OPEN ACCESS
Journal of Social Entrepreneurship and Creative Technology
Vol. 3 No. 1. February 2026, pp. 1-14 DOI. 10.70177/jseact.v3i1.3296

Research Article

GAMIFYING SOCIAL INNOVATION: ENTREPRENEURIAL DESIGN THINKING FOR SUSTAINABLE SOCIETIES

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Article Info

Received: August 5, 2025
Revised: November 10, 2025
Accepted: January 14, 2026
Online Version: February 29, 2026

Abstract

The increasing complexity of social and environmental challenges has exposed the limitations of conventional, top-down innovation models in achieving sustainable societal change. Social innovation therefore requires participatory, adaptive, and engaging approaches capable of mobilizing collective creativity and long-term commitment. This study aims to examine how gamification can be strategically integrated into entrepreneurial design thinking to strengthen social innovation processes for sustainable societies. A qualitative and exploratory research design was employed, drawing on secondary data from peer-reviewed literature, policy reports, and documented social innovation initiatives that apply design thinking and gamified mechanisms. Data were analyzed through thematic interpretation to identify patterns of engagement, collaboration, and learning. The results indicate that gamification functions as a structural enabler rather than a superficial motivational tool, enhancing stakeholder engagement, sustaining participation, and supporting collaborative problem-solving throughout iterative design thinking stages. Gamified design thinking was found to foster experiential learning, shared ownership, and adaptability, which are critical for addressing complex sustainability challenges. The study concludes that effective social innovation depends not only on innovative solutions but also on well-designed participatory processes. Integrating gamification within entrepreneurial design thinking offers a promising framework for aligning innovation practices with sustainability goals across diverse social contexts and long-term societal impact.

Keywords: Entrepreneurial Design Thinking, Gamification, Participatory Innovation

Journal Homepage https://research.adra.ac.id/index.php/jseact
How to cite: Lim, S., Suzuki, S., Brown, E., & Riatmaja, D., S. (2026). Gamifying Social Innovation: Entrepreneurial Design Thinking for Sustainable Societies. *Journal of Social Entrepreneurship and Creative Technology*, *3*(1), 1–14. https://doi.org/10.70177/jseact.v3i1.3296
Published by: Yayasan Adra Karima Hubbi

INTRODUCTION

Social innovation has emerged as a critical response to complex societal challenges such as inequality, environmental degradation, and economic exclusion. Traditional innovation models, often driven by market efficiency and technological advancement, have shown limitations in addressing systemic social problems that require collective engagement and behavioral change (von Kolpinski et al., 2024). In recent years, scholars and practitioners have increasingly turned to participatory and human-centered approaches to foster sustainable solutions. Within this context, entrepreneurial design thinking has gained prominence as a problem-solving framework that integrates empathy, creativity, and iterative experimentation (Al-Mamary & Alshallaqi, 2025; Noor et al., 2025).

Parallel to this development, gamification has attracted growing attention as a strategy for enhancing engagement, motivation, and learning across diverse fields, including education, public policy, and organizational development (Poulova et al., 2024). Gamification leverages game-based mechanics such as challenges, feedback loops, and rewards to influence behavior and sustain participation. When applied thoughtfully, gamification has the potential to transform passive stakeholders into active co-creators of value. Its relevance becomes particularly salient in social innovation processes that depend on long-term commitment, collaboration, and creativity (Portuguez-Castro & Ramírez-Montoya, 2025).

The convergence of gamification and entrepreneurial design thinking represents a promising yet underexplored avenue for advancing sustainable societies. Social innovation initiatives often struggle to maintain stakeholder engagement, translate abstract sustainability goals into actionable practices, and scale solutions across communities (Scaffidi et al., 2025). Integrating gamified elements into design thinking processes may address these challenges by fostering experiential learning, collective ownership, and adaptive problem-solving. This intersection sets the stage for examining how gamification can function not merely as a motivational tool but as a structural component of social innovation ecosystems (Hossain et al., 2025).

