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The Frugal Scalability Paradox in Emerging Innovation Ecosystems

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Abstract

This integrative systematic review addresses the existing gap in understanding how frugal innovation can scale sustainably in emerging economies. Through a mixed-methods analysis based on the PRISMA 2020 protocol, 142 documents published between 2019 and 2025 in Scopus and Web of Science were examined. Scientific and grey literature. The methodology combined bibliometric mapping using VOSviewer, qualitative analysis with NVivo, and a Delphi panel of 15 experts, allowing for the triangulation of theoretical, empirical, and prospective evidence. The findings reveal a transition from a phase of contextual adaptation (2019–2021) to one of systematization and governance (2022–2025), highlighting that the so-called «Frugal Scalability Paradox»—the tension between hyper-contextualization and standardization—constitutes the main obstacle to the sustainability and expansion of frugal models. This study contributes both theoretically and practically by offering a taxonomy of value mechanisms, proposing a hybrid governance framework, and outlining a research agenda focused on inclusion, technological modularity, and impact funding. Frugal innovation is redefined here as a paradigm of intelligent tension management, capable of balancing local relevance and global replicability.

Keywords: frugal innovation; scalability; entrepreneurship; emerging ecosystems; hybrid governance

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1. Introduction

Emerging economies, characterized by a unique dynamic of rapid economic growth coexisting with persistent structural challenges, have generated fertile ground where resource scarcity, far from being an absolute impediment, stands as a singular catalyst for innovation (Rubaj, 2023; Autio & Fu, 2015). In these contexts, frequently defined by insufficient infrastructure, profound institutional gaps, and internally fragmented markets, frugal innovation has emerged with increasing force as a paradigm of disruptive relevance. This approach challenges conventional models of value creation by empirically demonstrating how it is possible to achieve more with less, without necessarily compromising the essential quality of products and services (Hossain, 2018; Radjou & Prabhu, 2015). Far from being a simple reactive improvisation or a reduced version of traditional innovation, this approach represents a systematic and rigorous framework for the development of radically efficient, accessible and sustainable solutions, which fundamentally prioritize core functionality,

robustness against adverse conditions and conscious contextual adaptability (Weyrauch & Herstatt, 2017; Arif et al., 2024).

The notion of value creation under constraints finds one of its most influential antecedents in the work of Prahalad (2004), who proposed that base-of-the-pyramid markets represent not only a moral challenge but also a strategic economic opportunity. His pioneering approach laid the groundwork for linking innovation, inclusion, and profitability in low-income contexts.

This approach represents more than a simple reactive improvisation. Frugal innovation represents a systematic framework for developing radically efficient solutions capable of balancing local relevance and global replicability (Prahalad, 2004; Arif et al., 2024). It is included here due to its fundamental theoretical value regarding the critical transition of frugal innovation from a purely adaptive logic to a systematic and proactive design logic. This conceptual evolution has found solid empirical confirmation in recent research that has expanded and refined its central postulates for the dynamic context of the 2022–2025 period (Schaefer et al., 2024; Kaur, 2020).

The growing academic focus on managing organizational paradoxes (Smith, 2022; Miron-Spektor et al., 2018) has provided a fertile framework for analysing the tensions inherent in frugal innovation. Recent studies demonstrate that successful scaling in resource-constrained contexts requires dynamic capabilities to navigate apparent contradictions, rather than seeking definitive solutions (Moleka, 2024). This perspective is particularly relevant for understanding the evolution of frugal innovation toward more systematized and governable models, where paradox ceases to be an obstacle and becomes a driver of strategic design. However, this potential for positive impact coexists with unresolved structural tensions, particularly the «Frugal Scalability Paradox»—the tension between hyper-contextualization and standardization—which constitutes the main obstacle to the sustainability of frugal models (Tiwari et al., 2017a; Kaur, 2020). This paradox is developed conceptually in Section 4.5, where it is integrated with the theory of organizational paradoxes (Smith & Lewis, 2011).

The strategic intersection between this innovative paradigm and entrepreneurship in emerging economies creates a particularly fertile ecosystem for disruptive business models that operate under an inherent hybrid logic, intricately combining traditional economic objectives with profound social and environmental impacts (George et al., 2020; Ferlito & Faraci, 2022). This synergistic interaction forms what several contemporary authors term the «strategic triad»: the dynamic and mutually reinforcing interaction between emerging contexts, adaptive entrepreneurship, and frugal innovation, which together create a unique space for experimentation and the creation of inclusive value (Agarwal et al., 2020; Zeschky et al., 2011). Paradigmatic examples such as M-Pesa in Kenya or Ilumexico in Mexico eloquently illustrate how this synergy can generate transformative solutions that effectively address the real needs of populations traditionally excluded from formal markets.

