrupting Development Driver

Epidemics of emerging and re-emerging infectious diseases, including zoonoses with the potential to rapidly spread across the globe, have occurred more frequently and spread faster and further than ever before in different regions of the world. The increase in these occurrences reflects the impact of climate change, high population pressure expanding to previously uninhabited areas, poorly planned and managed urbanization, and growing global interconnectedness (Dodds, 2019; Madhav et al., 2017; Van Doorn, 2021; Wu, 2021). The COVID-19 outbreak succeeded in drawing our attention away from those global challenges and focused it – albeit temporarily – on local time and place. The rapid spread of the virus required stringent measures like travel restrictions, lockdowns, and physical distancing that debilitated the circulation of people, information, and commodities on both global and local scales. Migratory flows froze or even reversed, powerhouses in global cities emptied, streets remained deserted for extended periods of time, and public life came to a standstill (Mofijur et al., 2021; Škare et al., 2021; Tran et al., 2020). At the local level, access to healthcare and medical facilities became a primary cause of distress as quarantine and isolation measures forced people to withdraw to their homes, and many people sought succor in online platforms for work and education, but also for leisure and social life. While virtual escape routes remained open to many, physical realities and infrastructural conditions prevented those living in dense, underserviced areas from following the basic hygienic measures, let alone abiding by physical distancing directions (De Wandeler et al., 2020; De Wandeler et al., 2021; Durizzo et al., 2021).

Meanwhile, medical scientists worldwide developed effective vaccines at record speed which the pharmaceutical industry mass-produced, and governments administered through unprecedented vaccination programs. Nevertheless, pricing and distribution delayed access to vaccines for entire populations, notably in the Global South, further exacerbating existing inequalities (Rydland et al., 2022; Tatar et al., 2021).

The pandemic did more than accentuate the differential access to healthcare. It brought a renewed attention to the socio-economic and spatial implications of uneven urban development, the heightening of cultural and ethnic heterogeneity, and the multiplication of different strains of cosmopolitan experiences. Like other urban crises, COVID-19 emphasized that cities are locally contested sites where covert stresses accumulate or sudden shocks may result in social breakdown, physical collapse, or economic deprivation. Since it affected every aspect of daily life so deeply, this crisis clearly demonstrated that cities thrive on a multiplicity of systems that are highly connected and interdependent.

In some ways, we might consider COVID-19 as a disrupting development driver (Fejerskov & Fetterer, 2021) that compelled us to consider the relationship between healthcare and the manifold urban systems in an innovative way. The authors readily acknowledge the link between health crises, urban crises, and the threat of overshoot and collapse as forewarned in *The Limits to Growth* (Catton, 1982; Meadows et al., 1972). The warnings were based on system dynamics, a computer-aided approach for strategy and policy design which Ray Forrester first developed at the Massachusetts Institute of Technology in the mid-1950's. Forrester's writings (1961, 168, 1971) represented one of the strains of thought of a wider 'systems thinking' movement in biology, economy, engineering, and management sciences, that sought a "basic reorientation in scientific thinking attempting to overcome ever-increasing specialization, and trying to shift from reductionist to holistic thinking, while acknowledging the unity of reality and the interconnections between its different parts and aspects" (Strijbos, 2017, p. 291). His concept of system dynamics, which Meadows et al. (1972) adopted for their study of global sustainability, was itself an example of disruptive technology, as this was an early example of how newly developing computing power could be used to address global, societal crises. Adopting this limits approach led the research from examining how growth affects the carrying capacity of the human habitat to exploring how systems thinking can guide decision-making in addressing complex crisis situations in general, and health crises in particular.

1.1.2 Understanding Systems and Systems Thinking

Forrester's contemporaries, philosopher-biologist von Bertalanffy (1968) and the economist Boulding (1956) were leading figures in the rise of systems thinking by launching and refining the conceptual use of 'system' as a technical term in science and technology (Strijbos, 2017, p. 293). Meadows (2008, p. 11) defined a system as 'an interconnected set of elements that is coherently organized in a way that achieves something'. This definition identifies three key components that constitute the system: its elements, the interconnections between these elements, and the system's overall function or purpose. Following the WHO, for example, a health system consists of all infrastructures, organizations, people, and actions whose primary intent is to promote, restore or maintain health (WHO, 2007). Its goals are to improve health and health equity in ways that are responsive, financially fair, and make the best, or most efficient, use of available resources (WHO, 2007). This example illustrates that each of its elements can be subdivided into sub-elements and sub-sub-elements, some of which are tangible, traceable, and others intangible. Organizations like primary healthcare centers quite obviously consist of elements that are coherently organized for a purpose of their own. The interconnections between these elements can be as tangible as the provision of medical supplies and laundry services, or intangible such as the attention given to patients in pain. Information flows determine how well the system operates and serves its overall purpose i.e., to respond to local health issues in a way that is financially fair, efficient, and humane. To achieve this purpose, the information flows work within spatially and conceptually defined boundaries and hierarchies to direct relations and interconnections between the contributing, semi-autonomous sub-systems, and its individual elements into a complex adaptive system (CAS) characterized by self-organization, hierarchy, and resilience (Meadows, 2008).

Systems thinking is a way to understand the purpose that a system is accomplishing. It offers a holistic approach to analysis used to identify a system's constituent elements, understand how the linkages and interactions between these elements behave over time, and appreciate how the entirety of that system acts as an interactive component of larger systems (Arnold & Wade, 2015). This analysis predicts how a system's behavior results from reinforcing and balancing causal loops. A reinforcing loop tends to benefit one of the system's elements but may lead to its collapse if unchecked. A balancing loop tends to maintain equilibrium within the system. One of the benefits of systems thinking is that it seeks to detect causal loops as on-going processes, not a one-time event, with effect feeding back to influence the causes, and the causes affecting each other. This creates the opportunity to identify high-leverage intervention points and devise modifications in the system that help achieve desired effects (Arnold & Wade, 2015; Stroh, 2015). Systems thinking thus can promote creativity and innovation in design to address healthcare (and more broadly, urban) crises.

Given the growing complexity of our life world and the ever-increasing pace of change, systems thinking has become increasingly recognized as an important complement to traditional, linear, analytical thinking. Scholars from various disciplines have described the divergences and respective merits of the two approaches, and outlined the skills required to apply systems thinking to the study of medical, environmental, political, economic, human resources, and educational systems (Gannon, 2015; Kahn, 2021; Monat & Raworth 2017;

Richmond 1997; WHO, 2007). Table 1 illustrates that systems thinking relies on the deliberate, continuous, and comprehensive application of looking at issues in a dynamic way. This involves 'framing a problem in terms of a pattern of behavior over time' rather than focusing on particular events. Patterns of behavior can be explained by looking into the interactions between internal agents that follow self-imposed rules of self-organization, hierarchy, and resilience, rather than by tracing the influence of external forces. Understanding these patterns requires establishing the context of relationships and causalities between interdependent and interacting agents rather than detailing isolated factors and 'viewing causality in one direction' (Adam & de Savigny, 2012, p. iv2).

Table 1. Skills of Systems Thinking (adapted from Adam & de Savigny, 2012, p. iv2), based on Richmond (2000).

