Design Thinking for Frugal Innovation: Unleashing Sustainable Business Models in Emerging Markets

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Abstract: Frugal innovation is a hotbed for low-cost innovative solutions that addresses the needs of underprivileged customers in emerging markets. Many of such frugal innovations are designed and developed by organizations that work at grassroots, and develop solutions in response to the interest of disadvantaged communities. With a central tenet of transforming an existing or undesirable state into a desired state, Design plays a significant role in meeting the unmet needs of such disadvantaged communities. Lately, Design Thinking is increasingly gaining traction as a human-centered approach to innovation that focuses on creative, innovative and iterative development. The foundation of Design Thinking lies in a strong desire to understand more about the people for whom the products and services are developed. When combined with the principles of sustainable business models, design thinking can lead to frugal innovations that not only meet the needs of underprivileged customers but also engender long-term social, economic, and environmental implications. However, studies focusing on the interplay of design thinking and sustainable business models, to unravel the outcome of frugal innovation are scanty. The current study fills this knowledge gap by uncovering how design thinking and sustainable business models can jointly help in improving the outcomes of frugal innovation practices in emerging markets. The research methodology comprises qualitative data collection through a multi-case study strategy using a grounded theory approach. The findings result in a conceptual framework that can be utilized to assess the performance metrics of organizations practicing frugal innovation in an emerging market context. The framework suggests that the outcome of frugal innovation can be measured using various indicators such as affordability, accessibility, energy efficiency, empowerment, and a human-centric approach. By focusing on human-centered solutions and maximizing the potential of frugal innovation, the study's contribution can potentially offer insights for organizations aiming to create a sustainable impact.

Keywords: Frugal innovation, Design thinking, Sustainable business model, Emerging market

1. Introduction

The burgeoning need to solve local problems of emerging markets has become an absolute necessity among organizations. Frugal Innovation (FI) has lately become the linchpin by which firms and organizations create new processes, production systems, and products for unmet local needs (Wozniak & Wereda, 2023). The most recent study on the evolution of FI has demonstrated its critical role in combating the COVID-19 pandemic reviving academic interest in the field (De Marchi et al, 2022). Frugal innovation is characterized by an environment that has resource scarcity, institutional voids, and affordability constraints (Ebolor et al, 2022). This paradigm shifts in end-users' needs and the imperative of addressing sustainable development goals are making organizations change their business model and technological innovations (Hossain, 2020). To successfully respond to this transition, innovators and designers need to steer from a conventional decision-making attitude to a human-centric design strategy for developing affordable and appropriate solutions that establish sustainability. Even though the association between frugal innovation and sustainability has been conceptualized in the literature, there is limited discussion on how such innovative solutions are being designed, developed, and disseminated limiting the potential of frugal innovation.

Design has always been a stimulator for innovation both in the product and service domains (Liedtka, 2018). Over the last few years, design thinking has become a buzzword among businesses and researchers, and it has cemented its position as a study where organizations can gain a competitive advantage from a designer's way of thinking and executing. Design Thinking has been conceived as a potential way of obtaining solutions to complex business problems and managing innovation to newer forms of life (Frisk & Bannister, 2022). Design Thinking acts as a facilitator for businesses and organizations to frame their intention by clearly articulating business models and enhancing the understanding of end users (Sekoboto & Mazanai, 2022). Design Thinking has been employed more and more as a tactic to aid in the development of sustainable business models, a phenomenon that has attracted attention on a global scale (Kurek et al, 2023).