Given this complex scenario, academic literature has not yet fully unravelled the specific mechanisms through which this paradox manifests itself operationally and can be addressed strategically. Therefore, key questions arise that demand systematic research: How has the academic discourse on frugal innovation and entrepreneurship in emerging economies evolved diachronically between 2019 and 2025? Which business models have become dominant, and through what specific mechanisms do they generate value under severe conditions? And, fundamentally, what are the critical points of friction that inhibit the scalability of these initiatives, and how do these relate to the central paradox identified?

This study seeks to systematically address these issues through an integrative review that goes beyond exploring theory, but also identifies emerging trends, proposes useful taxonomies and, fundamentally, explores in depth the concrete manifestations and possible ways to resolve or manage the frugal scaling paradox, thus proposing a future research agenda consistent with the nature of these challenges.

2. Objectives

This study pursued three objectives: (i) To critically analyze current trends and priority sectors of frugal innovation in emerging economies, integrating multidisciplinary perspectives that link efficiency and ingenuity with socioeconomic inclusion. (ii) To examine emerging business models and implementation barriers, exploring how public–private partnerships and circular approaches can mitigate infrastructural and financial constraints. (iii) To propose a future research agenda focused on assessing the long-term impact and scalability of frugal solutions, highlighting their potential to contribute to the Sustainable Development Goals (SDGs) through the integration of digital technologies and sustainability practices.

3. Methodology

This study adopts a qualitative design based on bibliometrics, guided by the PRISMA 2020 protocol (Page et al., 2021), which aims to rigorously and critically synthesize the literature on frugal innovation in emerging economies published between 2019 and 2025. This mixed-methods approach is epistemologically appropriate for capturing the multidimensional complexity of the frugal innovation phenomenon, which encompasses technical, social, economic, and governance dimensions. The combination of quantitative (bibliometrics) and qualitative (content analysis, expert consensus) techniques allows for data triangulation that enriches the understanding of the field, integrating empirical, theoretical, and practical findings from different disciplines (Ferlito & Faraci, 2022).

From an epistemological perspective, the combination of PRISMA–bibliometrics–NVivo–Delphi approaches responds to the principle of complementarity inherent in complex systems studies. Frugal innovation, by articulating technological, social, and institutional dimensions, demands a pluralistic methodological strategy that captures structure (through bibliometric networks), meaning (through qualitative coding), and projection (through expert consensus).

This mixed methodological approach integrates the positivist logic of quantitative mapping with the interpretive hermeneutics of qualitative analysis, articulating the PRISMA, bibliometrics, NVivo and Delphi methods (Page et al., 2021; Skamagki et al., 2022; Taylor, 2005).

The Delphi method incorporates the contextual and prospective perspectives of diverse experts, validating and enriching the findings from practice. This integration is essential for addressing a subject of study that, by its very nature, is systemic and rooted in specific contexts.

3.1. Search Strategy and Selection Criteria

The systematic search was conducted between October 2024 and March 2025 in the Scopus and Web of Science (WoS) databases, complemented with grey literature (institutional repositories and Google Scholar). The period analyzed was from 2019 to 2025, in accordance with the study's timeframe. This delimitation aimed to capture the most recent scientific production, marked by the theoretical maturity of the field and its convergence with sustainability and digitalization.

Documents in English, Spanish, and Portuguese that addressed frugal innovation in emerging economies or the Global South were included. Scientific articles, book chapters, conference proceedings, and technical documents with a verifiable conceptual basis were considered.

The main search string was formulated with the following descriptors, adapted to the syntax of each database:

("frugal innovation" OR " jugaad" OR "frugal" OR "frugal innovation")
And ("emerging economy" OR "emerging markets" OR "Global South" OR "low and middle income countries" OR "base of the pyramid" OR "BOP")
And ("business model" OR "sustainable" OR "inclusion" OR "inclusive development" OR "scalab").

3.1.1. Complementary Chain (Spanish and Portuguese)

A complementary search was conducted to broaden linguistic and contextual coverage, integrating studies from Latin America and the Lusophone world that might not be indexed in the main databases. This search used the following terms:

("frugal innovation" or "jugaad")
And ("emerging economy" OR "global south" OR "emerging markets")
And ("business model" OR "sustainability" OR "inclusion" OR "scalability").

This complementary search proved essential for incorporating non-Anglophone literature and strengthening the epistemological diversity of the corpus. However, it is recognized that limiting it to three languages introduces a linguistic bias that may restrict the cultural and epistemological diversity of the results (Helm et al., 2024).

To ensure the transparency and reproducibility of the process, the updated PRISMA flow diagram (Figure 1) and the search strings used in each database are attached. A complementary timeline was also developed, visualizing the thematic evolution of frugal innovation from contextual adaptation (2019–2021) to systemic scalability (2022–2025), which reinforces the validity of the methodological triangulation applied (Page et al., 2021).

