Service Design as Intervention for Wicked Problems: Case Studies from a Service System Design Course

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Abstract. While the theoretical relationship between service design and wicked problems has been explored through typological models and strategic comparisons, empirical studies demonstrating how specific service design methods intervene in concrete wicked problems remain scarce—particularly in design education contexts. This paper addresses this gap by proposing a Service Design Intervention Mechanism Framework that maps four characteristics of wicked problems to four intervention mechanisms operationalised through service design methods. The framework is empirically examined through three student cases from a 16-week Service System Design course at a Chinese university, spanning community carbon behaviour change, food waste resource circulation, and menstrual stigma. Cross-case analysis validates the four mechanisms: enabling systemic perspective, facilitating participatory engagement, supporting iterative structuring, and catalysing problem reframing. The paper contributes a theoretically grounded and empirically supported operational framework that complements existing diagnostic and strategic models.

Keywords: Service design, Wicked problems, Design education, Intervention framework

1 Introduction

Contemporary societies face challenges—climate change, social inequality, food insecurity, gender-based stigma—that resist straightforward resolution. These involve multiple stakeholders with conflicting values, defy definitive formulation, and generate unpredictable consequences. Rittel and Webber [1] characterised such challenges as "wicked problems." The concept has since diffused across disciplines [2,3], reflecting recognition that pressing issues demand fundamentally different approaches.

Design has been recognised as uniquely positioned to engage with such complexity. Buchanan argued that design thinking is inherently concerned with wicked problems, with service design and systems design most directly relevant [4]. Knapp articulated a shift from seeking definitive "solutions" to designing structured

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"interventions. [5]" Service design, with principles of human-centredness, co-creation, systemic thinking, and iteration, appears well-suited to this role [6].

Scholarship at this intersection has grown. However, existing contributions—including the Iceberg Model and strategic model comparisons—remain at the theoretical level, without addressing how specific service design methods respond to specific characteristics of wickedness [7, 8]. There is a notable absence of empirical studies from design education contexts. This paper addresses this gap by: (1) proposing a Service Design Intervention Mechanism Framework that maps wicked problem characteristics to service design methods via four intervention mechanisms; and (2) empirically examining this framework through three student cases from a Service System Design course.

2 Literature Review

2.1 Wicked Problems: From Theory to Design Context

Rittel and Webber identified ten distinguishing properties of wicked problems, which subsequent scholars have consolidated into smaller sets [1]. Weber and Khademian reduced them to three dimensions: cross-cutting (independent stakeholders with different perspectives), unstructured (unclear causal links), and relentless (moving resolution targets) [9]. Building on these consolidations, four characteristics are particularly relevant to the present study: (a) multiple stakeholders with conflicting values (Properties 1, 6, 9), (b) ambiguous causality (Properties 3, 8, 9), (c) problem–solution co-evolution (Properties 1, 5), and (d) absence of a stopping rule (Properties 2, 4) [1, 4, 10].

Buchanan connected wicked problems to design through four orders, with service and systems design most directly relevant [4]. Scholars have since advocated shifting from "solving" to "intervening" in wicked problems [5, 10, 11].

2.2 Service Design Thinking: Principles and Methods

Service design emerged drawing on marketing, operations management, and interaction design [12, 13]. Stickdorn and Schneider articulated five principles: user-centredness, co-creation, sequencing, evidencing, and holistic thinking [6]. These principles translate into a repertoire of methods at different analytical levels: systemic tools (stakeholder maps, value network maps, service system maps) that make structural relationships visible; user-level tools (personas, empathy maps, cultural probes, journey maps) that ground design in diverse experiences; process tools (service blueprints, storyboards, Business Model Canvas) that structure insight into proposals; and generative methods (co-creation workshops, prototyping, scenario mapping) that enable stakeholders to collaboratively reframe problems [14-16].

2.3 From Existing Frameworks to an Operational Gap

Scholarship at the intersection of service design and wicked problems has produced two notable contributions. Suoheimo et al. proposed the Iceberg Model of Design Problems, classifying problems into tame, complex, and wicked categories as a diagnostic tool for selecting appropriate methods [7]. However, it does not specify how particular methods respond to particular characteristics once a problem is diagnosed as wicked. Kotaniemi et al. compared the Evolved Double Diamond and PPG's framework as strategic process models, but similarly did not descend to method–characteristic correspondence [8].