Another critical component that influences the outcome of innovation activity is a sustainable business model (SBM) (Jaksic, 2016). Many times, frugal solutions are developed by organizations from ideation to dissemination without proper consideration of the business model. The sustainable business model is a rising topic of interest

in the management discourse to address the needs of underserved users (Comin et al, 2020). Hossain et al. (2021) mention that a frugal innovation is an appropriate means to serve low-income users, and, developing a sustainable business model around frugal innovation can help in attaining sustainable development. Sustainable business models help organizations in maintaining a competitive advantage by delivering, capturing and creating new value (Dal Mas et al, 2020). As an innovative endeavor, design thinking puts forth the idea of developing goods and services based on human needs, with diverse teams in finding pertinent solutions for complicated issues to develop creative solutions towards sustainability (Carella et al, 2022). Even though design thinking is acknowledged to be a key driver of competitiveness on a global scale, there are still developing nations where design as an instrument of innovation serves a negligible role in terms of contributing to the community. Table 1 outlines the recent discourse around these three concepts and taps on the gap for strengthening research.

Table 1: Comparing recent works on Design Thinking, Business Model Innovation, Frugal Innovation

Author	Focus	Design Thinking (DT)	Sustainable Business Model (SMB)	Frugal Innovation (FI)	Combined Studies (DT+SBM+FI)	Context/Technique
Sekoboto and Mazanai (2022)	Applying DT for circular business model innovation	Yes	Yes	No	No	Case Studies in South- African Small and Medium-sized Enterprises
Carella et al. (2022)	Role of DT in creating new ventures	Yes	No	No	No	Exploratory research among European participants
Ebolor et al. (2022)	Understanding the role of FI in establishing sustainability in construction industry	No	No	Yes	No	Case studies in construction industry
Magistretti et al. (2022)	Uncovering the contribution of DT in research and development phase	Yes	No	No	No	Single case study
Kurek et al. (2023)	Checking the role of DT in creation of BMI	Yes	Yes	No	No	Contextual Review
Current Study	Synergistic role of DT, BMI in developing frugal innovations	Yes	Yes	Yes	Yes	Case Study on diverse organizations

Currently, there is scarce literature on frugal innovation that pivots on the interplay of design thinking and sustainable business models in conjunction. Exploring the concepts together will generate new avenues for discerning how to create, capture, and deliver value for the end users in emerging markets. Frugal Innovation in conjunction with Design Thinking can be used to develop new goods, services, and business models, in addition to changing processes or products (Ebolor et al, 2022). Any decisions made by organizations concerning role of innovation in business models will have a direct impact on performance. Thus, the study aims to investigate how frugal innovations are produced with novel business models that contribute to sustainable development. In response to the aforementioned questions, the study addresses two research questions (RQ):

RQ1: *How does the integration of principles of design thinking enhance the development of frugal innovations that align with sustainable business models?*

RQ2: *What metrics can be used to assess the performance of frugal innovations that have been developed using design thinking a sustainable business models practices?*

With the exploratory analysis of three organizations from an Indian context, the study illustrates how the generation of appropriate solutions is possible when product ideation and developmental and operational concerns are taken into account. Furthermore, the study also positions that a frugal solution should not be only technologically appropriate, but also be backed by sound business models in a given environment. The novelty of the studies lies in utilizing the concept of design thinking and sustainable business models for the development, dissemination, and evaluation of frugal innovation products. The remaining part of the article is

as follows: the next section discusses the methodology. The findings and discussions are presented in section three. Section four ends with the conclusion and proposed contributions.

2. Methodology

The study follows an exploratory approach and implements a multi-case-based strategy. The major intention of using a case-based approach is to investigate the qualitative information through an inductive process. A multi-case study was chosen to intensify the depth of observations; importantly, this enabled the researcher to revisit the primary research questions. According to Yin (2009), the vigor of a case study lies in dealing with multiple, significant sources for research questions allowing a multifaceted analysis. Mignenan (2022) stated that there are three kinds of organizations that are engaged in the approach of frugal innovation: multinational organizations, local organizations, and small-medium scale organizations. The study focused on choosing small-scale organizations that have attracted significant market traction despite the constraints in the development process. An exhaustive search of organizations was made to select the right cases through online databases and public resources. We selected three organizations from a large basket of organizations. The reason for selecting these organizations is because of the reflection of design thinking and frugal innovation in their functioning. The selected organizations fundamentally differ from each other, but they share a certain dimension of similarity. They have been operating in an environment characterized by resources and institutional voids, to address societal, economic, and environmental concerns. The major business idea of all these organizations centers on local development and sustainable operation in rural regions of India.