Classical Approach	Systems Thinking Approach
Static Thinking Focusing on particular events	**Dynamic Thinking** Framing a problem in terms of a pattern of behavior over time
Systems-as-effect Thinking Viewing behavior generated by a system as driven by external forces	**System-as-cause Thinking** Placing responsibility for a behavior on internal actors who manage the policies and 'plumbing' of the system
Tree-by-tree Thinking Believing that really knowing something means focusing on the details	**Forest Thinking** Believing that to know something requires understanding the context of relationships
Factors Thinking Listing factors that influence or correlate with some result	**Operational Thinking** Concentrating on causality and understanding how a behavior is generated
Straight-line Thinking Viewing causality as running in one direction, ignoring (either deliberately or not) the interdependence and interaction between and among the causes	**Loop Thinking** Viewing causality as an on-going process, not a one-time event, with effect feeding back to influence the causes and the causes affecting each other

1.1.3 Linking Systems Thinking and Systemic Design

Design thinking is a way to generate possible solutions to complex human, organizational, and societal challenges. It involves an iterative process whereby designers seek to understand the needs, perspectives, and interests of stakeholders and end-users, and engage them in creating 'delightful and quality products, services, experiences, or systems that work for those who use them' (Damabi, 2016, p. 28). Systems thinking and design thinking both use non-linear, iterative ways to examine complex, so-called 'wicked' problems[2] (Figure 1).

Jones (2014) described how the two solution-oriented modes of inquiry grew closer as designers faced projects that were increasingly wider in scope, multidisciplinarity, and organizational complexity. This situation required that designers address applications beyond products, services, and communications, and expand their professional practice beyond 'sociotechnical' expertise to include systemic skills like 'system sense-making' and 'system modelling' (Jones & Van Ael, 2022).

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[2] In *General Theory of Planning* (1973), Rittel and Webber described the features of 'wicked problems' as 'irreducibility into component issues, their continuous and adaptive configuration over time, their intractability to problem-solving approaches and so on' (quoted by Murphy & Jones, 2020).

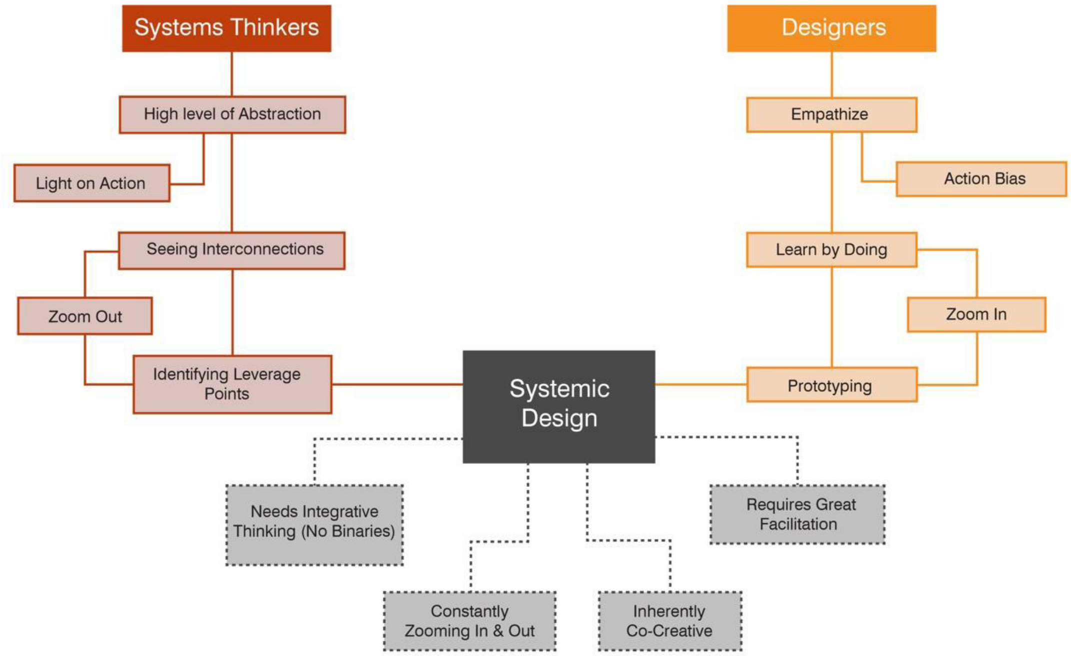

Figure 1. How Systems Thinking and Design Thinking merge into Systemic Design (adapted from Damabi, 2016, p. 25).

The resulting practice became known as systemic design. It enabled practitioners to 'select the elements of systems thinking and design thinking that best matched their specific challenge' (Damabi, 2016, p. 29). This adaptability has quickly made systemic design fit 'to advise and perform design for applications to complex societal problems, such as national healthcare services and disease management, mega-city urban planning, transition planning for energy and climate resilience, new economics and other public policy' (Jones & Van Ael, 2022, p. 7). These are complex dynamic systems that adapt the way they operate according to fluctuations in context and the complex interfaces between self-organization, hierarchy, and resilience (Meadows, 2008). They are not static, but constantly transmuting, so that a CAS problem can never be considered solved, only improved. In the Systemic Design Toolkit Guide, Van Ael et al. (2018) proposed a stepwise integration of the two approaches which later evolved into a methodological tool for systemic design practice as illustrated in Figure 2 (Jones & Van Ael, 2022).

Seeking to develop a learning module that introduced a 'system-wise' pedagogical method and approach in ADU education, the authors adopted the Jones and Van Ael model as the main methodological guideline for the first International Multidisciplinary Summer School on Systemic Design for Health. They also integrated elements of the System Practice Workbook (Omidyar Group, 2017) that forms the basis for the 8-week online Systems Practice Training course which the Acumen Academy organizes on a yearly basis (Acumen Academy Systems Practice, 2022).

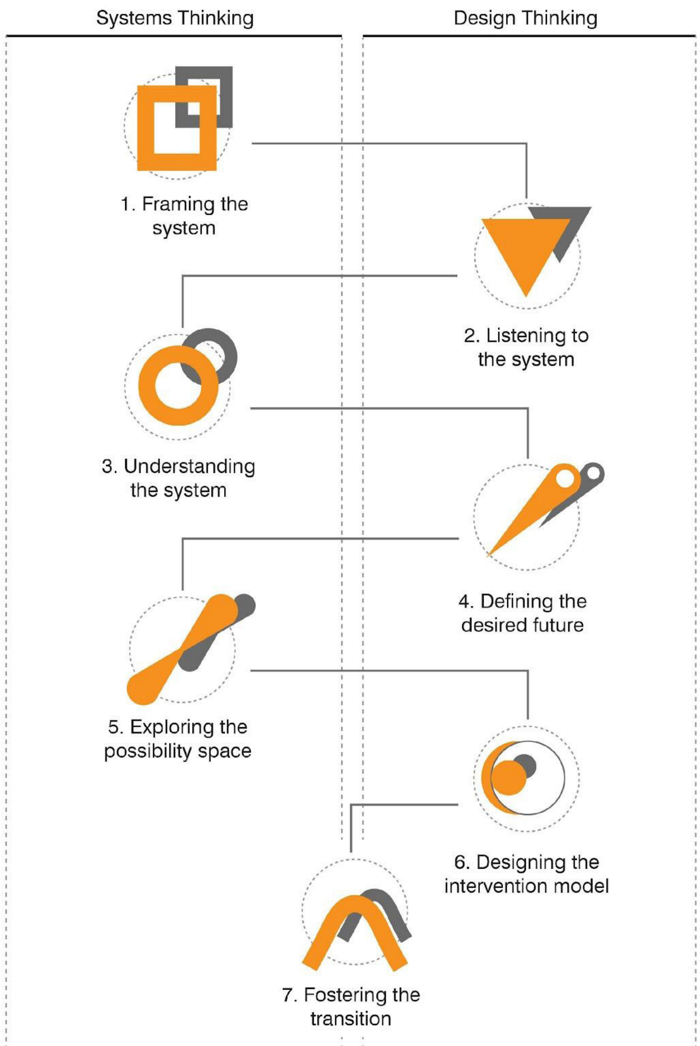

Figure 2. The Seven Steps of the Systemic Design Toolkit (adapted from Van Ael et al., 2018).