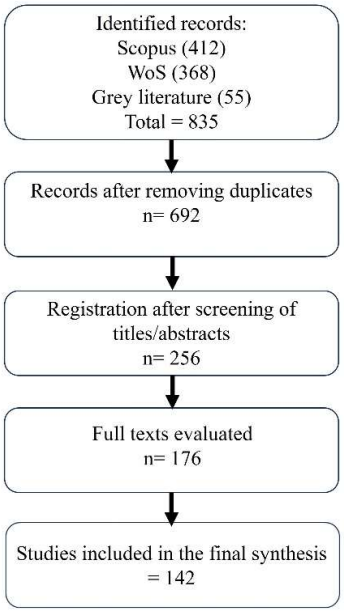

Figure 1. PRISMA flowchart of the study selection process. Source: Prepared for this study.

This choice has profound epistemological consequences, since reliance on dominant databases and languages (especially English) can create a biased representation of frugal innovation, rendering invisible the knowledge, practices, and narratives developed in peripheral linguistic and geographical contexts. This Western-centric representation, or at least one centred on hegemonic publishing channels, can privilege certain conceptualizations of frugality and scalability while marginalizing others, which is particularly problematic for a field of study that seeks to give voice to solutions emerging from the Global South.

3.1.2. Search Log and Debugging Process

The study selection process was conducted in accordance with the PRISMA 2020 protocol. The information is shown sequentially in the PRISMA flow diagram (Figure 1), which details the stages of identification, selection, eligibility, and inclusion.

3.1.3. Inclusion and Exclusion Criteria

The criteria were formulated in a manner consistent with the study objectives and the qualitative approach adopted:

- Inclusion criteria: Theoretical, empirical or case studies were included that analyzed frugal innovation in emerging or Global South economies, with special emphasis on its relationship with entrepreneurship, scalability or sustainable business models.
- Exclusion criteria: Purely technical documents, studies focused exclusively on developed countries without connection to emerging contexts, and non-academic literature lacking a verifiable conceptual or methodological basis were excluded.

3.2. Bibliometric Analysis

To identify research patterns, thematic overlaps, and collaboration networks, a bibliometric analysis was performed using VOSviewer (v. 1.6.20) on the 142 selected documents. The procedure consisted of:

- Export metadata (title, authors, abstract, keywords and references) from Scopus and WoS in .csv and .ris formats.
- Manual refinement and consolidation of duplicates and normalization of terms.
- Load into VOSviewer, applying the following parameters: type of analysis by keyword co-occurrence, full counting method and minimum threshold of five occurrences.
- Thematic grouping using the association strength algorithm and cluster visualization, with resolution 1.0.

The results revealed five main thematic groups that structure the intellectual landscape of the field: frugal innovation and sustainable models; base of the pyramid and inclusion; frugal technology in health and energy; governance and scalability; and environmental sustainability. The co-occurrence map is shown in Figure 2.

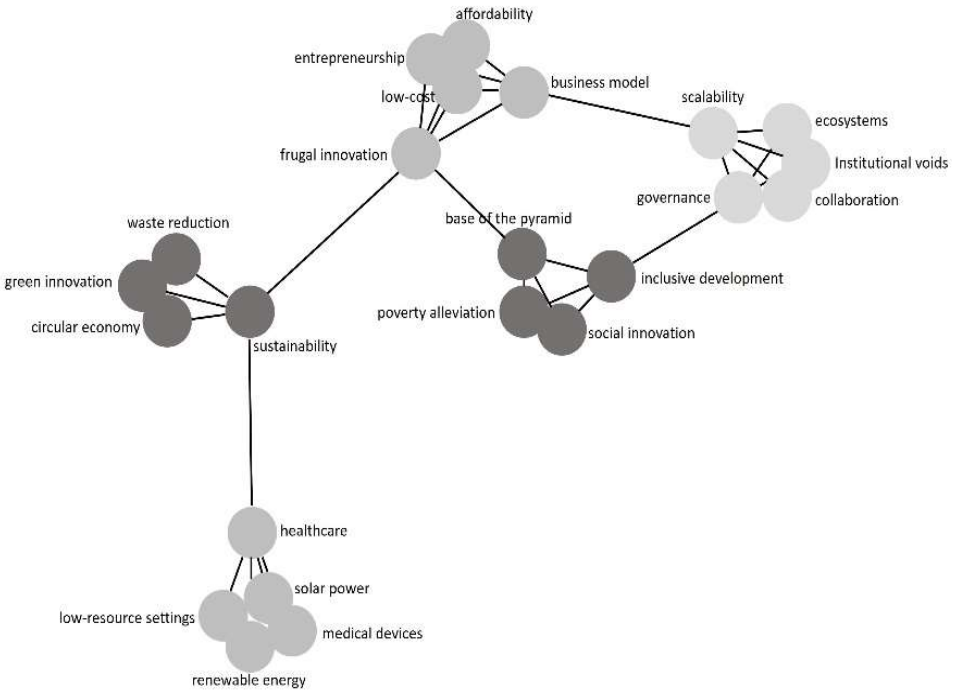

Figure 2. Keyword co-occurrence map (VOSviewer-type simulation). Source: Prepared for this study (review data, March 2025).