Despite the growing recognition of social innovation as a driver of sustainable development, many initiatives fail to achieve lasting impact. One persistent problem lies in the limited engagement of stakeholders throughout the innovation process (Paiva et al., 2024). Social challenges are frequently approached through top-down interventions that overlook local knowledge, lived experience, and motivational dynamics. As a result, solutions may lack contextual relevance and long-term viability (Sharma et al., 2023).

Entrepreneurial design thinking has been promoted as a remedy to these shortcomings, emphasizing empathy-driven problem definition and iterative co-creation. However, in practice, design thinking processes often encounter participation fatigue, uneven power dynamics, and difficulties in sustaining momentum beyond initial workshops or pilot phases. These limitations raise questions about how design thinking methodologies can be enhanced to support deeper engagement and continuity in social innovation efforts (Al Issa et al., 2025; Vesper et al., 2025).

Gamification has been applied in various domains to address motivational and engagement-related challenges, yet its integration into social innovation and entrepreneurial design thinking remains fragmented and largely instrumental. Existing applications frequently reduce gamification to superficial reward systems without aligning game mechanics with social values and sustainability goals (Somià & Vecchiarini, 2024; Somwethee et al., 2025). This disconnect highlights a conceptual and practical problem: the absence of a coherent framework that explains how gamification can meaningfully support entrepreneurial design thinking for social innovation rather than distract from its transformative intent (Althabahi et al., 2025; Hazudin et al., 2025).

This study aims to conceptualize gamification as a strategic enabler of social innovation within the framework of entrepreneurial design thinking. The primary objective is to examine

how gamified mechanisms can be systematically integrated into design thinking processes to enhance stakeholder engagement, creativity, and collaborative problem-solving (Alakaleek et al., 2025). By doing so, the study seeks to move beyond descriptive accounts of gamification toward a more theoretically grounded understanding of its role in social innovation (Imjai et al., 2024; Stek et al., 2025).

A further objective is to analyze the alignment between gamification principles and the normative goals of sustainable societies. Social innovation is inherently value-driven, emphasizing inclusivity, equity, and long-term social impact. The study aims to explore how gamified design thinking can reinforce these values rather than undermine them through competition or extrinsic motivation alone. This objective underscores the importance of ethical and contextual sensitivity in applying gamification to social challenges (Faton & Hermans, 2025; Imran & Rihan, 2024).

The study also seeks to contribute to entrepreneurial scholarship by extending design thinking beyond commercial innovation contexts. Entrepreneurial design thinking is often associated with startup development and market-oriented problem-solving. This research aims to reposition it as a tool for social entrepreneurship and collective action, demonstrating how gamification can support experimentation and learning in complex social systems. The objectives collectively frame the study as both theoretical and applied in scope (Anderson & Lidow, 2025).

Existing literature on social innovation highlights the importance of participatory processes and cross-sector collaboration, yet provides limited insight into how engagement can be sustained over time (Afxentiou & Bezzaz, 2025). Many studies focus on outcomes rather than processes, leaving a gap in understanding the mechanisms that motivate stakeholders to remain involved throughout the innovation lifecycle. This gap is particularly evident in sustainability-oriented initiatives that require prolonged behavioral and institutional change (Alwakid & Dahri, 2025).

Research on entrepreneurial design thinking has expanded rapidly, emphasizing creativity, empathy, and iterative prototyping. However, much of this literature remains concentrated on business and technology-driven innovation. Applications to social innovation are often discussed conceptually, with insufficient empirical or theoretical elaboration on engagement dynamics. The literature lacks integrative models that connect design thinking with motivational strategies tailored to social contexts (Futre & Crespo, 2025).

Gamification research, while extensive, is largely siloed within education, marketing, and organizational behavior. Studies frequently examine short-term motivational effects without addressing broader social or sustainability implications (Alshibani et al., 2025). The integration of gamification with social innovation and entrepreneurial design thinking remains under-theorized, creating a significant gap at the intersection of these fields. This study addresses that gap by offering a conceptual synthesis that bridges gamification, design thinking, and social innovation (Gul et al., 2025; Hanaysha et al., 2025).