1.1.4 Formulating a 'Systemic Design for Health' Case-study

Systems approaches are not new to architectural theory and practice but have long remained linked to typological classifications and tangible components of buildings per se, whether they be structural elements or technological equipment. The introduction of computer-programs in architectural practice and the rise of ecological awareness helped to increase the breadth of approaches albeit often in a polemical way. Hensel et al. (2019, p.1) argue that 'the question of linking systems thinking and design thinking and practice' has been one of the main reasons why systemic design, in the sense described here, has 'not made it to the forefront of the profession or academic design research'. They go on to point out that the Relating Systems Thinking and Design Conference series considerably contributed to bridging the gap between the two modes of inquiry. This influence culminated in the 2019 special issue of the FormAkademisk journal that included five articles focused on architecture and urban design from a linked systems-thinking and design-thinking perspective. Linkages between systems thinking and design thinking have further been elaborated since then, notably in a 2020 special issue of the Strategic Design Research Journal compiling ten articles that show how a 'systemic approach to design makes it possible to address multiple levels in an integrated manner and to engage local communities in co-creation processes that generate real, sustainable development' (Barbero & Pereno, 2020, p.4). This research signals that systemic approaches in architecture and urban design have veered away from designing products and services for clients towards co-creating realistic, time-phased, and sustainable solutions with stakeholders. It implies a multidisciplinary process in which end-users and other beneficiaries are involved from pre-project planning to implementation.

This multi-stakeholder approach corresponds to Téchne's objective 'to engage and activate greater involvement of technical experts, e.g., in architecture and engineering, in the public health response force' (WHO, 2023). It reflects the internal dynamics which WHO has adopted in its efforts to improve health outcomes and accelerate progress towards the Sustainable Development Goals (SDGs). WHO designed a framework for action recognizing that many challenges in global health are complex problems that require a holistic approach (WHO, 2007). It involved six interconnected building blocks that relate and interact to strengthen healthcare systems for people. Ever since 2009, the WHO-based Alliance for Health Policy and Systems Research (HPSR) has been advocating systems thinking approaches to strengthen these health systems (de Savigny & Adam, 2009). As a result, 'Systems thinking methods and tools are increasingly being used to explain epidemics and to inform programmatic expansion efforts' (Adam & de Savigny, 2012; Peters, 2014, p.5).

COVID-19 has brought the link between urbanization and the emergence and spread of zoonotic diseases to the forefront of public debate. UN-Habitat's (2022) World Cities Report 2022 emphasizes that securing urban public health is a growing societal priority, especially in the context of preventing future pandemics. It echoes recent calls for an Urban One Health approach which would combine systems thinking to examine the complexities of disease ecology in urban settings and systemic design to advise community development, planning, policymaking, and management in creating healthier and more sustainable urban social-ecological systems (Ellwanger et al., 2022; WHO et al., 2020). This recent development inspired the research question addressed in this paper, namely: "how can systems thinking and systemic design be integrated in a framework that promotes innovative and effective planning and design solutions to address healthcare and urban crises?". The summer school methodology and activities were designed as a hands-on 'research-by-design'[3] exercise to explore and test how systems thinking could be linked to the systemic design of healthcare facilities that matched the socio-economic and COVID-19 response systems of three distinct communities in the Bangkok Metropolitan Region.

2. Methods

Due to travel restrictions, the project coordinators from KU-Leuven, Thammasat University, and Téchne, relied on email exchanges and regular video conferences to organize this first collaborative summer school after COVID-19. Drawing on the lessons learned from the pandemic, the organizing partners outlined a broad framework whereby systems thinking (FAR) and systemic design (TDS) could contribute to gaining specific knowledge and insight that would help WHO-Téchne to determine how ventilation, temperature, humidity, and daylighting control strategies can be used for Infection Prevention and Control (IPC) in the context of Southeast Asia (WHO, 2020). Relying on a dynamic systems analysis and ensuing systemic design, the summer school

3 "The core elements of a research by design approach are a continuously interactive setting, in which participants in the design process are placed in the position to creatively exchange, collaborate and develop new knowledge together.[...] Through research by design new pathways are explored, people come up with innovative ideas and concepts that they would not encounter in a regular research or design process. The process is thought-provoking and binding. The results are not final spatial solutions, but merely conceptual innovations that could help to understand and deal with wicked problems." (Roggema, 2017, 15-16)

thus was to develop proposals for a multiple disease treatment center that could provide not only isolation units but also create a safe care environment centered around patients, families, and communities. Moreover, these proposals should be resilient to the most common natural hazards occurring in the region and would use local construction materials and natural ventilation to meet airborne precaution standards and indoor temperature control.

2.1 Summer School Outline

To meet these objectives the summer school was designed as an interactive and authentic learning experience that incorporated four phases. Throughout the process, design and peer review moments were incorporated to help participants to collaboratively define the key criteria and strategies for the new building typology.

In the first phase, a series of lectures, in part delivered online by Téchne personnel, introduced participants to available WHO guidelines and standards related to Infection Prevention and Control (IPC) measures (WHO, 2021). Téchne has contributed to the pandemic response on all levels, providing technical assistance to countries in all WHO Regions. It helped to make health settings and structures safer for health workers and patients and reduced the risk of hospital-acquired infections by improving environmental and engineering controls of health facilities (WHO, 2022). While the network's operational scope initially focused on COVID-19, it expanded into other infectious diseases and broader health issues, and later came to include primary healthcare and physical and mental well-being. Téchne engaged in our summer school as part of its long-term objective of national and international capacity building through multidisciplinary and multicultural working sessions. In parallel with the hybrid lecture series, the students had the opportunity to review best practices for ventilation, temperature, humidity, and daylighting control in Southeast Asia through online research, site visits, and mutual knowledge exchange.

In the next phase of the summer school the FAR instructor introduced participants to presentations by invited speakers related to systems thinking and the potential it offers in handling complex issues. To put the theory to the test, the TDS instructors introduced the participants to three distinct study sites in Bangkok and surrounding peri-urban provinces which represented different built environments with diverse physical and social infrastructure and had confronted the pandemic in ways of varying complexity. Through the dialogic guidance with the course instructors, students applied successive phases of Dynamic Systems Analysis to identify feedback loops and high-leverage interventions for their specific study sites.

The third phase revolved around Design Thinking whereby the course instructors coached each group to develop ideas for a multiple disease treatment center responding to the specific needs of their study site. An important objective in this phase was to develop students' capacity for generating innovative and creative designs in addressing the social, economic, and health challenges presented by the pandemic. In the concluding phase of the summer school, each group prepared the outputs of phases two and three for a hybrid presentation to a committee of faculty, design professionals, and Téchne personnel. The students subsequently integrated the feedback from that session into the final output of the summer school.

