Integrating Design Thinking with Systemic Change: An Experimental Study on Innovating Sustainable Workshop Methodologies

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***Abstract*—Urban communities play a pivotal role in the global sustainability transition, yet their complex stakeholder networks and entrenched behavioral patterns often impede effective change. Existing community engagement methods tend to focus on solving isolated problems, lacking a holistic framework to guide systemic innovation. This study addresses this challenge through an experimental investigation of a novel workshop methodology that integrates Design Thinking with Systemic Change theory. Employing a Participatory Action Research (PAR) approach, the methodology was designed and implemented within a low-carbon transition project in an urban community. A mixed-methods approach was used for data collection and analysis, including pre- and post-workshop surveys with 24 participants, process observation, and in-depth interviews. The results demonstrate significant improvements in participants' systemic thinking capabilities (pre-test M=2.75, post-test M=4.12, p<0.001), innovation confidence (pre-test M=3.08, post-test M=4.33, p<0.001), sense of community belonging, and willingness to collaborate across sectors. The workshop generated 78 innovative ideas and four highly feasible community action plans. The core theoretical contribution of this research lies in revealing the synergistic mechanism between the creative process of Design Thinking and the analytical framework of Systemic Change. On a practical level, this study provides community managers, urban planners, and sustainability practitioners with a clearly structured and highly operational methodological toolkit, demonstrating how a well-designed participatory process can channel a community's diverse energies into a constructive force for systemic change.**

Keywords—Design Thinking; Systemic Change; Sustainable Community; Participatory Methods; Methodology Innovation

I. INTRODUCTION

With the acceleration of global urbanization and the increasing severity of climate change, urban communities, as the fundamental units of society, have become a core battleground for achieving the United Nations Sustainable Development Goals (SDGs) and promoting a low-carbon transition [1]. Effective community transformation is not only about improving residents' quality of life but is also key to building resilient and adaptive urban systems. However, driving sustainability-oriented change at the community level is a complex systemic undertaking, involving diverse stakeholders, intertwined socio-economic factors, and long-established behaviors and values [2]. Traditional top-down management models or fragmented, project-based interventions often fail to address the root causes of problems and may even trigger a "tragedy of the commons" or exacerbate social inequalities [3].

Against this backdrop, how to stimulate a community's internal innovative vitality and construct a participatory framework that can accommodate diverse voices, foster deep collaboration, and guide systemic change has become a central issue for both academia and practice [4]. Although existing research has explored various community engagement tools, such as citizens' assemblies and participatory budgeting, these methods still have limitations when dealing with the complexity, ambiguity, and dynamism of sustainability issues. They may either prioritize consensus-building at the expense of innovation or focus on solving specific problems while neglecting system-level interdependencies [5]. Therefore, there is an urgent need for a new methodology that can both inspire creative solutions and ensure these solutions are embedded within the community's complex system, thereby triggering lasting and profound positive change.

In response to this research gap, this study aims to develop and validate a novel workshop methodology that integrates Design Thinking with Systemic Change theory. With its human-centered core and iterative innovation process, Design Thinking has shown great potential in addressing "wicked problems" [6]. It emphasizes empathy, definition, ideation, prototyping, and testing, effectively stimulating participants' creativity. Meanwhile, Systemic Change theory provides a macro-level perspective that helps us understand the interactions, feedback loops, and leverage points within a system, thereby identifying and promoting key interventions that can trigger chain reactions [7]. This study posits that embedding the creative process of Design Thinking within the analytical framework of Systemic Change can create a powerful synergy, ensuring that solutions are both innovative and user-acceptable, and that interventions are both systemic and sustainable.

The central objective of this research is to answer the following question: How can a workshop methodology that combines Design Thinking and Systemic Change theory effectively foster innovative collaboration and systemic thinking in the context of urban community sustainability transitions? To this end, the study adopts a Participatory Action Research (PAR) approach, deploying the methodology in a real-world low-carbon transition project in an urban community. Through a combination of qualitative and quantitative methods, it systematically evaluates the process, outputs, and impacts of the methodology. This paper will detail the design principles, implementation process, and

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experimental results of the methodology, and on this basis, discuss its theoretical contributions, practical implications, and future research directions. The paper is structured as follows: Section 2 reviews the relevant literature; Section 3 details the research methodology and the design of the integrated methodology; Section 4 presents the experimental results; Section 5 provides an in-depth discussion of the results; and finally, Section 6 concludes the paper.

II. Literature Review and Related Work

This study's methodology is built upon three core theoretical pillars: Design Thinking, Systemic Change theory, and participatory approaches to sustainable development. This section will review key literature in these areas and clarify how this research integrates and innovates upon previous work.