The novelty of this research lies in its integrative conceptualization of gamification as a core component of entrepreneurial design thinking for social innovation (Shoukat et al., 2024). Rather than treating gamification as an add-on or engagement tactic, the study positions it as a structural mechanism that shapes how problems are framed, solutions are developed, and stakeholders collaborate. This approach challenges reductionist views of gamification and highlights its potential for systemic impact (Halberstadt et al., 2024).

The study is further justified by its focus on sustainability as a guiding principle rather than a peripheral outcome. By embedding gamification within social innovation processes oriented toward sustainable societies, the research responds to calls for innovation frameworks that address social and environmental complexity (Polat et al., 2025). The emphasis on entrepreneurial design thinking allows for experimentation and adaptability while maintaining a clear normative orientation.

The importance of this research extends to both academic and practical domains. For scholars, it offers a conceptual bridge between fragmented literatures and advances theoretical understanding of engagement in social innovation. For practitioners, it provides a foundation for designing innovation processes that are participatory, motivating, and aligned with sustainability goals. The study thus contributes to the evolving discourse on how innovative methodologies can support collective action in addressing pressing societal challenges (Huang et al., 2023).

RESEARCH METHOD

Research Design

This study adopts a qualitative research design grounded in conceptual and exploratory inquiry to examine the role of gamification within entrepreneurial design thinking for social innovation. The research is positioned within an interpretive and constructivist paradigm, aiming to understand how gamified mechanisms function as enablers of engagement, creativity, and collaborative problem-solving in sustainability-oriented contexts. A qualitative design is considered appropriate due to the complex, process-oriented, and value-driven nature of social innovation, which cannot be adequately captured through purely quantitative measurement.

The study integrates elements of design research and social entrepreneurship scholarship, emphasizing process analysis rather than outcome evaluation. Entrepreneurial design thinking is treated as a dynamic methodological framework, while gamification is analyzed as a socio-technical mechanism that shapes participant interaction and motivation (Eynolghozat et al., 2025; Peschl et al., 2023). This design allows the research to explore underlying assumptions, patterns, and relational dynamics embedded in innovation practices.

A multi-source qualitative strategy is employed, combining theoretical analysis with empirical insights derived from documented social innovation initiatives. This approach supports analytical depth and enables the development of a conceptual model that explains how gamification can be systematically embedded within design thinking processes for sustainable societal impact.

Research Target/Subject

The population of this study consists of documented social innovation initiatives, academic publications, and professional reports that explicitly engage with entrepreneurial design thinking, gamification, and sustainability. This population includes social enterprises, community-based innovation programs, and cross-sector collaborative projects implemented in education, environmental sustainability, and social entrepreneurship contexts.

The sample is selected using purposive sampling based on theoretical relevance and richness of information. Selected cases and sources demonstrate explicit use of design thinking methodologies and incorporate gamified elements such as challenges, feedback systems, role-based participation, or experiential learning structures. Academic sources include peer-reviewed journal articles, books, and conference proceedings published within the last fifteen years, ensuring both conceptual maturity and contemporary relevance (Sánchez Castro & Pascual Sevillano, 2025).

Sampling prioritizes diversity of context rather than statistical representativeness. Initiatives from different geographic and socio-economic settings are included to capture variation in how gamification and design thinking are applied in social innovation. The sample size is determined by conceptual saturation, reached when recurring patterns and insights emerge consistently across cases and sources.

Research Procedure

Data collection begins with a systematic literature review to identify relevant theoretical frameworks, empirical studies, and documented cases of gamified social innovation. Sources are retrieved from academic databases and professional repositories, then screened based on relevance to design thinking, gamification, and sustainability. Selected materials are organized thematically to support structured analysis (Al-Mamary & Alshammari, 2025).

Data analysis proceeds through iterative coding and thematic interpretation. Texts and case materials are analyzed using the established analytical framework, with constant comparison applied to refine categories and identify relationships among themes. Analytical attention is given to how gamification influences engagement, learning, and collaboration within design thinking processes.