2.2. Field Sites and Site Investigations

The summer school participants worked together over a two-week period to conduct a dynamic systems analysis of three distinct, clearly delineated areas in the Bangkok Metropolitan Region and developed a systemic design of a multiple disease treatment center in each of those areas. The selection of the field sites involved considerations of demographic profile, settlement density, accessibility, socio-economic conditions, and public services. All three sites had been researched previously as part of TDS design studios. As a preliminary concern in the exercise of ‘Framing the System’, organizers had chosen the sites to represent an inner-city built-up area, a peri-urban informal settlement, and a rural setting, and clearly set out the physical boundaries of the system that summer school participants would examine (Figure 3). The respective communities’ response to COVID-19 determined the conceptual boundaries of the task. Moreover, the way the communities organized to this end, determined the hierarchical boundaries of the system.

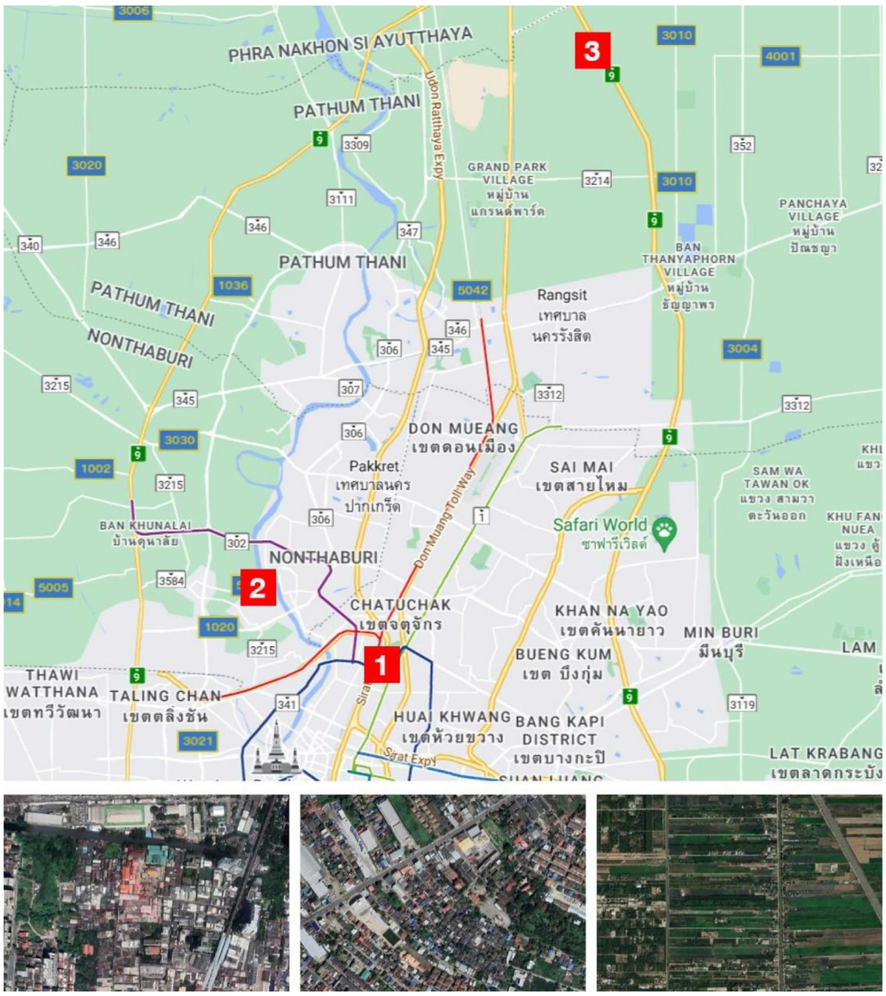

Figure 3. Location and aerial view (Google Maps) of the three sites: 1) inner-city Ari neighborhood (left), 2) peri-urban Bang Si Muang informal settlement (middle), and 3) rural community in the northern part of Klong Sam (right) (De Wandeler & Lo, 2022, p. 5).

COVID-19 struck hard in the inner-city Ari neighborhood in Bangkok. The ZENDAI Foundation was established as a citizens’ group that mobilized the financial and logistic means to organize screening, transport to hospitals, and isolation of mild infection cases from the poorer sections of the population. ZENDAI set up an isolation center in a nursery school at the far end of a dead-end alley.

The peri-urban informal community around the Parerai Temple in Bang Si Muang district of Nonthaburi Province handled the COVID-19 pandemic by collaborating with the monks of the temple, the district office, and the Community Organizations Development Institute (CODI) to organize screening, transport to the hospital, and isolation of mild cases. The multi-purpose hall of the temple served as a focal point for all of these activities. During the pandemic, the rural community in the northern part of Klong Sam in Pathum Thani Province was spared from infections because of their relative isolation and careful precautions. For the infections that occurred in the more urbanized areas further south along Klong Sam and to the east of it, the district office organized screening and transport to the nearby hospitals. It also established a temporary, purpose-built isolation facility in the vicinity.

After an introductory presentation by instructors at TDS, participants conducted a one-day field visit of the three sites. These visits included participant observation of the social spaces and services as a way of acquiring the sense of place necessary to conduct the dynamic systems analysis (Büscher, 2006; LeCompte et al. 1999). In addition, the students conducted an extensive interview with the founder of ZENDAI and a visit of the isolation center in the Ari community. In the Bang Si Muang community, the community leaders guided the students around the settlement and the multi-purpose hall as well as explaining their collaboration with external agencies during and after the pandemic. In the rural community of Klong Sam, students conducted a focus group discussion with community members. After the visits, participants formed three groups of seven to eight students at least one of whom was a Masters student and another one studied/practiced architecture. Each student joined a group according to their choice of where they wanted to undertake their design projects.

3. Results - Summer School Activities and Resulting Outputs

The first week of the summer school program introduced a holistic way to handle complexity through systems thinking followed by the second week of collaborative design exercises.

As part of the 'Listening to the System' phase, WHO and TDS experts introduced participants to the importance of indoor ventilation, temperature, humidity, and daylighting control for infection prevention and control. To complement the theoretical insights, field visits exposed participants to vernacular and contemporary best practices of ecological architecture, respectively at the Agricultural Museum Complex in Pathum Thani, the Jim Thompson House Museum and the MQDC Forestia Project (a Nature-based Solutions-oriented new housing development in Bangkok).

After these introductory activities, the instructors launched the Dynamic Systems Analysis that guided the teams through successive phases of framing the system, sense-making, and analysis, and reframing it in function of what they saw as a long-term goal and the short-term objectives leading towards that goal. In a first attempt at Framing the System, participants hypothesized the everyday realities of the project sites based on a summary introduction of TDS studio work that had been conducted in the project sites over the preceding academic year. They conjectured current neighborhood characteristics and the relationships that shaped the community's physical, socio-economic, and cultural dimensions. Field visits and site investigations at the project areas enabled participants to verify their initial hypotheses against the local realities. Participant observation and interviews helped them to ascertain how stakeholders' interactions and activities affected the various systems at the visited sites and delineate the system boundaries. This first step in sense-making was followed by a phase in which participants produced a mental model for understanding the system. Their efforts involved exploring forces that were detrimental to the system ('inhibitors' or 'balancing feedback loops') as well as forces that could generate positive dynamics ('enablers' or 'reinforcing feedback loops'). Subsequently, the participants focused on the most influential forces and analyzed their respective causes and effects. Also, they qualified whether the causes and effects were linked to the physical and social environment, to beliefs and value systems, or to social processes and interactions. Focusing on the factors that they considered most important, the teams traced how these factors affected other factors and how these interactions led to causal loops which could enhance, worsen, or maintain the status quo of the system. Informal dialogic exchanges with the instructors and among the teams as well as formal peer reviews ensured that teams learned from each other and benefitted from received feedback (Figure 4).