3.3. Data Extraction and Analysis

Data extraction was performed using a structured matrix that captured information on authors, year, objectives, methods, sectors of study, business models, barriers, value mechanisms, and key findings. To ensure traceability and consistency, the matrix included standardized fields and unique identification codes for each record.

The analysis was conducted in three interconnected phases:

- Bibliometric analysis with VOSviewer to map thematic networks and trends (objective 1).
- Qualitative content analysis was performed using NVivo 14, which allowed for thematic coding of the full texts and the construction of representative nodes. Initial codes were generated inductively and refined through constant comparison until theoretical saturation was reached. Axial coding allowed for the grouping of patterns around three axes: business models, barriers, and enabling factors. The use of NVivo facilitated the traceability and consistency of the analytical process, following the recommendations of Badampudi et al. (2015) and Lumivero (2024). Furthermore, coding decisions were documented (audit trail), and an inter-coder review was conducted with at least two researchers to monitor the reliability of the process.
- A two-round Delphi method was applied to a panel of 15 experts (academics and practitioners) from Latin America, Africa, and Asia. The panel consisted of 10 academics and 5 practitioners affiliated with NGOs and social enterprises, which provides thematic diversity but also introduces a bias toward institutionalized perspectives. The panel was selected based on criteria such as geographic diversity, thematic expertise (research or practice in frugal innovation or entrepreneurship in emerging economies), and sectoral representation (academia, NGOs, private sector). In the first round, the experts evaluated an initial list of gaps and priorities derived from the analysis; in the second, they provided feedback in the form of scores and comments to reach a consensus. The concordance index (percentage of agreement) and the interquartile range were calculated to measure consistency; a concordance index of $\geq$80% was

considered to indicate acceptable consensus. The process included providing feedback on the aggregated results to participants after the first round to allow for an informed reconsideration of their judgments (Landeta, 2020; Niederberger & Spranger, 2020).

While the Delphi method was initially conceived as a validation mechanism, in this study, it is more appropriately interpreted as an exploratory consultation with academic and professional experts. Given the limited panel size (n = 15) and the overrepresentation of academia, the results should not be considered a statistically robust validation, but rather a tool to enrich the qualitative interpretation of the findings. This composition limits the interpretation of the results, which should be understood as an exploratory contribution rather than a definitive validation. This approach allows for informed perceptions, but it does not replace empirical verification in the field or the direct participation of community actors, whose voices are essential for understanding the practical tensions of frugal innovation.

The integration of quantitative (frequency and co-occurrence of terms) and qualitative (emerging themes and narratives) results was carried out through convergent triangulation (Creswell & Plano Clark, 2018), ensuring a holistic and robust understanding of frugal innovation in resource-constrained contexts.

4. Conceptual Framework

This section establishes the conceptual framework that underpins the analysis, presenting the core constructs and their interrelationships. To strengthen the framework's theoretical coherence and address the contemporary debate on the tensions between contextualization and standardization, this section explicitly draws on the theory of organizational paradoxes (Smith & Lewis, 2011). From this perspective, the «Frugal Scalability Paradox» is conceptualized as a persistent and simultaneous tension between seemingly contradictory forces—local hyper-contextualization and global standardization—that cannot be definitively resolved but must be dynamically managed within frugal business models. These three concepts—emerging economies, entrepreneurship, and frugal innovation—form the analytical basis of the conceptual framework, articulating business micro-processes with institutional macrostructures (George et al., 2020; Ferlito & Faraci, 2022).

Together, they form the analytical basis for examining how value creation under constraints can be articulated in hybrid ecosystems where economic efficiency and social inclusion coexist (Agarwal et al., 2020; Kaur, 2020). These three notions are addressed sequentially, but in an interconnected way, to show how frugal innovation is embedded in the business processes of emerging economies and how this interaction gives rise to the «Frugal Scalability Paradox», understood, following Smith and Lewis (2011), as a persistent organizational tension between the forces of contextualization and standardization.

4.1. Emerging Economies

The concept of emerging economies has occupied a central place in the literature on development and globalization. The International Monetary Fund (IMF, 2023) defines them as nations experiencing rapid economic growth and industrialization, but which have not yet reached advanced economic status. This term, coined by Antoine van Agtmael in 1981, emerged as an alternative to the categories of «third world» or «developing countries», which carry negative connotations (Rubaj, 2023).