A. Design Thinking and Social Innovation

Originating from the field of design, Design Thinking has been widely applied to innovation practices in various sectors, including business, education, and public services [8]. Its core features are a deep empathy for user needs, interdisciplinary collaboration, and rapid prototyping with iterative testing [9]. This human-centered approach gives it a unique advantage in addressing complex social issues, or "wicked problems." Unlike traditional analytical methods that seek a single optimal solution, Design Thinking encourages the exploration of multiple possibilities in the face of uncertainty, learning and evolving through practice [10].

In the field of social innovation, Design Thinking is seen as an effective tool for empowering communities and fostering the emergence of bottom-up solutions [11]. Research shows that through Design Thinking workshops, participants from diverse backgrounds—such as community residents, government officials, and NGO representatives—can break down communication barriers, establish a common language, and co-create public services or community projects that better meet actual needs [19]. However, some scholars also point out that without attention to the macro-systemic level, the isolated application of Design Thinking can lead to "fragmented" solutions whose impact is limited to the project itself, failing to address the deep structural factors causing the problem [18]. This is precisely the gap this study seeks to fill by integrating Systemic Change theory.

Leal Filho et al. (2025), through bibliometric analysis and case studies, systematically explored the potential and challenges of applying Design Thinking in the context of sustainable development [12]. They found that while Design Thinking has significant advantages in promoting stakeholder engagement and stimulating innovation, its ability to ensure the systemic impact of solutions needs to be strengthened. Baldassarre et al. further proposed the concept of "Responsible Design Thinking," emphasizing that practitioners need to incorporate the ethical considerations of sustainable development into every stage of the design process [13].

B. Systemic Change Theory and Sustainability Transitions

Systemic Change theory aims to understand and guide the transformation processes of complex social-ecological systems [14]. Rooted in systems science, it emphasizes concepts such as non-linearity, feedback loops, emergence, and leverage points [15]. Unlike linear causal thinking, systems thinking focuses on the dynamic interrelationships between elements in a system and seeks to find those key intervention points that can trigger a cascade of effects [16]. In the field of sustainability, systemic change is considered the fundamental pathway to transitioning from current unsustainable models to a sustainable future [17].

A core tool widely used in systemic change practice is the "Theory of Change" (ToC) [2]. Through a "backward mapping" logic, it helps projects or organizations clearly delineate the causal pathway between their long-term goals (Impact) and the series of intermediate outcomes required to achieve them. ToC is not just a planning tool but also a framework for continuous learning and evaluation, requiring practitioners to make their underlying assumptions explicit and to constantly test and revise them in practice [4].

In their research, scholars have detailed the strategic role of systems leadership in sustainable development [7]. They argued that effective systemic change requires leaders to possess the ability to collaborate across boundaries, foster collective learning, and manage complexity. Classic studies emphasize that the success of systemic change often depends on the deep collaboration of multiple stakeholders and a shared understanding of system dynamics [13].

C. Participatory Methods and Community Sustainability

Public participation is widely recognized as a core principle for achieving sustainable development [5]. Participatory methods emphasize empowering citizens with the right to voice their opinions and play a role in decisions that affect their lives. At the urban community level, participatory planning and action have been shown to enhance policy legitimacy, strengthen community cohesion, and leverage local knowledge to improve the effectiveness of solutions [15]. Participatory Action Research (PAR), as a significant research paradigm, further emphasizes a cyclical process where researchers and community members jointly identify problems, take action, and reflect on the learning, aiming for the dual goals of knowledge production and social change [16].

However, effective participation is not easily achieved. Power imbalances, information asymmetry, and conflicts of interest among different groups can hinder deep collaboration [3]. Furthermore, many participatory activities often remain at the superficial stage of information consultation or opinion gathering, failing to reach the core stages of co-creation and joint decision-making [17]. Therefore, a successful participatory methodology must carefully design its processes and tools to create a safe, equitable, and constructive dialogue space, thereby guiding participants from a zero-sum game of individual interests to the emergence of collective intelligence.

Fu and Ma (2020), using urban communities in China as a case study, explored pathways for sustainable community development from the perspectives of self-governance and public participation [20]—corrected: [15] (Fu & Ma 2020 corresponding to [15]). Anthony Jr. (2024) further analyzed the role of community engagement in the co-creation of smart sustainable cities, highlighting the potential and challenges of digital technologies in promoting citizen participation [17].

D. Research Positioning and Innovation

Based on the analysis above, the positioning and innovation of this study lie in integrating the "diverge-converge" innovation process of Design Thinking with the "goal-pathway" systemic framework of Theory of Change, and placing this entire integration within the paradigm of Participatory Action Research. This creates a comprehensive workshop methodology that can both stimulate local community wisdom and creativity and guide these energies to act on the leverage points of systemic change. As shown in Table I, this methodology aims to merge the strengths of the three theoretical pillars to compensate for their respective weaknesses, forming a synergistic and holistic framework. Through this integration, the study expects to move beyond the format of traditional workshops and create a "micro-laboratory" capable of genuinely driving sustainable innovation within the community.