The first case selected is “X”, a for-profit social enterprise (*name changed to maintain anonymity*) alleviating poverty by giving people access to clean energy, building an ecosystem for sustainable energy innovations, bridging gaps through holistic solutions, and scaling solutions via replication. The inclusive approach followed by X has generated employment for many rural entrepreneurs. The second case selected for the study is “Y”, a development initiative mission that improves the rural economy by conducting science & technology intervention in the traditional practice of rural farm and non-farm production. The third case selected is “Z” an organization actively operating in energy, health, drinking water, skill development, and education. The vision of “Z” is to bring change by involving vulnerable communities from developing countries to design technologies for improving their economic and social well-being.

The data collection involved both primary interviews and secondary responses in the form of field notes, brochures, reports, and website articles. The data collection was done on the frugal innovation, design thinking aspects, and business model of these organizations from their origin to the present time. The data comprises face-to-face semi-structured interviews, field observations, and secondary documents as shown in Table 2. A semi-structured interview was made with six management and technology personnel from these three organizations. The interview was audio-recorded taking permission from the respondents at their organization’s premises. The field observations allowed us to note down their conduct and laid the ground for a contextual understanding of the concepts. Furthermore, the interviewed personnel demonstrated the entire mechanism of frugal innovations and business functioning.

The study follows an inductive approach which is concerned with finding the most probable description of what has happened from the respondents’ context for developing themes (Varma & Dutta, 2022). The data analysis is led by following the ideals of Grounded Theory (Gioia et al, 2013). NVivo12 software, which is frequently used for complex, heterogeneous, and qualitative datasets, was used to analyze the qualitative data (Patnaik & Bhowmick, 2020). The first stage of the analysis concerns with creating the data structure which starts with the data coding procedure. We examined the relationships between the transcripts and organized them into 1st-order codes based on our framed research questions. We further checked the idea that the first-order code might assist us in understanding the respondents' perspective. The data generated from the 1st-order codes were theoretically-focused and abstract.

The first stage further involved repeated cycling between theory and data. Once we reached a manageable number of codes, we handled the data by continually adding and removing codes that were emerging from the structure. We deduced that the saturation of the first-order codes has been reached when no meaningful insights emerged. Using axial coding (Strauss & Corbin, 1998), we looked for connections between and within the structure of 1st-order codes at the second level of analysis. In line with the underlying data structure, this leads to the creation of the 2nd-order codes. As we iterated over the 1st-order codes, we looked for any concepts that would help to clarify the respondents' narration. Second-order codes were created during this iterative process, and they eventually came together to form eight aggregate themes. The degree of importance of each of the themes discovered was once more reviewed throughout each instance in the last level of analysis.

Consequently, the development of data structures fulfills two purposes. First, it offers an apparent summary of the analysis performed on the original data. Second, it offers a foundation for illustrating an in-depth narrative of the study in its entirety. The data structure is shown in Table 3, which shows how the movement from raw data to the aggregate theme was achieved visually.

Table 2: Overview of selected organizations

Case	X	Y	Z
Nature	For-profit	Academic	Non-governmental
Year of establishment	1995	2008	1972
Location	Bangalore	Guwahati	Rajasthan
Product	Solar-energy related products	Agriculture, Energy, Assistive, Animal Husbandry, Textile, and Handicrafts	Solar-energy, Water, Education
No of Employees	100	30	50
Interview (semi-structured) participants	Head consultant, Project design associate	Senior faculty, Project lead	Co-founder, Field engineer
Time (in mins) taken for interviewing each of the respondent	90-120		120