Emerging economies do not constitute a homogeneous bloc, but rather a diverse spectrum of national trajectories characterized by hybrid structures where elements of backwardness and modernity coexist. Thus, consolidated institutions and informal systems, high-tech sectors and subsistence economies, and globalized markets alongside traditional practices are observed simultaneously (Lee, 2023). These economies exhibit particular dynamics that make them fertile ground for frugal innovation. Their common attributes

include above-average GDP growth rates, accelerated urbanization, increased international trade, and strengthening capital markets in development (World Bank, 2023). Countries such as Brazil, India, China, Mexico, and South Africa are representative examples, albeit with distinct trajectories (Altenburg & Assmann, 2021).

Their competitive potential lies in factors such as demographic dividends, large domestic markets, and the ability to adopt technologies without inheriting obsolete systems, a phenomenon known as «skipping stages» (United Nations, 2024; Zeschky et al., 2011). Examples such as the expansion of mobile payments in Kenya or distributed solar energy in Bangladesh illustrate these advantages. However, they also face structural disadvantages such as high macroeconomic volatility, dependence on raw materials, vulnerability to external shocks, and institutional weakness (Transparency International, 2023). The persistence of socioeconomic inequality reinforces the dual nature of these economies, in which innovative sectors coexist with structural poverty (Piketty, 2022). Added to this are political and regulatory risks, as demonstrated by the recurring crises in Argentina and Turkey (IMF, 2023). While there are limitations related to technological dependence and brain drain, countries like China and India have demonstrated the possibility of consolidating innovation ecosystems with global reach (Lee, 2023).

In this structural context, entrepreneurship acts as the mechanism through which the economic and social dynamics of emerging economies translate into concrete opportunities for innovation and inclusive development.

4.2. Entrepreneurship

Given that this study focuses on the interrelationship between frugal innovation and entrepreneurship, it is pertinent to reflect on why we propose revising or updating the concept of entrepreneurship. While the concept is widely established in classical economic literature, its application to emerging economic contexts requires a reinterpretation that recognizes the hybrid dynamics of formality and informality, resource scarcity, and the social orientation of value created (Stam & van de Ven, 2018; Shepherd et al., 2019). In this sense, the redefinition does not imply a replacement of the traditional concept, but rather its adaptation to the institutional and cultural conditions in which frugal innovation operates.

Entrepreneurship has undergone a conceptual evolution that transcends its mere creation. Authors such as Autio et al. (2011) define it as a process oriented towards identifying and exploiting opportunities through innovation and risk-taking. Although Richard Cantillon introduced it in the 18th century, it was Schumpeter in 1934 who integrated it into economic theory as an agent of creative destruction (Landström & Lohrke, 2011).

Contemporary research emphasizes its dynamic and iterative nature, combining opportunity discovery, resource mobilization, and strategic execution (Stam & van de Ven, 2018). In this sense, it is not limited to self-employment or small business management, but encompasses social entrepreneurship, corporate intrapreneurship, and practices in informal economies (George et al., 2020). Its characteristics include product or process innovation, proactivity, resilience, and the ability to operate with scarce resources (Shepherd et al., 2019).

The impact of entrepreneurship manifests itself at different scales: it drives economic growth, competitiveness, and job creation (Acs et al., 2009); it offers autonomy and opportunities for individual wealth creation (Donaldson et al., 2023); and it addresses market failures in underserved sectors, especially in emerging contexts (Bruton et al., 2013). Examples include M-Pesa in Kenya and Narayana. Health in India demonstrates its relevance in providing inclusive and low-cost solutions. However, its risks are significant: failure rates close to 50% after five years, financial stress, unequal access to capital and networks, and the reproduction of inequalities (OECD, 2023; Yun et al., 2024).

The literature has evolved from individual-centred perspectives to ecosystemic approaches, where success depends on interaction with support networks, institutions, and markets (Baker & Welter, 2021; Stam & van de Ven, 2018). In emerging economies, entrepreneurship exhibits a hybrid nature: it combines formal and informal logics, operates within ambiguous regulatory frameworks, and faces institutional obstacles such as corruption and poor governance (Autio & Fu, 2015). African examples show how businesses integrate small rural producers into global value chains, balancing social inclusion and competitiveness (Ajide & Dada, 2023)

4.3. Frugal Innovation

Frugal innovation has become a relevant paradigm for addressing resource constraints in emerging markets. Its origins are linked to the Indian concept of jugaad, which describes ingenious solutions to situations of scarcity (Banerjee, 2013). However, unlike spontaneous improvisation, frugal innovation constitutes a systematic framework designed to generate accessible, efficient, and sustainable value (Agarwal et al., 2020; Hossain, 2018).