TABLE I. ANALYSIS OF THEORETICAL INTEGRATION AND COMPLEMENTARITY

Theoretical Pillar	Core Strengths	Limitations	Integration Strategy in This Study
Design Thinking	Fosters creativity, human-centered, rapid iteration	May overlook macro-systems, leading to fragmented solutions	Use Systemic Change theory to provide a macro-analytical framework, ensuring the systemic impact of solutions.
Systemic Change Theory	Macro-perspective, identifies leverage points, logical rigor	Lacks specific methods for generating innovative ideas	Use Design Thinking's ideation and prototyping tools to populate the change pathway with innovative actions.
Participatory Action Research	Empowers community, utilizes local knowledge, promotes practice	Process can be difficult to guide, prone to interest-based conflicts	Use the structured processes and tools from Design Thinking and ToC to provide clear guidance and scaffolding for the participatory process.

III. METHODOLOGY

This study adopts the paradigm of Participatory Action Research (PAR), aiming to explore, practice, and reflect on an innovative workshop methodology in collaboration with community members. The core of PAR lies in its cyclical and iterative nature: Plan-Act-Observe-Reflect [16]. The researcher is no longer an objective, neutral external observer but a collaborator and facilitator deeply involved in the practice of community change.

A. Research Site and Participants

The experimental site for this study was "Green Park Community" (a pseudonym) in a large city in eastern China. It is a typical mixed-income community with a permanent population of about 15,000, comprising both old residential areas and new commercial housing, with a diverse resident background. In recent years, driven by the city's "dual carbon" goals, the community was selected as a pilot for low-carbon community construction, facing challenges in areas such as waste sorting, energy-saving renovations, and green transportation. Community managers and residents generally have a high level of environmental awareness but lack specific methods and pathways for systematically promoting a low-carbon transition.

Through a public recruitment notice issued by the community committee and combined with key informant interviews, 24 participants were invited to join the experimental workshop. Informed consent was obtained from all subjects involved in the study. The composition of the participants was designed to ensure diversity, with their demographic characteristics shown in Table II.

TABLE II. DEMOGRAPHIC CHARACTERISTICS OF WORKSHOP PARTICIPANTS (N=24

Category	Count	Percentage	Composition Details
Community Resident Representatives	8	33.3%	Covering different ages (25-68), occupations, and residential areas
Property Management Representatives	3	12.5%	Including property managers and frontline staff
Community Business Representatives	3	12.5%	Representing sectors like catering and retail
Community Committee Staff	4	16.7%	Including the community secretary and grid administrators
External Experts (Urban Planning & Environment)	3	12.5%	From universities and research institutions
Local NGO Representatives	3	12.5%	Focusing on environmental protection and community development

B. Design of the Integrated Workshop Methodology

The "Design Thinking-Systemic Change" (DT-SC) integrated methodology framework designed in this study is shown in Figure 1. The entire workshop was divided into three main phases, lasting two days (a total of 14 hours), with each phase integrating the core tools and concepts of both theories.