A significant gap therefore persists: existing frameworks address the diagnostic dimension — identifying the level of problem complexity — and the strategic dimension — selecting an appropriate process model — but not the operational dimension — specifying how particular service design methods respond to particular characteristics of wickedness. Empirical studies from design education contexts remain scarce [17-19]. This paper addresses both gaps.

2.4 Theoretical Framework: Service Design Intervention Mechanisms

Building on the four wicked problem characteristics (Section 2.1) and the service design method repertoire (Section 2.2), we propose a Service Design Intervention Mechanism Framework (Figure. 1). The four characteristics are consolidated from Rittel and Webber's ten properties, following the precedent of Weber and Khademian who demonstrated that the ten properties can be meaningfully grouped into a smaller set of analytically distinct dimensions [1, 9]. The framework maps each characteristic to an intervention mechanism—the functional logic through which service design methods address that characteristic. Unlike the Iceberg Model's diagnostic function, this framework operates at the operational level: specifying how methods respond to what aspects of wickedness.

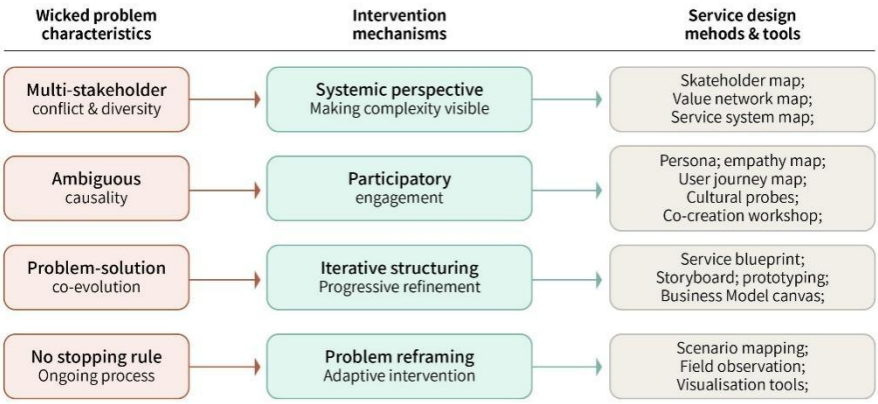

Figure. 1 Service design intervention mechanism framework

This framework will be used as the analytical lens for examining the three student cases in Section 4 and will be revisited in the cross-case discussion in Section 5.

3 Method

This study adopts a multiple case study approach. The cases are drawn from Service System Design, a 16-week, 4-credit elective (64 hours) at Guangdong Baiyun University, China. Fifty-one students participated. The curriculum progressed through four phases: (1) theoretical foundations; (2) design methods; (3) service design tools; and (4) a capstone group project. Cases were selected via purposive sampling based on diversity of wicked problem types and quality of output. Data sources include student deliverables, instructor observation notes, and project portfolios. Table 1 summarises the cases.

Table 1. Overview of selected cases

Case	Project Title	Wicked Problem Domain	Primary SD Methods
A	CyCheers — Community Carbon Service System	Low-carbon behaviour change; carbon neutrality	Stakeholder map; value network; journey maps; multi-scenario blueprints; BMC
B	Food Waste Recycling System	Food waste; resource circulation	Personas; empathy map; journey maps; stakeholder diagram; storyboard; blueprint; BMC
C	Her Share: Menstrual Pad Mutual-Aid	Menstrual stigma; period poverty	Dual-context personas; system diagram; journey map; blueprint; BMC

4 Case Studies

4.1 Case A: CyCheers — Community Carbon Service System

Problem and Methods. This project addresses translating China's "3060" carbon neutrality policy into community-level behaviour change. The problem exhibits multiple hallmarks of wickedness: diverse stakeholders (residents, merchants, property management, government), no definitive formulation, and no stopping rule. The team developed a stakeholder map and value network map, constructed user journey maps for three service scenarios (coffee shop recycling, circular shop, brand redemption), created corresponding service system map (Figure. 2), service blueprints, and validated the model through a Business Model Canvas and field research across three community settings.

Design Output. CyCheers comprises: (1) a mobile app converting low-carbon behaviours into "carbon coins"; (2) a recycled rPET points card; and (3) "carbon

trading stations" repurposed from abandoned newsstand kiosks for recycling, retail, and workshops. The system creates a closed loop from low-carbon actions through coin accumulation to redemption (Figure. 3).