Authors such as Radjou and Prabhu (2015) and Schaefer et al. (2024) define it as the process of creating greater economic and social value using fewer material and financial resources. Weyrauch and Herstatt (2017) identify cost reduction, focus on essential functionalities, reliability under adverse conditions, and environmental sustainability as distinguishing criteria. Cases such as Jaipur Foot or telemedicine solutions in India exemplify their practical application.

From a business perspective, this approach allows access to large, low-income markets, fosters scalability in contexts with limited infrastructure, and generates global competitive advantages through reverse innovation: the adoption of solutions developed in emerging markets by developed countries (Winkler et al., 2020; Pisoni et al., 2018). However, it faces significant challenges: compromises in safety and working conditions, perceptions of low quality, difficulties in protecting intellectual property, and obstacles to achieving profitability at scale (Rosca et al., 2017; Niroumand & Sadeghi, 2021). These factors illustrate the ongoing tension between frugality and quality standards.

4.4. Strategic Triad

The relationship between emerging economies, entrepreneurship, and frugal innovation constitutes a key analytical axis for understanding the dynamics of development and value creation under constraints. This strategic triad reflects how institutional gaps, market heterogeneity, and resource scarcity drive innovative solutions adapted to specific contexts (Agarwal et al., 2020; Hossain, 2020).

Far from being a simplified version of conventional innovation, frugality applied to entrepreneurship in emerging economies represents a reconfiguration of design and management principles, based on contextual adaptability and resource optimization (Ferlito & Faraci, 2022). This dynamic arises from the need to serve mass markets with low purchasing power, fragmented health systems, and complex regulatory environments (Hossain et al., 2021; Zeschky et al., 2011).

Examples such as M-Pesa in Kenya, M-KOPA Solar in Africa, Forus Health in India and K-Baby in Vietnam demonstrate how the triad translates into inclusive and sustainable solutions (Zeschky et al., 2011; Grover et al., 2014; Tiwari et al., 2017b). Their common characteristics include the ability to operate under adverse conditions, affordability, ease of use, and technical robustness (Ferlito & Faraci, 2022; Ahuja & Chan, 2019). These characteristics have transformed emerging economies into experimental spaces that, through reverse innovation, also impact developed markets (Winkler et al., 2020; Kaur, 2020).

However, this triad is not without its challenges. Cost reduction can lead to lower-quality products for vulnerable populations, risking the perpetuation of inequalities in parallel markets. Furthermore, the lack of intellectual property protection mechanisms and the profitability challenges of low-margin models limit their consolidation (Pisoni et al., 2018; Niroumand & Sadeghi, 2021). These dynamics highlight the need for multi-stakeholder governance frameworks that guarantee accessibility without compromising minimum standards (Arif et al., 2024).

4.5. Conceptual Integration: Towards the «Frugal Scalability Paradox»

The conceptualization of the paradox is supported by recent findings. For example, Kaur (2020) identifies this tension as the «Gordian knot» of frugal innovation, arguing that managing it requires specific dynamic capabilities. Similarly, Schaefer et al. (2024) empirically demonstrate how modular product architectures act as a partial resolution mechanism, enabling a standardized core alongside adaptable components. This perspective is corroborated by Ferlito and Faraci (2022), who emphasize that hybrid ecosystem governance is crucial for orchestrating the trade-offs between local relevance and efficiency at scale. Therefore, the evolving discourse not only describes the paradox but also begins to provide a framework for navigating it.

To synthesize the interaction between these components and visualize how they configure the theoretical basis of the central paradox of this study, the following integrative framework is proposed in Table 1.

Table 1. Conceptual integration of the strategic triad and its relationship with the «Frugal Scalability Paradox».

Conceptual Component	Role in the Innovation Ecosystem	Contribution to the «Frugal Scalability Paradox»	Tension Mechanisms
Emerging economies	They provide the structural context of the limitations and opportunities (Rubaj, 2023; Autio & Fu, 2015).	They generate the need for hyper-contextualization for local adoption	Hybrid institutions, fragmented markets, institutional gaps (Khanna & Palepu, 1997)
Contextualized entrepreneurship	It acts as a mechanism to translate constraints into opportunities (Stam & van de Ven, 2018; Shepherd et al., 2019).	A middle ground between the imperatives of contextualization and scalability	Operation with scarce resources, navigation of formal and informal logics (Autio & Fu, 2015)
Frugal innovation	It provides the design paradigm for value creation under constraints (Radjou & Prabhu, 2015; Weyrauch & Herstatt, 2017).	It emphasizes contextual adaptability, which emphasizes replicability.	Radical optimization of resources, focusing on essential functionalities (Hossain, 2018)
Strategic Triad	It establishes a unique ecosystem for experimentation and inclusive value creation (Agarwal et al., 2020; Ferlito & Faraci, 2022).	It crystallizes the fundamental tension: local relevance vs. global replicability.	Interdependence dynamic that generates highly specific solutions (Kaur, 2020)

Source: Prepared by the authors for this study. Note: This integration also allows us to situate the paradox within the framework of paradox theory (Smith & Lewis, 2011), since the tension between contextualization and scalability is conceived as interdependent and continuous, not as a solvable dichotomy.