Figure 4. Causal feedback loops and systems map peer review, Group 1, Ari, Bangkok.

Having analyzed the forces of the system and the inner dynamics of causes and effects, participants moved to envisioning the desired future of the system. They did this by clustering the identified feedback loops in thematic regions around a central loop driving the system dynamics. They then generated a systems map to visualize those thematic regions, their interconnections, and how they contributed to the central loop driving the system dynamics (Figure 5).

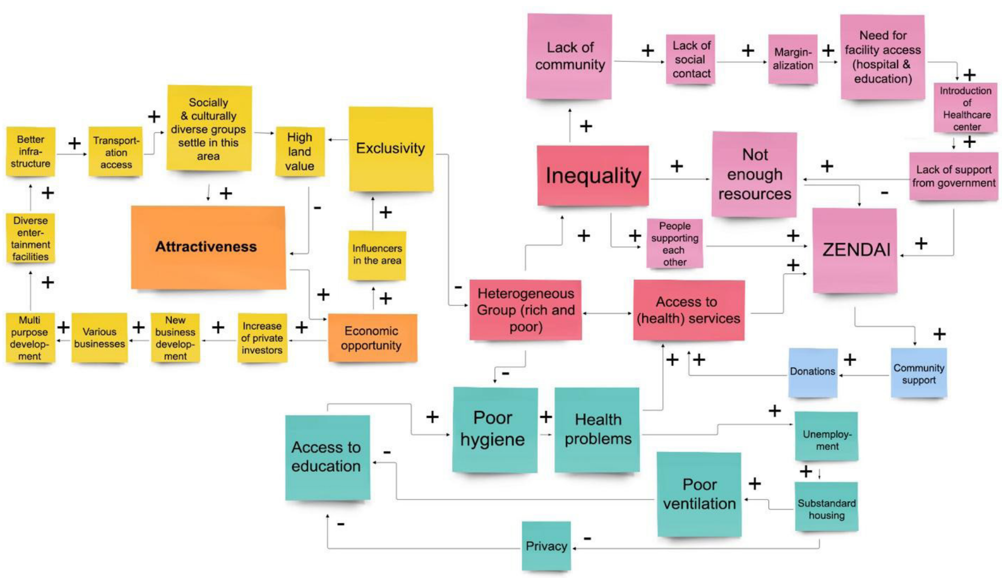

Figure 5. Final systems map, Ari neighborhood revolving around the ZENDAI Foundation, Bangkok, as identified by Group 1 (with original student work showing enabling (+) and inhibiting (-) effects between the elements and further modified for publication and clarity purposes)

This helped each team to fine-tune the short- and long-term goals they had formulated earlier and, in turn, to recalibrate the systems map and highlight the patterns that they would like to disrupt, mitigate, or shift. In this way, they could identify the areas of high-impact leverage (Figure 6).

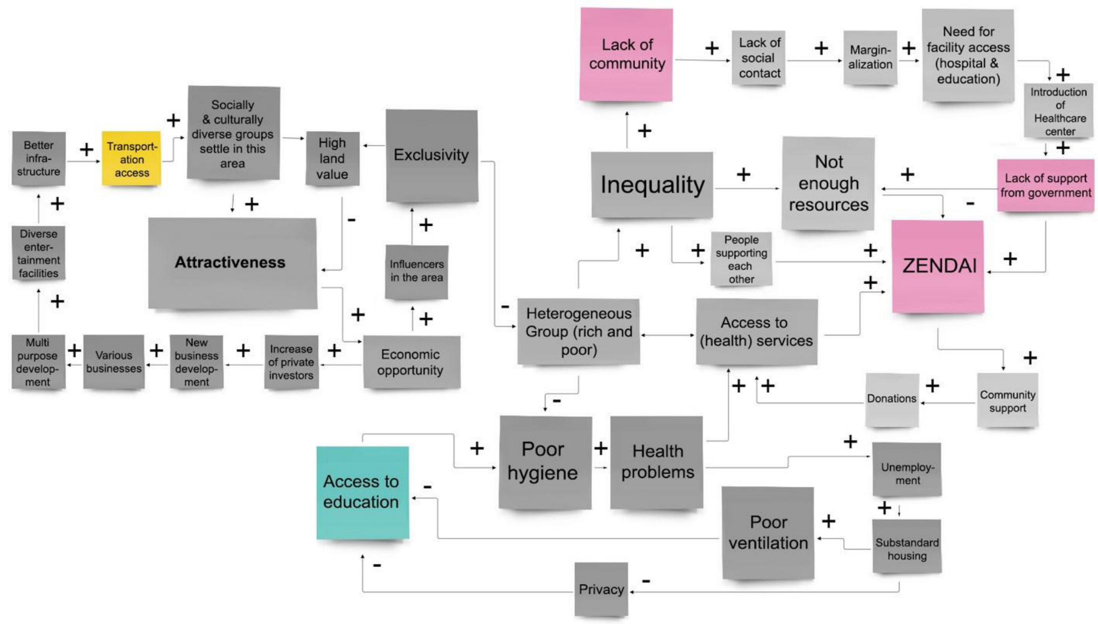

Figure 6. Identification of leverage points derived from the enabling (+) and inhibiting (-) feedback loops, Group 1, Ari neighborhood revolving around the ZENDAI Foundation, Bangkok.

Determining how each of the leverage points could impact the system, the student teams formed connections between short-term impacts and long-term systems change which they set out on a roadmap. This exercise helped participants to articulate leverage hypotheses that formed the basis for the second week of work (Figure 7).