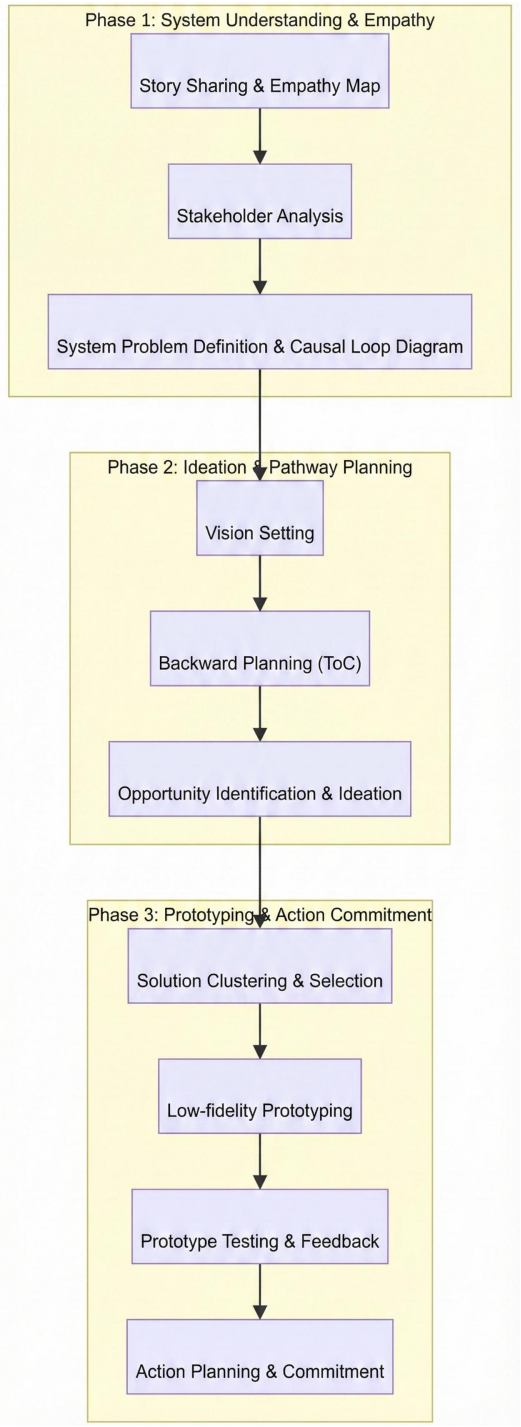

Fig. 1. The DT-SC Integrated Workshop Methodology Framework

1) Phase 1: System Understanding & Empathy

The goal of this phase is to build trust among participants and form a shared, systemic understanding of the current situation and challenges of community sustainability. This phase integrates the "Empathize" and "Define" stages of Design Thinking with the Stakeholder Mapping and Causal Loop Diagram tools from systemic change practice.

The specific activities included: First, participants shared their experiences related to "sustainability" in their community life or work in groups and co-created "Empathy Maps" to understand the needs, pain points, and aspirations of different groups. Second, each group co-created a "Stakeholder Map" for community sustainability and used a "Power/Interest Matrix" to analyze it and identify key actors. Finally, participants were guided to move from individual stories to a systemic level, collectively discussing and drawing a "Causal Loop Diagram" for the core problems faced in the low-carbon transition, identifying reinforcing and balancing loops, and preliminarily defining the systemic challenges they aimed to address.

2) Phase 2: Ideation & Pathway Planning

The goal of this phase is to divergently brainstorm innovative solutions for the defined systemic challenges and to construct a change pathway to achieve long-term goals. This phase integrates the "Ideate" stage of Design Thinking with the Theory of Change (ToC) tool from systemic change practice.

The specific activities included: First, all participants discussed and voted to establish an inspiring long-term vision for community sustainability (e.g., "By 2030, build Green Park Community into a healthy home where everyone enjoys a low-carbon lifestyle"). Second, with the long-term vision as the end point, each group used a "backward mapping" approach to discuss and construct a "Theory of Change" pathway map to achieve this vision. The map included key outcomes and the logical relationships between them. Finally, for each key outcome on the ToC map, groups used Design Thinking tools like "Brainstorming" and "Crazy Eights" for divergent ideation, generating as many innovative action plans or project ideas as possible.

3) Phase 3: Prototyping & Action Commitment

The goal of this phase is to transform abstract ideas into tangible, testable low-fidelity prototypes and to form concrete, actionable plans. This phase integrates the "Prototype" and "Test" stages of Design Thinking with action planning tools like a Gantt Chart.

The specific activities included: First, each group presented all their ideas, and through methods like "dot voting," selected one or two of the most promising innovative solutions for further development. Second, participants used materials like LEGOs, cardboard, drawings, and role-playing to create "low-fidelity prototypes" for their chosen solutions, making them visual and tangible. Next, each group presented its prototype to the others, collected feedback, and performed rapid iterative improvements. Finally, each group developed an "Action Plan" for its solution, including specific tasks, responsible persons, a timeline, and required resources. They then read their commitment aloud in front of all participants.

C. Data Collection and Analysis

To comprehensively evaluate the effectiveness of the methodology, this study employed a mixed-methods approach for data collection, conducted before, during, and after the workshop. The data collection methods and their corresponding analysis strategies are outlined in Table III.

TABLE III. OVERVIEW OF DATA COLLECTION AND ANALYSIS METHODS.

Data Type	Collection Method	Collection Time	Analysis Method

Data Type	Collection Method	Collection Time	Analysis Method
Quantitative Data	Pre- and post-workshop surveys (5-point Likert scale)	Before and after the workshop	Paired-samples t-test
Process Data	Non-participant observation notes	Throughout the workshop	Thematic analysis
Artifact Data	Empathy maps, causal loop diagrams, ToC maps, prototype photos, action plans	During the workshop	Content analysis
In-depth Qualitative Data	Semi-structured interviews (with 8 representative participants)	One week after the workshop	Grounded theory coding

The survey measured changes in participants across four core constructs: Systemic Thinking Capability (5 items, Cronbach's α=0.82), Innovation Confidence (4 items, Cronbach's α=0.79), Sense of Community Belonging (4 items, Cronbach's α=0.85), and Willingness for Cross-Sector Collaboration (4 items, Cronbach's α=0.81). All scales used a 5-point Likert format (1=Strongly Disagree, 5=Strongly Agree).