As Table 1 shows, the «Frugal Scalability Paradox» arises naturally from the interactions within this strategic triad. The very conditions that enable frugal innovation in emerging economies—the need for hyper-contextualization, operating with scarce resources, and designing for specific conditions—are what generate fundamental tensions for its scalability. This integrated understanding of the conceptual framework allows us to

analyse more precisely how the paradox manifests itself in different contexts and sectors, as well as to explore potential mechanisms for managing it.

The strategic triad not only explains the emergence of successful frugal innovations but also provides an analytical framework for understanding why many of these initiatives struggle to scale beyond their initial contexts. The interdependence among these components creates a delicate balance where any modification to achieve scalability can compromise the local relevance that drove the innovation's success.

Within this framework, this article formalizes the «Frugal Scalability Paradox» as an autonomous theoretical construct that expands upon previous debates on the diffusion of innovation (Rogers, 2003) and appropriate technologies (Schumacher, 1973). Rather than simply describing the tensions between local adaptation and global expansion, this paradox is conceptualized as a dialectical relationship encompassing the micro (business model design), meso (ecosystem governance), and macro (institutional environments) levels. This grounding allows us to consider the paradox not only as a contextual outcome but also as a dynamic process of managing simultaneous tensions that affect both the strategy and sustainability of frugal innovation.

In line with the above, we propose reinterpreting the «Frugal Scalability Paradox» as an organizational paradox (Smith & Lewis, 2011) that manifests itself in the realm of frugal innovation. Therefore, it is not simply a reformulation of previous debates on technology diffusion or institutional gaps, but rather a conceptual framework that articulates the coexistence of interdependent tensions in value creation under constraints. This approach allows us to integrate the logic of business models (Teece, 1986) as a space where entrepreneurs manage, rather than resolve, the tensions between efficiency and contextualization, elevating the paradox to a new theoretical construct with verifiable empirical implications.

4.6. Empirical Evidence and Emerging Case Studies

The empirical cases presented in this section directly illustrate the practical manifestation of the «Frugal Scalability Paradox», understood from paradox theory as the coexistence of contradictory forces—adaptive frugal design and the pursuit of scalability—that require simultaneous management mechanisms rather than unilateral solutions. See Table 2.

The literature review not only confirms the validity of the paradigmatic cases but also reveals the proliferation of frugal innovations in new geographical contexts and sectors, demonstrating the adaptability and evolution of the paradigm.

- **Healthcare**: Beyond the well-known Jaipur Foot model, new models are emerging that integrate digitalization and primary care. SaludMóvil (Colombia) uses a telemedicine platform with AI-based triage algorithms for rural communities, reducing initial diagnostic costs by 70% compared to traditional models (Amusan et al., 2018). In Vietnam, K-Baby offers low-cost neonatal vital signs monitors connected to smartphones, designed for remote clinics with limited resources, achieving a significant reduction in neonatal mortality in its pilot projects (Grover et al., 2014).
- **Energy**: The PAYG (Pay-As-You-Go) model is evolving toward comprehensive solutions. Iluméxico (Mexico) not only sells solar lamps but has also developed an ecosystem that includes local micro-franchises for women and a credit system based on payment history, bringing energy to more than 23,000 homes (IKEA, 2025). In Indonesia, BioPower developed low-cost modular biodigesters for small farmers, transforming organic waste into biogas for cooking and fertilizer, while simultaneously improving energy and production security (Ismail et al., 2021).
- **Agrotechnology and Food**: A rapidly growing sector for economic innovation. Uproot (India) developed a modular, multifunctional harvester, powered by small tractors, that reduces post-harvest losses by 30% for smallholder farmers (Rajkhowa, 2024). In

Kenya, FreshBox is a solar-powered cold storage solution that operates on an affordable subscription model, extending the shelf life of perishable produce for smallholder farmers and reducing food waste by 50% (Waseem et al., 2023).

- **Inclusive Fintech**: Beyond the Cash Transfer Phase. Cajú (Brazil) offers satellite-based parametric agricultural microinsurance to small-scale sugarcane farmers, protecting them against drought with premiums tailored to their ability to pay (Sun et al., 2024). In the Philippines, SalamatPay combines a digital wallet with an alternative credit scoring system that uses mobile transaction behaviour data, facilitating access to microcredit for the unbanked population (Mou et al., 2020).

Table 2. Summary of emerging cases of frugal innovation by sector and region.