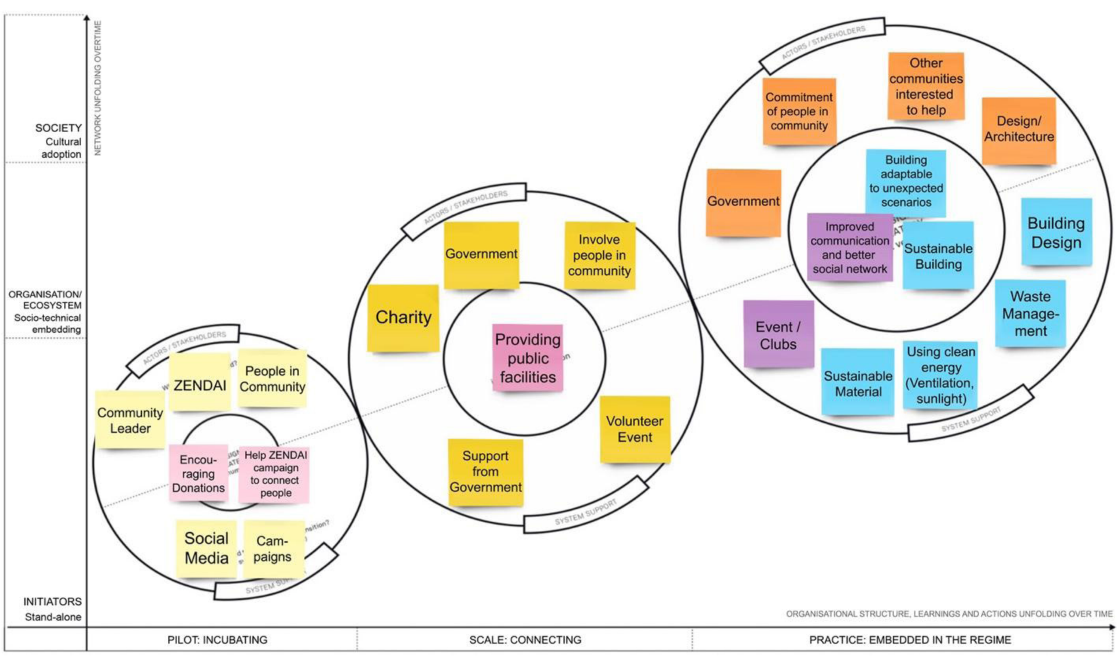

Figure 7. Roadmap envisioning short-term impacts and long-term systems change, Group 1, Ari neighborhood revolving around the ZENDAI Foundation, Bangkok (adapted from Jones & Van Ael (2022)).

The second week of the program revolved around systemic design workshops that sought to articulate the leverage hypotheses showing the most potential to improve the system. The systemic design methodology kick-started with the production of a Lego sectional model, which students subsequently developed into an annotated section sketch (Figure 8). This concept model enabled the teams to creatively examine possible innovative interventions whilst considering solar orientation and angles, sun shading, cross ventilation, prevailing wind, and other aspects as discovered in their systems mapping exercise.

Figure 8. Systemic Design – Lego model making, Group 2, Bang Si Muang, Nonthaburi.

Based on the leverage hypotheses, students explored ideas for design strategies and interventions ranging from lifestyle changes to policy recommendations. The process entailed the parallel production of a systemic matrix (matrix of prescriptive actions) and a building typology design (descriptive schematic set of architectural drawings). In the systemic matrix, each group strategized its leverage hypotheses into actionable items steering towards a transitional / future system in line with their systems map and roadmap (Figure 9). In this phase, students were able to experience how systemic codesign enabled them to formulate these outputs. Thus, the systemic design approach was innovative in the way the summer school was conducted, while the systemic codesign towards the design outputs resulted in creative and innovative solutions towards complex problems, relating to site, environment, health, and other urban issues.

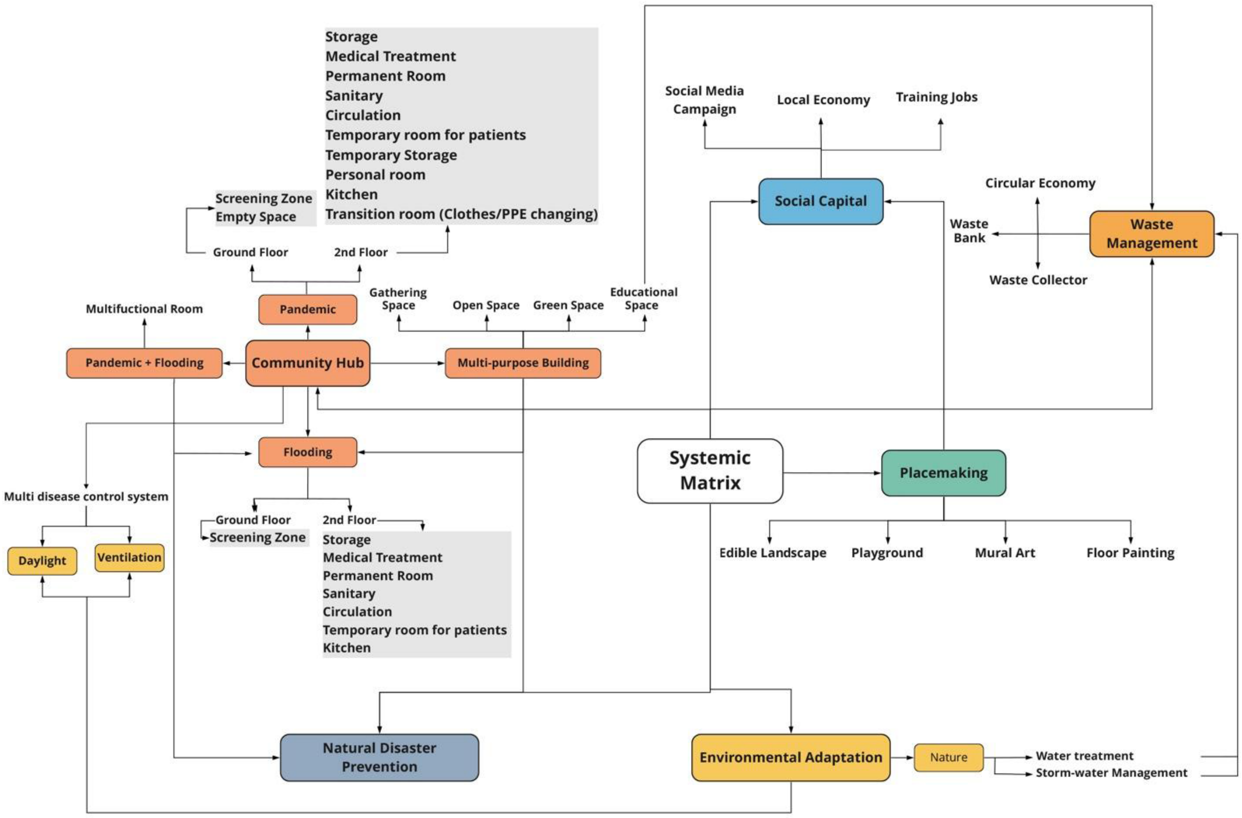

Figure 9. Systemic matrix, Group 2, Bang Si Muang, Nonthaburi.

In parallel, the groups translated the matrix into a design for a multiple disease treatment center. This necessitated each group to identify detailed space requirements according to the specific needs of the site and develop those into a zoning diagram. This schematic representation then formed the basis to develop floorplans and sections, as well as 3D strategic diagrams and digital models. (Figure 10).

Participants compiled all materials in a hybrid final presentation for a multidisciplinary, international panel of experts and integrated the feedback received during this session into the final output of the summer school.