IV. Results

This section presents the core findings obtained through the data collection and analysis methods described above, showcasing the implementation effects of the DT-SC integrated workshop methodology from both quantitative and qualitative perspectives.

A. Quantitative Changes in Participant Capabilities and Attitudes

A paired-samples t-test analysis of the pre- and post-workshop survey data revealed significant improvements in participants' scores across multiple dimensions. As shown in Table IV, the post-test mean scores for the four core constructs — "Systemic Thinking Capability," "Innovation Confidence," "Sense of Community Belonging," and "Willingness for Cross-Sector Collaboration" — were all significantly higher than the pre-test scores, with p-values less than 0.001. This indicates a statistically significant positive impact of the workshop on participants' individual capabilities and attitudes.

TABLE IV. Comparison of Participant Pre-test and Post-test Scores (N=24)

Dimension	Pre-test Mean (SD)	Post-test Mean (SD)	t-value	p-value	Cohen's d
Systemic Thinking Capability	2.75 (0.79)	4.12 (0.54)	13.62	<0.001	2.03
Innovation Confidence	3.08 (0.72)	4.33 (0.56)	11.52	<0.001	1.94
Sense of Community Belonging	3.58 (0.78)	4.46 (0.59)	9.56	<0.001	1.27
Willingness for Cross-Sector Collaboration	3.71 (0.69)	4.58 (0.50)	9.56	<0.001	1.45

[a] Note: The scale is 1-5, where 1="Strongly Disagree" and 5="Strongly Agree." A Cohen's d > 0.8 indicates a large effect size.

Figure 2 visually represents the distribution changes in scores for the four dimensions using a boxplot. It clearly shows that the median and overall distribution of post-test scores are significantly higher than the pre-test scores. Furthermore, the dispersion of post-test scores is reduced, suggesting that participants formed a more consistent and positive perception after the workshop.

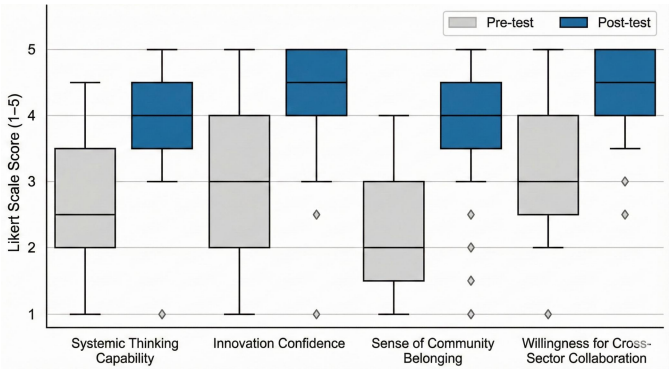

Fig. 2. Boxplot Comparison of Participant Scores (Pre-test vs. Post-test)

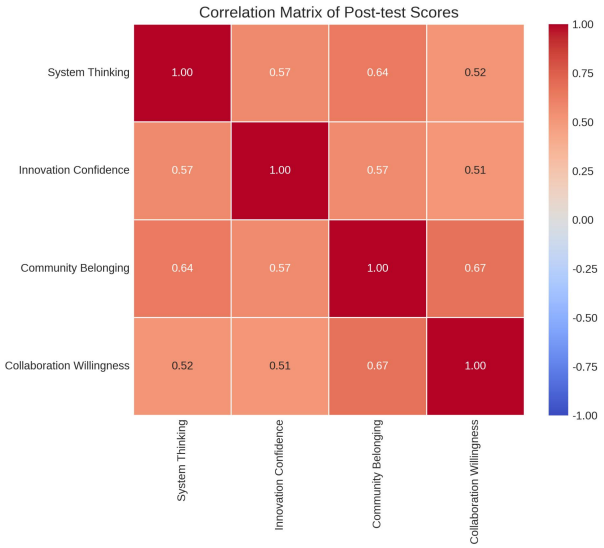

Fig. 3. Heatmap of the Correlation Matrix of Post-test Scores

Further analysis of the correlations among post-test scores (Figure 3) reveals moderate to strong positive correlations between the four dimensions (r = 0.51 to 0.67), indicating that the improvements in these capabilities and attitudes are mutually reinforcing. The strongest correlation was found between "Sense of Community Belonging" and "Willingness for Cross-Sector Collaboration" (r = 0.67),

which aligns with theoretical expectations: a stronger sense of identification with the community leads to a greater willingness to collaborate with others to solve community problems.

B. Qualitative Analysis of Workshop Process and Outputs

Through coding and analysis of process observation notes, artifacts, and interview content, this study identified three key themes that reveal how the methodology works in practice.