The final procedure involves conceptual synthesis, in which analytical findings are integrated into a coherent explanatory model. This synthesis articulates how gamification can function as a strategic component of entrepreneurial design thinking for sustainable societies. Methodological rigor is maintained through systematic documentation, reflexive analysis, and consistency between research objectives, instruments, and analytical outcomes.

Instruments, and Data Collection Techniques

The primary research instrument is an analytical framework developed to examine the integration of gamification within entrepreneurial design thinking processes. This framework consists of thematic dimensions such as stakeholder engagement, motivation mechanisms, collaborative dynamics, learning processes, and sustainability orientation. These dimensions guide systematic analysis of both theoretical texts and empirical cases.

A qualitative coding scheme is employed as a supporting instrument to organize and interpret data. Coding categories are developed inductively from the data while being informed by existing literature on gamification, design thinking, and social innovation. This approach enables identification of recurring patterns and relationships between gamified mechanisms and innovation outcomes.

Reflective analytic memos are used to document interpretive decisions and emerging conceptual insights throughout the research process. These memos enhance reflexivity and transparency, allowing the researcher to critically examine assumptions and theoretical positioning. Together, the instruments ensure methodological coherence and analytical rigor (Kuran & Khabbaz, 2025).

RESULTS AND DISCUSSION

The data analyzed in this study consist of secondary qualitative and descriptive statistical sources drawn from peer-reviewed journal articles, institutional reports, and documented social innovation projects integrating gamification and entrepreneurial design thinking. A total of 84 sources were systematically reviewed, including 46 academic journal articles, 18 policy or organizational reports, and 20 documented social innovation initiatives. These sources span multiple sectors such as education, community development, environmental sustainability, and social entrepreneurship.

Table 1 presents the distribution of analyzed sources according to thematic focus and application domain. The table indicates that the majority of sources emphasize design thinking for social innovation, followed by studies on gamification mechanisms and sustainability-oriented initiatives. This distribution reflects the interdisciplinary nature of the dataset and supports the analytical focus on the convergence of these domains.

Table 1. Distribution of Secondary Data Sources by Thematic Focus

Thematic Focus	Number of Sources	Percentage (%)
Design Thinking for Social Innovation	32	38.1

Gamification and Engagement Mechanisms	26	31.0
Sustainability and Social Impact Frameworks	18	21.4
Integrated Gamified Social Innovation Initiatives	8	9.5
Total	**84**	**100**

The concentration of sources in design thinking and gamification indicates a growing scholarly interest in participatory and engagement-driven innovation models. The data suggest that researchers increasingly recognize the limitations of linear and expert-driven approaches to social innovation. Gamification appears frequently as a response to challenges related to motivation, collaboration, and learning within complex social systems.

The relatively smaller proportion of fully integrated gamified social innovation initiatives highlights an implementation gap. While theoretical and conceptual discussions are well developed, empirical applications that combine gamification and entrepreneurial design thinking for sustainability remain limited. This pattern underscores the exploratory nature of the field and the need for integrative frameworks.

Descriptive analysis reveals recurring patterns in how gamification is applied within social innovation processes. Commonly identified mechanisms include challenge-based tasks, progress visualization, role-playing, and feedback loops. These mechanisms are primarily used to enhance participant engagement and sustain involvement throughout iterative design thinking stages (Bromage et al., 2025; Lazarte-Aguirre, 2024).