Table 3: Thematic Analysis

First Order Codes	Second-order Codes	Aggregate Dimension
I. Communities trying to work hard to improve their lives and reduce dependency II. We focus to design technologies in response to unmet local needs III. There exists an immense opportunity to utilize rural resources for boosting their livelihood IV. We have to familiarize with community lifestyle to help them talk comfortably about their problems	• *Understand Field Requirements* • *Identifying Opportunities at grassroots* • *Recognizing appropriate solutions* • *Fostering Trust*	*Empathy*
I. Discerning exact needs of community to define the problem statement and identify the gap in the market and community II. Validating community indigenous knowledge and mobilizing scientific ideas to design appropriate solutions	• *Aiming for Productivity* • *User Segmentation* • *Bridging demand and supply*	*Define*
I. Making exhaustive discussions among different stakeholders to identify the best solution II. Involving communities in the development process for bridging the knowledge gap and ensuring improved technical advancement	• *Collaboration with stakeholders* • *Generating Ideas* • *Resource Mobilization*	*Ideate*
I. Ensuring our innovation are efficient than traditional techniques and flexible as high-end technologies II. Checking the compatibility of technologies with the users and local manufacturing facilities for the utility	• *Experimentation* • *Training Partners* • *Networking*	*Prototype*
I. Conducting workshops and engaging communities to evaluate the utility of the technological innovation II. Carrying out demonstration and training with different NGOs for a wide-scale technology adoption	• *Feedback* • *Field Trials* • *Knowledge Diffusion*	*Testing*

First Order Codes	Second-order Codes	Aggregate Dimension
I. Technologies developed are affordable, require less maintenance, user-friendly, efficient and maintain optimal performance II. Technologies have potential for transforming well-being by making proper interventions	• *Delivering customized end-to-end solutions* • *Effective-delivery mechanism*	*Value Deliver*
I. Sensitizing communities regarding opportunities associated with innovation through different workshops I. Increasing technology accessibility and availability to different geographic regions by forming local networks	• *Entrepreneurial Opportunities* • *Developing the appropriate technological solutions*	*Value Create*
I. Increased revenue generation for community members by selling technologies in local markets II. Technologies have potential for transforming well-being by making proper interventions	• *Market Creation* • *Profit accrued on sales*	*Value Capture*

3. Findings and Discussions

The section shares the findings of the empirical analysis concerning the key elements of design thinking (empathy, defining, ideating, prototyping, testing) and sustainable business models (value delivery, value creation, value capture). The obtained themes represent the diverse opportunities, unexploited needs, and constraints overcome by these organizations in their day-to-day activities for creating frugal innovation and delivering value in the livelihood of the end-users.

Empathy and Defining user insights are considered important aspects of design thinking (Micheli et al, 2019). Immersing into the lives of the end users and letting go of the biases serve as the first step in the innovation process (Liedtka, 2018). Our empirical findings support this statement. The significant aspect of empathy lies in how these organizations undertake efforts to understand their end users for whom they are developing and designing innovative solutions. These organizations tap into empathy by identifying the pain points, and behavioral, and physiological patterns of their users, and feeling their perspective. The case of "Z" demonstrated that women from low-income sections can also be innovators and designers. Thus, from the perspective of design thinking, "Z" recognized and empathized with these women and their social conditions. They trained them as innovators who were able to develop low-cost solar products using minimum resources that were appropriate to their socio-economic context. The Define stage in the organizations is undertaken by converting the observations in the empathy stage into meaningful and actionable problem statements. These organizations attempted to give a precise structure to the identified pain points among the end users in the defined stage. Comprehending the users' perspectives, and inferring their undiscovered needs will give clarity to the problem statement. The organization "Y" identified the field requirements of the rural people, interacted with them, understood their perspective, and identified the opportunities associated with upgrading the existing technological innovation.

The ideation stage in organizations is marked by the generation of ideas for translating the defined problem statement. These organizations employ different brainstorming techniques to create ideas for solving the identified problem. For example, "X" conducts brainstorming sessions with the women to generate feasible ideas for designing solutions, thus giving them equal decision-making responsibility. Furthermore, "X" implements verbal expressions and mental imaging for visualizing and creating interesting ideas.