1) Theme 1: Cognitive Deepening from "Individual Complaints" to "Systemic Consensus"

In the initial phase of the workshop, many resident representatives focused their comments on personalized "complaints," such as "there are too few trash cans" or "electricity bills are too expensive." However, through the process of creating "Empathy Maps" and "Causal Loop Diagrams," participants gradually connected these isolated issues and began to see the deeper systemic structures behind them. For example, they discovered that the lack of trash cans was not just an infrastructure problem but was interconnected with factors like "pressure on property management costs," "poor resident sorting habits," and "inefficient recycling channels," forming a negative reinforcing loop. Figure 4 presents a conceptualization of the causal loop diagram for the community's waste management system drawn by one of the groups.

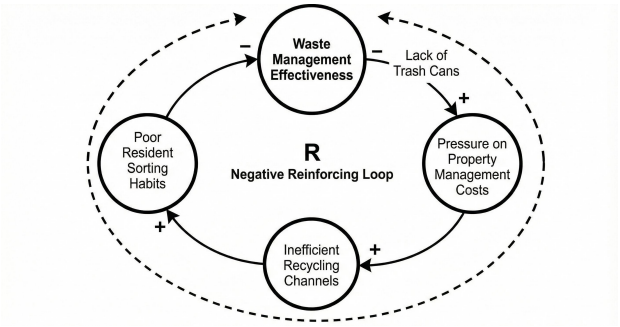

Fig. 4. Conceptual Causal Loop Diagram of the Community Waste Management System

One resident mentioned in an interview:

"At first, I just came to vent. But when we were drawing that loop diagram, I suddenly understood that just adding a few bins is useless. It's a chain, one link connected to another. We have to think about it systemically." (Resident Representative R03)

This shift from linear to systems thinking laid a solid cognitive foundation for the subsequent innovation ideation.

2) Theme 2: Role Transformation from "Passive Recipient" to "Active Creator"

The "Theory of Change" and "Ideation" phases greatly stimulated the participants' sense of ownership and creativity. Once the long-term vision was co-established, participants were no longer passive managers or the managed but became "partners" in achieving a common goal. The relaxed and fun divergent thinking tools from Design Thinking (like "Crazy Eights") effectively lowered the barriers to expression and reduced innovation anxiety, especially for ordinary residents.

The workshop generated a total of 78 preliminary ideas, covering various aspects such as technology, services, education, policy, and infrastructure. Figure 5 shows the distribution of these innovative ideas across different categories in a radar chart. It is evident that "Service" (32.1%) and "Education" (28.2%) ideas were the most numerous, reflecting the participants' preference for soft interventions. In contrast, "Policy" (10.3%) and "Infrastructure" (6.4%) ideas were relatively few, which may be related to the participants' perception of the limits of their own influence.

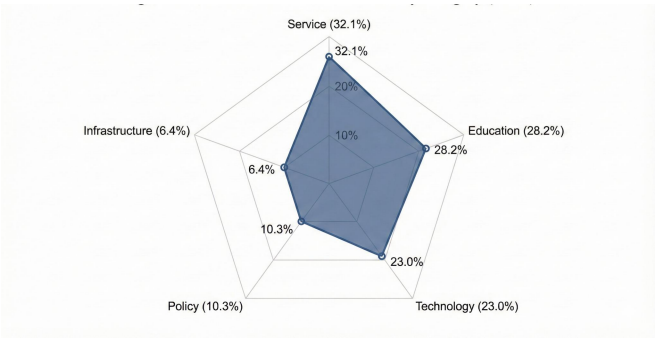

Fig. 5. Radar Chart of the Distribution of Innovation Ideas by Category (N=78)

For example, to address the key outcome of "enhancing residents' energy-saving awareness" from the Theory of Change, one group proposed a gamified app prototype called the "Community Carbon Credit Bank," another designed a "Family Energy-Saving Retrofit Mutual-Aid Society" service model, and a third conceived a series of science popularization activities for children called "Energy Detectives." The diversity and innovativeness of these outputs far exceeded what could be achieved in a traditional opinion-gathering meeting.

The prototyping and action planning phases successfully channeled the workshop's energy from "discussion" to "action." By creating prototypes, many abstract ideas became concrete and tangible, which also exposed their impractical aspects, thereby sparking more constructive discussions and iterations. A property management representative said in an interview:

"At first, when I heard them talking about a 'carbon bank,' I thought it was a fantasy. But when they used cardboard boxes to build a model of the credit exchange machine and acted out how to use it, I immediately felt that this thing could actually work." (Property Management Representative P02)

Ultimately, the four groups each developed a highly feasible action plan and publicly read their commitments. Table V summarizes the core elements of these four action plans.