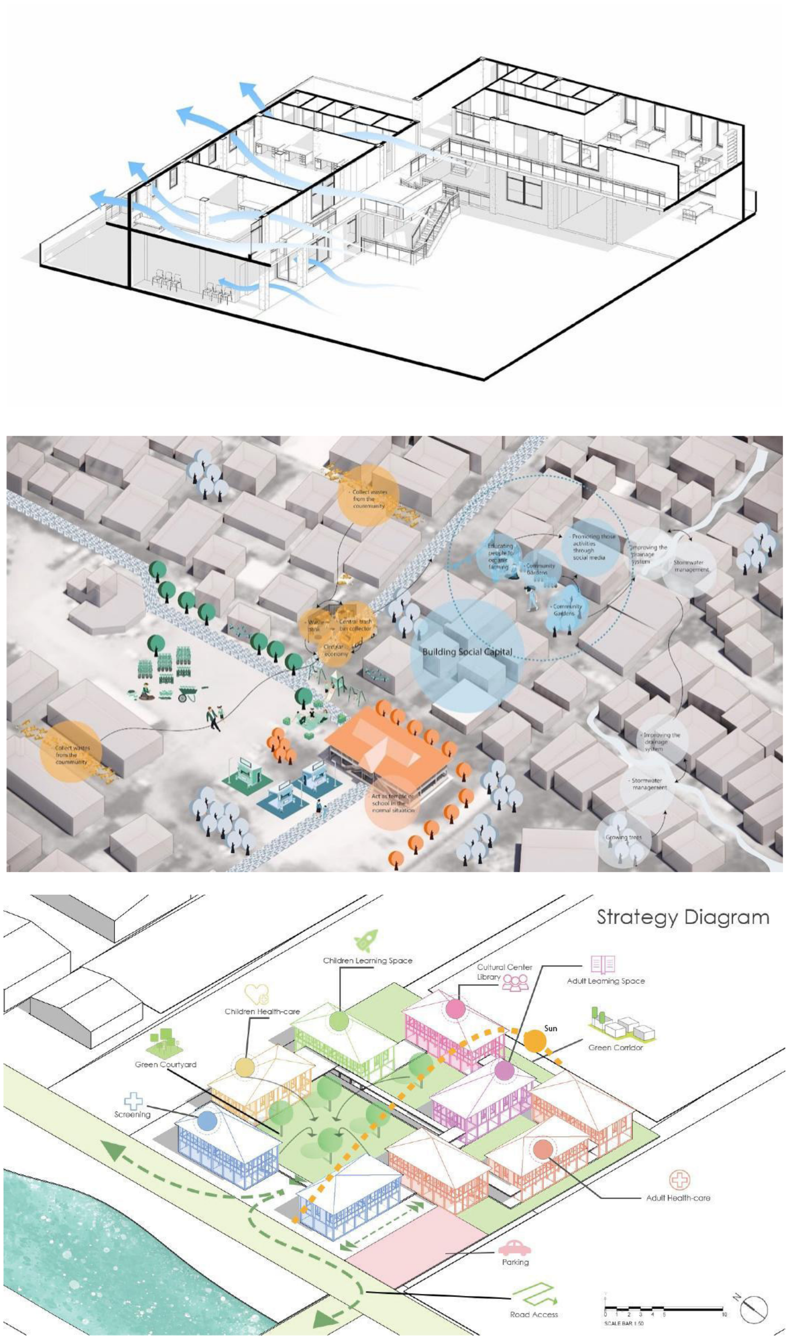

Figure 10. 3D models and diagrams of multiple disease treatment center for Ari (a) showing the existing nursery building redesigned to have spaces naturally cross ventilated as part of IPC measures; Bang Si Muang (b) showing the spatial representation of the identified components of the systemic matrix.; and Klong Sam (c) demonstrating a different approach whereby a network of separated buildings with connecting passageways can work with the sun, wind, and IPC guidelines.

4. Discussion and Conclusion

This section considers three aspects of the summer school experiment. First, the impact of the shift in research focus from urban crises to health crises. Second, the validity of combining systems thinking and design thinking into the systemic design of a healthcare facility. And finally, the adequacy of the summer school experiment in applying this approach. The conclusion draws upon the lessons learnt and proposes a tentative agenda for the further development of this experiment.

Research processes often are less predictable than anticipated. Yet, close monitoring of research activities and results enables researchers to adapt methodological tools and techniques for better results and progressively fine-tune their research focus. By comparison, the interruption that COVID-19 caused to the physical implementation of the planned research plan was both sudden and disruptive. It necessitated a radical shift from examining tangible urban realities to appraising something as ethereal as airborne infection threats. The study of urban realities relied on the view that crises arose either from disaster and climate hazards, or from the side-effects of poorly planned and managed urbanization. Examining airborne infections amidst the pandemic downscaled that global scope to hands-on efforts to realize corporeal isolation and maintain physical distancing.

The collaboration with Téchne proved beneficial to bridge this seemingly large gap between global challenges and local interventions. It made clear that urban crises and health hazards are two sides of the same coin and often are rooted in the same causes. As stated in the World Cities Report 2022: 'The emergence of urbanization as a global mega-trend is intertwined with the existential challenges that the world has faced in the last 50 years, including climate change, rising inequality and the rise in zoonotic viruses' (UN-Habitat, 2022, p.xvi). Whereas systems thinking proved adequate to understand and address the complexity of urban crises, socio-technical interventions in healthcare facilities required a broader methodological lens. This need for a complementary mode of inquiry can be compared to the WHO mainstreaming of systems thinking to strengthen health systems, or to the process whereby design-thinkers embraced systems thinking to address complex, multifaceted issues. Whilst Téchne can readily depend on WHO's experience in systems thinking, it needs systemic design competencies to address its widening scope of action, thereby contributing to more creative and innovative designs in addressing healthcare challenges. This implies that the academically and operationally trained ADU experts who support Téchne must have expertise in systemic design. The summer school experiment thus served the double purpose of introducing 'system-wise' approaches into ADU education, and of exploring the ways how systemic design can be mainstreamed into the Téchne network. A critical evaluation of the limitations and the potential of the summer school can clarify to what extent these intentions were met.

4.1 Limitations and Potentials of the Summer School

Limitations on international travel forced the organizers of the summer school to elaborate the concept and preparatory steps online. Whereas Téchne closely guided this preparatory phase, it left the authors free to focus on the launch, scheduling, and practical organization of the summer school. When the summer school call was launched, the pandemic was still ongoing, and uncertainty remained whether international travel restrictions would be lifted in time or whether on-site field visits would be possible. This considerably hampered timely selection of the intended range of students and imposed the limitation of on-site field visits to a single day without a possibility to re-visit the sites. Consequently, the dynamic systems analysis and subsequent systemic design exercise proceeded with little involvement of stakeholders in the study areas. For most participants the exercise was the first on-site, face-to-face exchange after an extended period of lockdown and online learning. This added an additional layer of difficulty to communicating across different cultures, languages, and disciplines. Moreover, participants were not familiar with systems thinking or systemic design and learning-by-doing. As such, we believe the summer school addressed an important gap in ADU student education that better prepares them to participate in planning and design projects effectively, creatively, and innovatively as they move forward either to graduate work or their professional career. Time constraints necessitated cutting down some of the steps and outputs proposed in the methodology of Jones and Van Ael (2022). Together with the limited possibility to consult and receive feedback from stakeholders this led to design results that did not always coincide with the efforts invested in the dynamic systems analysis.

4.2 Conclusion and Way Forward

Despite these limitations, the organizers and participants positively evaluated the summer school. The organizers appreciated the collaboration between the academic partners, Téchne and the WHO Thailand Country Office (WHO, 2022). The majority of the students found the international, interdisciplinary character of communicating and working together the most challenging yet the most rewarding aspect of the summer school.