The prototype stage in the organizations is characterized by a rudimentary model of the identified problem statement (Samadhiya & Agrawal, 2022). These organizations create a low-fidelity prototype for seeking answers and try to evaluate if the solution is capable of addressing the intended problem. Testing is the last phase of design thinking in organizations where the prototype is tested in a real-life setting by the actual end users. The practice of prototyping and testing are significantly reflected in the "Y" design activity. Once, "Y" prepares a low-fidelity prototype, it is taken to the field where the local community uses it, if there is any discrepancy in the operation, then the community gives feedback, and the technology is again modified in the lab until the design in the technology is made appropriate. Once the final design is ready for use, it is transferred to the communities with the help of support partners like NGOs, and local action groups. Blank & Dorf (2020) posit that testing solutions from conception to problem resolution verifies their viability from a commercial perspective and their appeal to end-users.

According to Baumeister et al (2015), a sustainable business model considers the interest of the various beneficiary that also includes the community and its ecosystem, and our findings support this concept. Various groups were associated with different stages in the innovation process of these organizations including funding agencies, professional designers, and intermediary organizations that further mobilized the economic, social, and environmental values for the frugal innovation. The major value creation of these organizations is appropriate, affordable, customizable, and good enough solutions that fit local needs. These organizations respond to the unmet local needs at the grassroots and the lack of access to such technological solutions that will improve their living standards and transform their well-being. For example, the organization "Y" creates and shapes an ecosystem where innovation and entrepreneurship can flourish at the grassroots and where the rural end-users can eliminate dependency on external agencies. The new frugal solutions developed eliminated the drudgery and manual labor of the people and resulted in increased productivity.

A major aspect of value delivery in all three organizations is they rely on local resources, and networking opportunities to create delivery at the grassroots thereby bridging the institutional gaps and resource constraints. Utilizing the available resources makes these firms address any financial, or operational issues that may inhibit the development process. "X" operations are a hub and spoke model that ensures the availability of services across different locations by providing financing options. The hub represents the established energy centers in rural areas where the spoke denotes hiring agents, training the local who further acts as a prime linkage to the end-users. Furthermore, it continues to maintain a long-term association with its partners, which facilitates generating a superior quality of product offerings, door-step financing, managing inventory, conducting flexible prototyping, and leveraging capabilities. The three organizations cater to the different constraints in their functional environment with their models of value capture.

Emerging markets often do not have typical institutional support. For example, the organization "Y" does not give direct loans but closely works with financial organizations to provide credit to their customers. It rents products to local customers, where the product or service is often free for the first year, and then an optimal fee is charged for that service. The members visit each service rented to the user once in three months to ensure performance. It helps in curbing dependency on non-renewable resources and mentors' rural people to become entrepreneurs. The "Y" business model constitutes a set of innovative nexuses that seek to diffuse sustainable technologies to the people at the grassroots in an economically viable way.

Thus, the findings from the analysis stress affordability, accessibility, energy-efficient, empowerment, and human-centric solutions as the outcome of frugal innovations when design thinking and sustainable business models are incorporated into the development process. The empirical framework shown below in Figure 1 represents the association between design thinking and business models for fostering frugal innovations. These entire dynamic aids the organization in increasing performance, and sustainability and bringing a positive change in the lives of the community.