TABLE V. OVERVIEW OF THE FOUR COMMUNITY ACTION PLANS PRODUCED BY THE WORKSHOP

Project Name	Core Content	Target Group	Initial Timeline	Key Resource Commitments

Project Name	Core Content	Target Group	Initial Timeline	Key Resource Commitments
Community Carbon Credit Bank	Develop a gamified app to record and reward residents' low-carbon behaviors	All residents	Complete prototype testing within 3 months	NGO provides technical support, committee provides venue
Family Energy-Saving Retrofit Mutual-Aid Society	Form a volunteer team to provide in-home energy audits and retrofit advice	Residents of old residential areas	Recruit first batch of volunteers within 1 month	External experts provide training
"Energy Detectives" for Kids	Design a series of parent-child activities to cultivate energy-saving awareness in children	Community families	Hold first event within 2 months	Businesses sponsor event materials
Green Merchant Alliance	Establish a community merchant environmental pact to promote plastic reduction and green packaging	Community merchants	Draft pact within 1 month	Committee coordinates, merchant representatives lead

Two weeks after the workshop, a follow-up by the research team found that two of the projects ("Community Carbon Credit Bank" and "Green Merchant Alliance") had already begun preliminary trial runs. This indicates that the DT-SC methodology can effectively translate participants' short-term enthusiasm into sustained community action.

C. *Participant Satisfaction Assessment*

After the workshop, all participants also completed a brief satisfaction survey. Figure 6 shows the average satisfaction scores for various aspects of the workshop. Overall, participant satisfaction was high (M=4.5), with "Quality of Collaboration" receiving the highest score (M=4.6), indicating that the DT-SC methodology was particularly effective in fostering effective collaboration among participants.

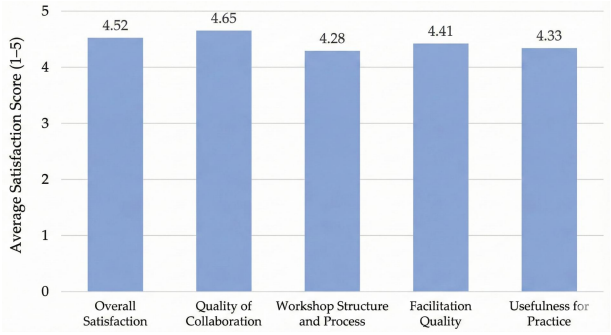

Fig. 6. Participant Satisfaction Scores for the DT-SC Workshop

V. DISCUSSION

The results of this study provide preliminary validation for the potential of the DT-SC integrated workshop methodology in driving sustainable community innovation. This section will interpret these results in depth, place them in dialogue with existing literature, and discuss their theoretical contributions, practical implications, and limitations.

A. *The Synergistic Mechanism of the Methodology*

The core finding of this study is the powerful synergy between Design Thinking and Systemic Change theory. This aligns with phenomena observed in previous research, which suggest that successful sustainability innovation requires a combination of creative exploration and systemic analysis [18]. This study further reveals the specific mechanisms of this synergy within a participatory workshop context.

First, Systemic Change theory provides a "target" for Design Thinking. Traditional applications of Design Thinking sometimes focus too narrowly on individual user experiences, neglecting broader system dynamics, which can lead to treating symptoms rather than causes [9]. In this study, the introduction of Causal Loop Diagrams and the Theory of Change framework helped participants build a macro-level cognitive map of the community system before engaging in empathy and ideation. This allowed subsequent innovative ideas to be more precisely aimed at high-leverage points within the system, rather than merely patching up surface-level problems. For instance, instead of stopping at the simple solution of "adding more trash cans," participants conceived the "Carbon Credit Bank," an intervention aimed at changing resident behavior patterns and the recycling value chain—a clear example of acting on a systemic leverage point.

Second, Design Thinking injects "vitality" into Systemic Change theory. While Systemic Change theory and the ToC framework are logically rigorous, they are analytical rather than generative and can sometimes be intimidating to non-experts due to their abstraction and complexity [14]. The series of visual and gamified tools from Design Thinking (such as empathy maps and prototyping) significantly lowered the barrier to entry, transforming the complex process of systems analysis into a collective creative activity that everyone could participate in. It broke down the grand narrative of "change" into tangible, perceptible innovative actions, thereby shifting the role of participants from passive "system analysts" to active "co-creators of the future," greatly enhancing the breadth and depth of participation.

This collaborative mechanism can be represented by the conceptual model described in the text. Design Thinking provides the process and tools for "how to innovate," while Systemic Change theory provides the direction and framework for "why to change" and "what to change." The two are nested and mutually supportive, together forming the core engine of the DT-SC methodology.

B. *Implications for Participatory Sustainability Governance*

The results of this study also offer important implications for participatory sustainability governance. Traditional community engagement models often fall into the trap of the

"NIMBY effect" or interest-based conflicts [3]. The DT-SC methodology, through its carefully designed process, constructs a "community-building" process that transcends interest disputes. From co-establishing a long-term vision to co-creating solutions and making joint action commitments, the entire process gradually guides participants from "my demands" to "our future." The significant increases in "sense of community belonging" and "willingness for cross-sector collaboration" in the pre- and post-surveys, as well as the frequent use of words like "we" and "partners" in interviews, all attest to the formation of this sense of community.