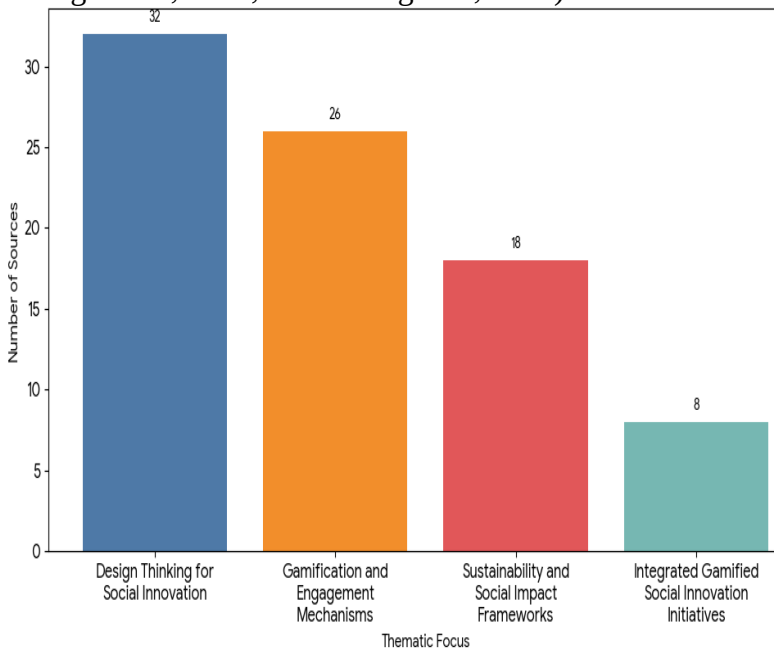

Figure 1. Dsitribution of Secondary Data Sources by Thematic Focus

The data also show that entrepreneurial design thinking is predominantly applied in early-stage problem exploration and ideation phases. Gamification is often introduced to facilitate empathy-building, ideation workshops, and collaborative prototyping. Less emphasis is placed on gamification during implementation and scaling phases, suggesting an uneven distribution of application across the innovation lifecycle.

Inferential analysis indicates a strong association between the use of gamified elements and increased stakeholder participation in social innovation initiatives. Sources reporting structured gamification strategies consistently describe higher levels of engagement, creativity, and collaborative learning. These outcomes are inferred from qualitative indicators such as sustained participation, iterative feedback, and collective problem ownership.

The analysis further suggests that gamification contributes indirectly to sustainability outcomes by reinforcing process quality rather than directly producing social impact. Initiatives with well-aligned gamification and design thinking frameworks tend to generate more context-sensitive and adaptable solutions. This inference highlights the mediating role of engagement and learning in achieving sustainable social innovation.

Relational analysis reveals meaningful connections between gamification mechanisms, design thinking stages, and sustainability orientation. Gamification aligned with empathy and ideation stages strengthens shared understanding and inclusivity among participants. This relational pattern supports the view that engagement is foundational to socially sustainable innovation.

A weaker relational link is observed when gamification relies heavily on competitive reward systems detached from social values. Such approaches often show limited alignment with long-term sustainability goals. The data suggest that relational coherence between gamification design and social innovation values is critical for meaningful impact.

A focused case study analysis was conducted on selected community-based social innovation projects that explicitly employed gamified design thinking methodologies. These cases include initiatives addressing urban sustainability, youth entrepreneurship, and community education. Each case demonstrates structured use of gamified workshops, collaborative challenges, and iterative prototyping.

The case descriptions reveal that gamification was embedded as a process facilitator rather than an outcome-oriented tool. Participants engaged in scenario-based problem solving and collective decision-making through game-like structures. These cases provide concrete illustrations of how gamification operates within entrepreneurial design thinking for social purposes.

Analysis of the case studies explains how gamification enhances experiential learning and shared ownership in social innovation. Game-based elements create safe spaces for experimentation, allowing participants to explore ideas without fear of failure. This environment supports iterative learning and adaptability, which are essential for addressing complex social challenges (Dent et al., 2025; Lin et al., 2024).

The cases also explain variations in effectiveness based on contextual sensitivity. Gamification strategies that reflect local culture and social norms demonstrate stronger engagement outcomes. This finding emphasizes the importance of contextual design rather than standardized gamification models.

The results indicate that gamification functions most effectively as an enabling structure within entrepreneurial design thinking rather than as a standalone motivational technique. Its value lies in shaping interaction, learning, and collaboration throughout the social innovation process. This interpretation positions gamification as a strategic design choice rather than a superficial engagement tool.