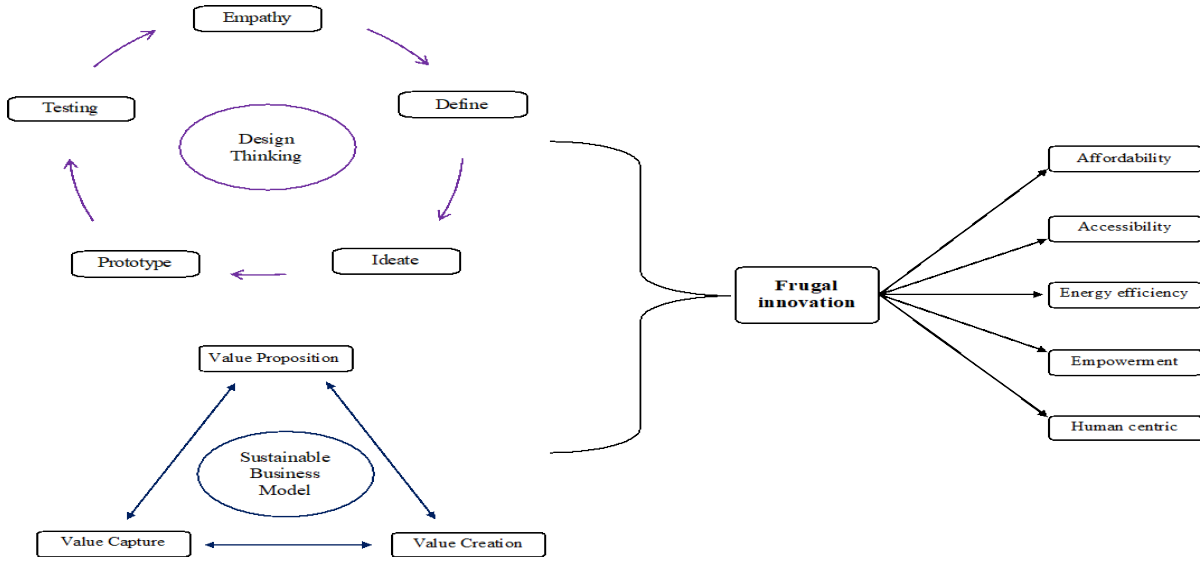

Figure 1: The Analytical Framework

4. Conclusion

The objective of this study was to uncover the desirability, feasibility and, viability of frugal innovation from the lens of design thinking and sustainable business model. The study explored organizations engaged at the grassroots developing human-centered solutions and building a novel sustainable business model. The findings provided a simplified dynamic of frugal innovation, demonstrating a wide range of contextual activities like empathy, define, ideate, prototype, testing, value creation, value capture, and value delivery. Even the research on design thinking, frugal innovation, and sustainable business models have received attention over the years, exploring this concept together for entailing development in the emerging market is still in its infancy. There is a perceptible gap in the existing practice of frugal innovation using design thinking to study the genesis of such innovations. The pairing of 'design' and 'thinking' in design thinking will provide the arena to implement design tools for problem-solving that are not only related to functionality but also to the form of business planning. The theoretical implications of this study lie in uncovering the stages of design thinking for identifying the problems at the grassroots and demonstrating the scope of value delivery and value capture. The study also demonstrated how tenets of design thinking can be applied to small-scale and low-cost innovations.

Organizations engaged at the grassroots have exhaustive knowledge about the rural end-users in emerging markets, when the need arises, they create human-centered solutions making an affordable value proposition for them. This frugal innovation designed through the lens of design thinking is solving problems at the local level which conventional companies have failed to solve. Thus, managers and practitioners need to rethink their strategies for gauging the effects of frugal innovation. Furthermore, this study will make managers, policymakers comprehend the opportunities and impediments linked with the management of frugal innovation. The empirical findings from the study lay the ground for advanced research on the nexus between design thinking and frugal innovation. This study comes with its own set of limitations and outlines pathways for future studies. The study considers three diverse cases of frugal innovation from an Indian context; thus, the findings cannot be generalized to all organizations. New studies can include a larger number of cases from a different geographical context and validate these findings, thereby, generating more insights into the frugal innovation mechanism. The concept of Design thinking and sustainable business model for mobilizing frugal innovation at the grassroots is a new addition to the academic discourse, thus there has been a limited understanding in the context. Future research can delve into how frugal innovation emerges from the ideation to the prototype stage would be interesting to explore.

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