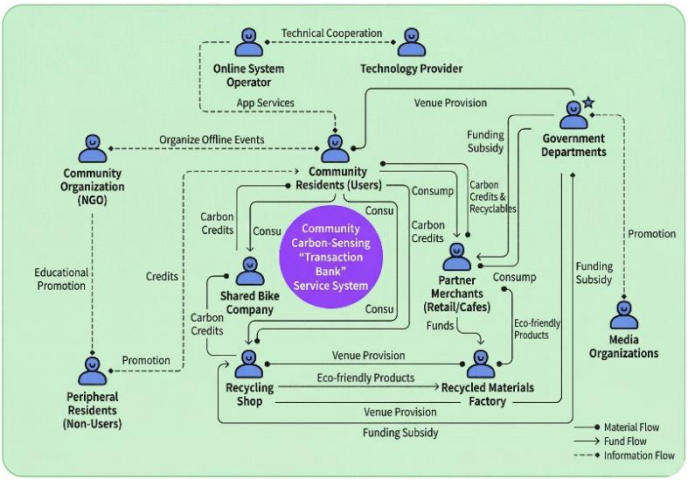

Figure. 2 Service system map of CyCheers

Figure. 3 Design output of CyCheers

Analysis. Mapped to the framework (Figure. 1): the stakeholder map and value network map enacted systemic perspective by making visible the complex actor web. Multiple scenario-specific blueprints enacted iterative structuring by acknowledging no single "solution." Field observation of community living scenes enacted problem reframing, shifting the problem from "how to reduce emissions" to "how to make low-carbon behaviour tangible and rewarding." The system is designed to evolve as merchants and behaviours are added, framing the output as ongoing intervention.

4.2 Case B: Food Waste Recycling — Community Circular System

Problem and Methods. Kitchen waste accounts for ~60% of urban household waste in China, yet recovery rates remain ~30%. The problem involves conflicting stakeholders, ambiguous causality (insufficient knowledge, lack of incentives, inconvenient infrastructure), and entanglement with air pollution, soil contamination, and methane emissions. The team analysed social media attitudes, constructed five user personas, created journey maps revealing opportunity points, developed a storyboard illustrating a day in the life of a resident, developed a stakeholder correlation diagram identifying four system modules (waste processing, fertiliser, farming, supermarkets) (Figure. 4), and completed a service blueprint and Business Model Canvas.

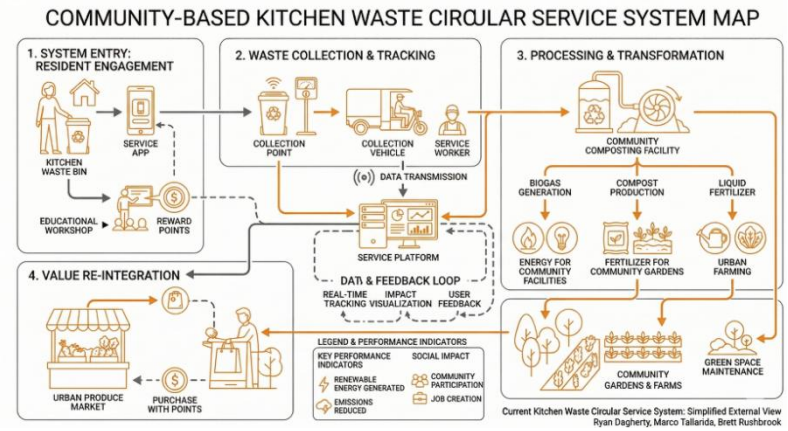

Figure. 4 Service system map illustrating the community circular system

Design Output. A closed-loop system: food waste → composting → organic fertiliser → farming → community supermarkets → cycle repeats. Components include smart recycling bins with QR scanning, a points-tracking app, community infrastructure, and a "seed plan" allowing points exchange for planting kits (Figure. 5).

Figure. 5 Design output of Case B: (a) app interface; (b) seed plan product kit.

Analysis. The stakeholder correlation diagram enacted systemic perspective, helping the team see food waste as a node in a broader resource circulation—responding to the characteristic that every wicked problem is a symptom of another [1]. Personas and empathy maps enacted participatory engagement, revealing ambiguous causal factors behind low participation. The storyboard and service blueprint enacted iterative structuring, progressively refining the closed-loop output that restructures waste into resource

4.3 Case C: Her Share — Menstrual Pad Mutual-Aid System

Problem and Methods. Research revealed 10–30% of women experience menstrual product shortages, ~20% of adolescent girls miss school due to period poverty, and 67% have experienced menstruation-related ridicule. In China, menstruation remains a cultural taboo. The problem is simultaneously a health, economic, gender, and cultural issue with no endpoint. The team created dual-context personas (rural girls vs. urban women), a three-phase journey map, a service system diagram (Figure. 6), differentiated stakeholder maps, and a service blueprint mapping the "buy-one-donate-one" mechanism.