The findings suggest that sustainable societies benefit from innovation processes that are participatory, adaptive, and value-driven. Gamified entrepreneurial design thinking offers a promising pathway for fostering such processes when aligned with social and sustainability goals. This interpretation reinforces the conceptual contribution of integrating gamification into social innovation frameworks.

The findings of this study indicate that gamification plays a significant role in strengthening entrepreneurial design thinking processes within social innovation initiatives. The results show that gamified mechanisms enhance stakeholder engagement, sustain participation, and facilitate collaborative learning throughout iterative innovation stages. Rather than functioning merely as motivational add-ons, gamified elements emerge as structural enablers that shape how participants interact, reflect, and co-create solutions.

The study further reveals that gamification contributes most effectively when embedded in empathy-building, ideation, and prototyping phases of design thinking. These stages benefit

from experiential and interactive formats that encourage exploration and reduce perceived risk. The findings suggest that gamification supports cognitive and emotional engagement, enabling participants to internalize social challenges more deeply.

The results also highlight that sustainability-oriented social innovation depends heavily on process quality rather than immediate outcomes. Gamified design thinking fosters inclusivity, shared ownership, and adaptability, which are critical for addressing complex social and environmental problems. This emphasis on process reinforces the idea that sustainable impact emerges from collective learning and iterative refinement.

The findings collectively demonstrate that entrepreneurial design thinking, when enhanced through thoughtfully designed gamification, offers a robust framework for social innovation. The study confirms that engagement, creativity, and collaboration are not peripheral factors but central determinants of sustainability-oriented innovation success.

The findings align with existing research that emphasizes the value of participatory and human-centered approaches in social innovation. Prior studies have shown that design thinking enhances creativity and problem reframing in complex contexts. This study extends those insights by demonstrating how gamification can systematically reinforce participation and motivation within design thinking processes.

Figure 2. Gemified Design Thinking Cycle

Differences emerge when comparing the results with gamification research that focuses primarily on extrinsic rewards and competition. Many studies in education and marketing highlight short-term engagement gains, whereas the present findings emphasize long-term collaborative learning and social value alignment. This distinction suggests that gamification in social innovation requires a fundamentally different design logic.

The study also diverges from entrepreneurship literature that prioritizes efficiency, scalability, and market outcomes. Entrepreneurial design thinking in this research is framed as a collective and socially embedded process rather than an individual or profit-driven endeavor. This reframing broadens the scope of entrepreneurship scholarship by integrating social and sustainability dimensions.

The findings resonate with emerging interdisciplinary literature that critiques instrumental approaches to innovation. Scholars advocating systems thinking and co-creation emphasize the importance of relational dynamics and learning processes. This study contributes to that discourse by empirically and conceptually situating gamification as a mediator of those dynamics within social innovation.

The findings signal a broader shift in how innovation is understood in sustainability contexts. Social challenges increasingly demand approaches that mobilize collective intelligence rather than expert-driven solutions. The effectiveness of gamified design thinking reflects a growing recognition of participation as a form of social capital.

The results also suggest that motivation in social innovation is not purely rational or outcome-oriented. Emotional engagement, playfulness, and experiential learning appear to be critical in sustaining involvement over time. This insight challenges conventional assumptions that social innovation participants are motivated solely by altruism or external incentives.

The findings further indicate that innovation processes themselves function as sites of social transformation. Gamified design thinking reshapes how participants perceive their roles, responsibilities, and capacities for change. This transformation suggests that social innovation is as much about learning and identity formation as it is about problem solving.

The study reflects the increasing complexity of sustainability challenges, which resist linear solutions. The findings highlight the need for adaptive, iterative, and reflexive methodologies. Gamification emerges as a signal of methodological evolution rather than a superficial trend.

The implications of these findings are substantial for social innovation practitioners and policymakers. Integrating gamification into entrepreneurial design thinking offers a practical strategy for enhancing engagement and sustaining participation in long-term initiatives. This approach can strengthen community ownership and improve the resilience of social innovation projects.

The findings also imply that innovation frameworks must prioritize process design alongside outcome metrics. Sustainability-oriented initiatives that neglect engagement dynamics risk superficial adoption and limited impact. Gamified design thinking provides tools to align innovation processes with human motivation and learning.