With the experiment conducted to the satisfaction of all parties, the organizers have decided to repeat the initiative in a more elaborate format for two more years. Drawing on the lessons learned from the 2022 summer school, preparations for this exercise will be coordinated in partnership with a broad range of expertise including architecture, engineering technology, public health, and nursing. The broader disciplinary involvement is meant to ensure that design efforts during the summer schools are based on reliable data and knowledge exchange between disciplines. Experts in public health, for example, can provide experimental real-time measurements of indoor quality, ventilation flows, and concentrations of bacteria, while engineering technology data specialists can apply Building Information Modelling (BIM) to calculate ideal models, time variations, etc. As in 2022, ADU participants will contribute their discipline-specific 'designerly ways of knowing' (Cross, 2001; Doucet & Janssens, 2011; Findeli, 1999). With limitations to fieldwork due to COVID-19 being lifted, the 2023 and 2024 summer schools will adopt a transdisciplinary mode of inquiry that implies a broader consultation with stakeholders and beneficiaries (Hirsch Hadorn et al., 2008; Jahn et al., 2012; Rigolot, 2020). Doucet and Janssens (2011, p.2) characterized this approach in an ADU context as a kind of knowledge production that revolves around 'the integration of discipline and profession (theory and practice), an ethical dimension and an important element of experimental, designerly modes of inquiry'.

The overall intention is to move beyond design per se towards systemic design. Besides the methodological tools proposed in Jones and Van Ael (2022), the summer schools will seek to realize design interventions that rely on Jones' (2014) five dimensions of systemic thinking. True to WHO's (2007) framework for action, the summer schools will foster research and design methods that are human-centered and contribute to an understanding of human activity and human concerns. To ensure that design participants have a personal stake in the outcome of the intervention, the proposed format will convene students and instructors from various partner universities in Southeast Asia and Europe. They will be invited to participate in preliminary online training sessions enabling them to gather local case-studies in their respective home countries. All participants will subsequently gather at the host institution in face-to-face plenary and group sessions to compare and analyze their respective case studies through dialogic processes of inquiry and design. To handle the complexity of this exercise, the organizers will consult the literature for structured approaches to dialogue that enable participants to achieve a collective systems view. The sequence of training, data gathering, and joint analysis will be repeated in two consecutive summer schools (Figure 11).

The organizers hope that this process of iterative inquiry will consolidate the innovative pedagogical and methodological practices set out in the 2022 summer school and confirm a systemic approach as a valid alternative to more traditional linear design processes. They believe that the combined practices of systems mapping and systemic design create the potential to tackle complex societal challenges from a multiplicity of perspectives and disciplines and achieve social organizational transformation in a co-creative way. With the envisaged broad-based consultative process, the organizers seek to enhance intercultural, transdisciplinary learning that involves a wide variety of stakeholders, including researchers as well as those who are likely to benefit from the research outputs (Peters, 2014). Overall, this innovative transdisciplinary initiative intends to contribute to 'system-wise' ADU education and support Téchne in creating safer, healthier, equitable, and sustainable healthcare systems.

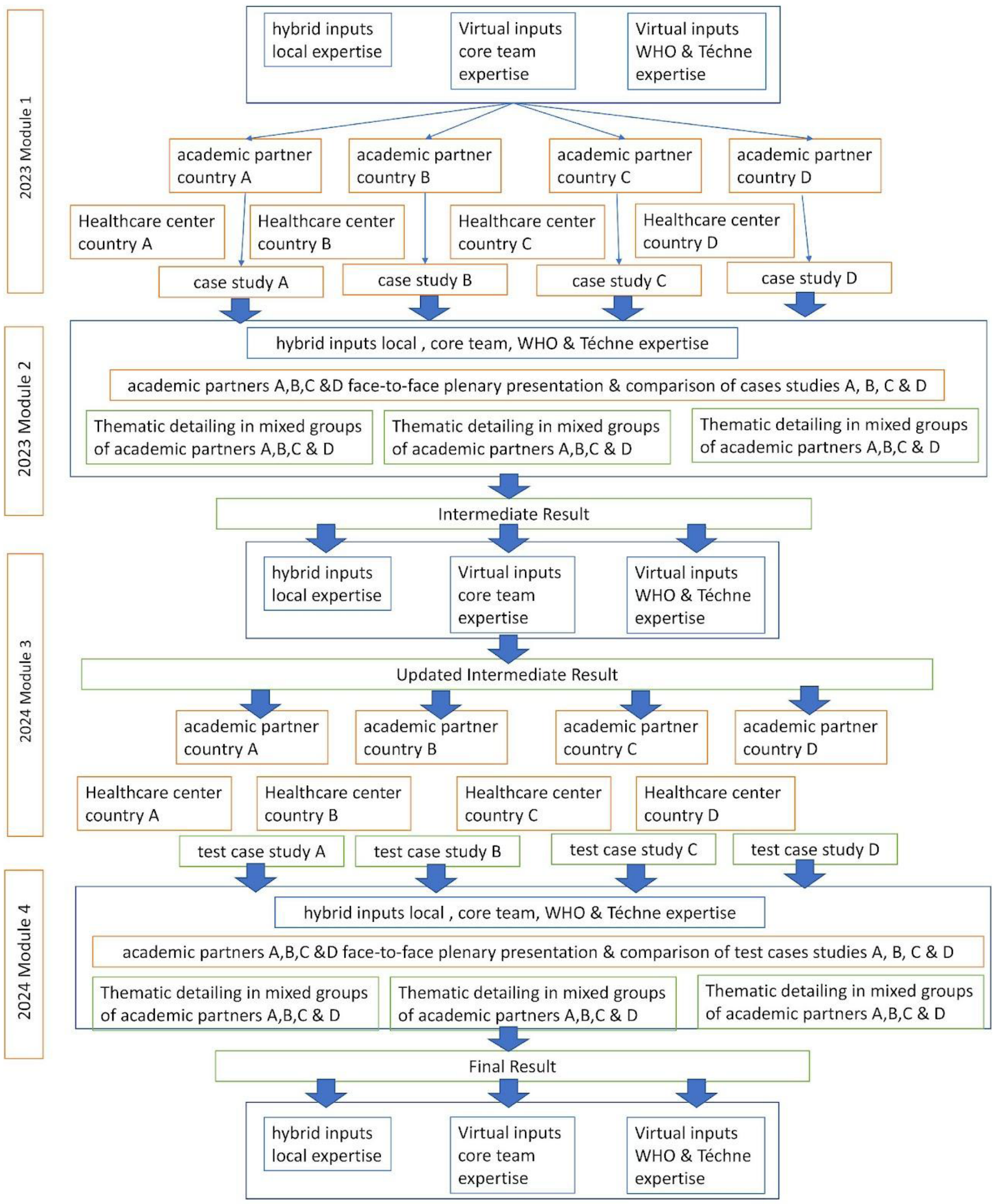

Figure 11. Schematic overview of the proposed knowledge production process.

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Data Availability Statement

No quantitative data were collected for this paper.

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List of Abbreviations

CAS Complex Adaptive Systems
CODI Community Organizations Development Institute
HPSR Health Policy & Systems Research
IPC Infection Prevention & Control
KUL-FAR KU Leuven Faculty of Architecture
SDG Sustainable Development Goals
TDS Thammasat Design School, Faculty of Architecture and Planning, Thammasat University (APTU)
WHO World Health Organization

Author Contributions

Conceptualization, KDW; Methodology, KDW and AYWL; Organization, KDW and AYWL; Investigation, KDW and AYWL; Resources, KDW and AYWL; Writing – Original Draft, KDW; Writing - Review & Editing, KDW and AYWL, Visualization, AYWL; Supervision, KDW; Project Administration, KDW and AYWL; Funding acquisition, KDW and AYWL. Both authors agreed to the published version of the manuscript and declared no conflict of interest.

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