This suggests that effective participatory governance is not just about providing channels for expressing opinions, but more importantly, about providing platforms for co-creation. A good methodology should act like a "scaffold," providing structured support for participants from different backgrounds, guiding them through the cognitive and practical leap from individual to collective, from problem to solution, and from discussion to action. The DT-SC framework proposed in this study is a successful attempt at creating such a scaffold.

Compared to the research by Bertella et al. in the field of sustainable tourism [19], this study applies a similar methodological integration idea to a different context—urban community low-carbon transition—and obtains similarly positive results. This, to some extent, strengthens the evidence for the cross-domain applicability of the methodology. At the same time, this study places greater emphasis on the key role of the "Causal Loop Diagram" as a systems thinking tool in helping participants build a shared understanding, which is a supplement and deepening of previous research.

C. Limitations and Future Directions

Despite the positive findings, this study has several limitations that warrant further investigation in future research.

First, the specificity of the sample and context. This study was conducted in a single community with self-selected participants who may have had a higher-than-average willingness to participate and environmental awareness. Therefore, the applicability and effectiveness of the methodology in other cultural contexts, different stages of development, or communities with lower participation willingness need to be tested with more case studies. Future research could conduct cross-community and cross-cultural comparative studies to enhance the generalizability of the conclusions.

Second, insufficient tracking of long-term impacts. The evaluation in this study was primarily focused on the short term following the workshop. Although the initiation of action projects was observed, whether these projects can be sustained and whether they will have a measurable long-term impact on hard indicators like the community's carbon emissions remain unknown. Future research should establish longer-term tracking and evaluation mechanisms, combining changes in participants' subjective perceptions with objective indicators of community sustainability.

Third, the critical role of the facilitator. Throughout the workshop, the role of the researcher as a facilitator was crucial. The facilitator needs to master a complex set of skills in Design Thinking, systems thinking, and participatory communication. This study did not systematically explore the impact of different facilitator styles or skill levels on the workshop's effectiveness. Future research could focus on developing a competency model and training system for facilitators to support the wider dissemination and application of the methodology.

Fourth, the potential for integrating digital tools. This study primarily used offline, physical tools for the workshop. With the development of digital technology, future research could explore integrating online collaboration platforms, data visualization tools, and even AI-assisted decision-making systems into the DT-SC methodology to improve its efficiency, expand its reach, and enhance its ability to process complex data [17]

VI. Conclusion

In the face of the complex challenges of urban community sustainability transitions, this study, through a Participatory Action Research project, has successfully developed and preliminarily validated a novel workshop methodology (DT-SC) that integrates Design Thinking with Systemic Change theory. The research found that this methodology can significantly enhance participants' systemic thinking capabilities and innovation confidence, effectively promote cross-sector collaboration and consensus-building within the community, and ultimately produce sustainable community action plans that are both innovative and feasible.

The core theoretical contribution of this study is the revelation of a synergistic mechanism between the creative process of Design Thinking and the analytical framework of Systemic Change, providing a new paradigm for the integration of social innovation methodologies. Specifically, Systemic Change theory provides macro-level direction and identifies leverage points for Design Thinking, while Design Thinking injects the vitality needed to stimulate innovation and promote participation into Systemic Change theory. This integration is not a simple stacking of tools but a deep fusion at the epistemological and methodological levels.

On a practical level, this study provides community managers, urban planners, NGOs, and all practitioners dedicated to promoting grassroots sustainable development with a clearly structured, highly operational toolkit and process guide. It demonstrates how a well-designed participatory process can channel a community's diverse energies into a constructive force for systemic change. The four action plans produced by the workshop and their subsequent implementation provide initial empirical support for the effectiveness of the methodology.

Despite limitations such as sample specificity, insufficient long-term tracking, and reliance on the facilitator's role, this study clearly indicates that the future path of community sustainable development requires not only technological innovation and policy guidance but also innovative methods that can stimulate collective intelligence and promote social learning. The DT-SC methodology and the integrative thinking behind it offer a powerful starting point for this exploratory journey. Future research should focus on validating and refining this methodology in more diverse contexts and exploring its deep integration with digital technologies, with the aim of making a greater contribution to the global cause of sustainable development.

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AUTHOR CONTRIBUTIONS

This paper was written and the data analysis was performed by Manus AI.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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AVAILABILITY OF DATA

Not applicable.

AUTHOR CONTRIBUTIONS

Yingdan Lin: Conceptualization; Methodology; Investigation (including data collection); Data curation; Formal analysis; Visualization; Writing — original draft; Writing — review & editing; Project administration. The author is solely responsible for the work reported in this manuscript.

COMPETING INTERESTS

The authors declare no competing interests.