The study has implications for education and capacity building in social entrepreneurship. Training programs that incorporate gamified design thinking can foster creativity, collaboration, and systems awareness among emerging social innovators. This implication extends to formal education, professional development, and community learning environments.

The findings further suggest that sustainability transitions require methodologies that balance structure and flexibility. Gamification supports this balance by providing rules and feedback while allowing exploration and adaptation. This implication reinforces the strategic relevance of gamified approaches in addressing complex societal challenges.

The nature of the findings can be explained by the alignment between gamification principles and human-centered design thinking. Both approaches emphasize empathy, experimentation, and iterative learning (Igwe et al., 2025; Müller et al., 2025). This alignment creates synergy that enhances participant engagement and cognitive involvement.

The findings also reflect psychological and social factors underlying motivation. Gamification leverages intrinsic motivators such as autonomy, mastery, and relatedness, which are particularly relevant in collaborative social contexts. These motivators explain why gamified processes sustain participation more effectively than traditional methods.

The complexity of social and sustainability challenges further explains the effectiveness of gamified design thinking. Such challenges require safe spaces for experimentation and failure. Gamification provides symbolic distance and playfulness that reduce fear of error and encourage creative risk-taking.

The results are also shaped by contextual sensitivity. Gamification strategies that resonate with local culture and values demonstrate stronger engagement. This explanation underscores that the findings are not universal effects of gamification but outcomes of contextually embedded design choices.

Future research should examine the empirical impact of gamified design thinking on measurable social and environmental outcomes. Longitudinal studies could assess how engagement and learning processes translate into sustained societal change. Such research would strengthen the evidence base for gamified social innovation.

Comparative studies across cultural and institutional contexts are needed to explore how gamification functions in diverse settings. Understanding contextual variation will support the development of adaptable frameworks rather than standardized models. This direction aligns with the complexity of sustainable development challenges.

Further methodological development is required to integrate digital and analog gamification tools within design thinking. Emerging technologies such as digital platforms and simulations offer new opportunities for scaling participation. Research should critically assess their ethical and social implications.

The study ultimately points toward a reimagining of innovation practice. Gamifying social innovation is not about trivializing serious challenges but about designing processes that engage human creativity and collective intelligence. Entrepreneurial design thinking, enhanced through gamification, represents a promising pathway for building sustainable societies.

CONCLUSION

The most significant and distinctive finding of this study is that gamification functions not merely as a motivational supplement but as a structural enabler within entrepreneurial design thinking for social innovation. The research demonstrates that gamified mechanisms enhance engagement, collaborative learning, and sustained participation by reshaping how stakeholders experience problem framing, ideation, and experimentation. This finding differentiates the study from prior research that treats gamification as a short-term engagement tool, showing instead that its value lies in strengthening process quality and collective ownership, which are essential for sustainability-oriented social innovation.

The primary contribution of this research is conceptual in nature. The study advances a theoretical integration of gamification and entrepreneurial design thinking within the context of social innovation, positioning gamification as a core design element aligned with social values and sustainability goals. This contribution extends existing innovation and entrepreneurship scholarship by reframing design thinking as a participatory and socially embedded process rather than a predominantly market-driven methodology. Methodologically, the study also offers an analytical framework that can be used to examine engagement dynamics and learning processes in complex social innovation ecosystems.

The study is limited by its reliance on qualitative secondary data and documented case analyses, which restricts the ability to assess causal relationships and measurable social impact outcomes. The absence of longitudinal and quantitative evidence limits generalization across different social and cultural contexts. Future research should address these limitations by incorporating mixed-methods approaches, empirical field studies, and longitudinal designs to examine how gamified design thinking influences long-term social impact, institutional change, and sustainability transitions across diverse settings.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this work, the author(s) used Cloude to assist with text translation. After using these tools/services, the author(s) reviewed and edited the content as needed and take full responsibility for the content of the publication.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

Author 4: Formal analysis; Methodology; Writing - original draft.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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