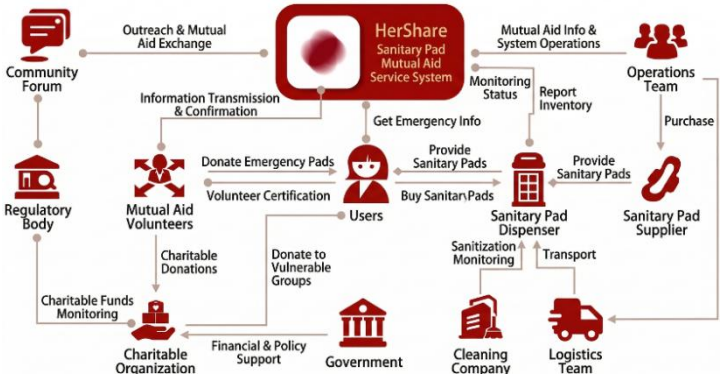

Figure. 6 Service system diagram of the Her Share mutual-aid service system

Design Output. Her Share operates across online and offline channels. The app enables locating vending machines, accessing health info, and participating in mutual aid. Offline: compact mutual-aid boxes (10–30 pads) for schools and larger intelligent vending machines (50–100 pads) for high-traffic locations. The butterfly-and-flower brand identity destigmatises the act of obtaining menstrual products publicly (Figure. 7).

Analysis. Dual-context personas enacted participatory engagement by acknowledging the value-conflicting nature of the problem across rural and urban contexts. The

service system diagram enacted systemic perspective by exposing the institutional ecosystem connecting welfare organisations, suppliers, government, and volunteers. The "buy-one-donate-one" mechanism enacted iterative structuring through a self-reinforcing cycle. Critically, the project enacted problem reframing, shifting from "charity for the disadvantaged" to "normalised mutual support among women."

Figure. 7 Design output of Case C: (a) app; (b) mutual-aid box; (c) vending machine.

5 Cross-Case Discussion

Table 2 maps the three cases against the four intervention mechanisms from the framework (Fig. 1), showing how each mechanism was operationalised across different wicked problem domains.

Table 2. Cross-case mapping to intervention mechanisms

Mechanism	Case A: CyCheers	Case B: Food Waste	Case C: Her Share
Systemic perspective	Stakeholder map; value network map	Stakeholder correlation diagram; system map	Service system diagram; stakeholder map
Participatory engagement	Multi-scenario journey maps	Personas; empathy maps; journey maps	Dual-context personas; journey map
Iterative structuring	Multi-scenario blueprints; BMC	Storyboard; blueprint; BMC	Blueprint; buy-one-donate-one; BMC
Problem reframing	Field observation → "make behaviour rewarding"	Social media analysis → "create personal benefit"	Dual-context personas → "normalised mutual support"

The cross-case comparison reveals that all four mechanisms were activated in each case, with different emphasis depending on dominant wicked characteristics. Case A emphasised systemic perspective; Case B relied on participatory engagement; Case C foregrounded problem reframing. The framework thus operates as a configurable toolkit: all mechanisms are present, but designers emphasise different ones depending on which dimensions of wickedness are most salient.

The framework complements existing models: Suoheimo et al.'s Iceberg Model diagnoses problem level [7]; Kotaniemi et al.'s comparison guides process strategy selection; the present framework addresses the next step—how specific methods respond to specific characteristics [8]. The three cases support this diagnostic–strategic–operational sequence.

Pedagogically, three insights emerge: explicit wicked problem theory provided conceptual vocabulary preventing oversimplification; the phased course structure scaffolded engagement with complexity; and the facilitator role enabled iterative problem (re)definition.

6 Conclusion

This paper has made three contributions. First, it proposed a Service Design Intervention Mechanism Framework mapping four wicked problem characteristics to four intervention mechanisms, complementing existing diagnostic and strategic models. Second, through three student cases, it provided empirical evidence that service design methods function as structured interventions—not definitive solutions—in wicked problems. Third, it demonstrated that a structured pedagogical approach can cultivate students' capacity to engage with complex social challenges.

Limitations include single-institution scope, conceptual (not implemented) proposals, and absence of longitudinal learning outcome data. Future work could replicate across contexts, incorporate user feedback, test the framework's applicability in professional service design practice, and integrate complementary approaches such as transition design.

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