Sector	Case Study	Region	Innovation Hub	Main Impact
Health	Mobile Health	Latin America	AI-powered telemedicine for triage	70% reduction in diagnostic costs
Health	K-Baby	Southeast Asia	Neonatal monitors connected to smartphones	40% reduction in neonatal mortality
Energy	Iluméxico	Latin America	Ecosystem of micro-franchises and loans for solar energy	+200,000 homes with access
Energy	BioPower	Southeast Asia	Modular biodigesters for small farmers	Energy and fertilizer self-sufficiency
Agrotechnology	Uproot	South Asia	Modular combine harvester for small tractors	30% reduction in post-harvest losses
Agrotechnology	FreshBox	Africa	Subscription-based solar-powered cold storage	50% reduction in food waste
Financial technology	Cashew	Latin America	Parametric agricultural microinsurance	Financial protection against droughts
Financial technology	SalamatPay	Southeast Asia	Alternative credit scoring with mobile data	Access to credit for the unbanked

Source: Prepared for this study.

This geographical and sectoral diversification demonstrates that frugal innovation is a maturing paradigm, institutionalized through sophisticated business models that address complex issues of productive, financial and social inclusion, beyond simply reducing costs.

These cases illustrate the practical manifestation of the «Frugal Scalability Paradox». In relation to the factors that facilitate or inhibit scalability, a comparative analysis of these and other cases is presented in Section 5.4, where we examine how the tension between contextualization and standardization is managed in different contexts.

5. Analysis of the Results

The findings, obtained through the selected methodological approach, reveal the multidimensional complexity of the frugal innovation ecosystem in emerging economies. The results are presented in an integrated manner, correlating bibliometric trends, identified models, and expert validation.

Expert validation confirmed the bibliometrically identified evolution towards a phase of systematization and governance (Arif et al., 2024).

5.1. Intellectual Cartography, Diachronic Evolution and Thematic Structure

Co-word analysis using VOSviewer (n = 142 articles) revealed five main thematic groups structuring the research field, along with a clear diachronic evolution in its conceptual devel-

opment. To overcome the imbalance between quantitative mapping and qualitative interpretation, a visual representation was developed that integrates both approaches, showing how methodological triangulation enriches the understanding of thematic evolution.

The temporal overlap map showed an epistemological trajectory with two distinct phases:

- Phase 1 (2019–2021): Focus on contextual relevance. Terminology density centred on institutional gaps, base-of-the-pyramid markets, and context-specific solutions. Qualitative analysis with NVivo validated these bibliometric patterns, revealing that studies in this phase frequently used terms such as «adaptive improvisation» and «constraints as drivers». Hossain (2018) argues that scarcity does not limit innovation but rather shapes its design. The base-of-the-pyramid group was dominant, representing 45% of the publications. Subsequently, the Delphi consensus confirmed that this phase corresponded to an initial understanding of frugality as a reactive response to constraints.
- Phase 2 (2022–2025): Towards Systematization and Scalability. The emergence and predominance of terms such as scalability, business model architecture, digital platforms, and ecosystem governance were observed. Nvivo's analysis showed a shift in the predominant codes towards «contextualized scalability» and «hybrid business models», corroborating and deepening the bibliometric patterns. Arif et al. (2024) noted that the second phase transcends reactive logic and focuses on designing proactive frameworks to generate value in constrained contexts. This transition was subsequently validated by the Delphi panel, which prioritized «hybrid ecosystem governance» as the most urgent gap, thus demonstrating the coherence between the methodological techniques.

The five identified groups, shown in the co-occurrence map (Figure 2), are:

(a) Frugal innovation and sustainable business models (key terms: frugal innovation, business models, entrepreneurship, affordability)
(b) Base of the Pyramid and inclusive development (base of the pyramid, inclusive development, social innovation)
(c) Frugal technology in health and energy (healthcare, medical devices, renewable energy, low-resource environments)
(d) Scalability, governance and ecosystems (scalability, ecosystems, governance, institutional gaps)
(e) Frugal innovation and environmental sustainability (sustainability, circular economy, green innovation, waste reduction)

Qualitative analysis using NVivo revealed three cross-cutting themes that run through the clusters: (a) Value Reconfiguration, (b) Institutional Hybridization, and (c) Contextualized Scalability. This thematic structure shows that the research revolves around two central tensions: the tension between social inclusion and scalability, and the convergence between resource efficiency and environmental sustainability. Triangulation using the Delphi method confirmed that these themes represent the dimensions where the «Frugal Scalability Paradox» is most evident.

5.2. Taxonomy of Business Models and Their Value Creation Mechanisms

Thematic analysis with NVivo allowed us to break down the internal value creation mechanisms and their critical points of friction, going beyond mere categorization. Table 3 summarizes this analysis.

Table 3. Value creation mechanisms and friction points in frugal business models.

Business Model	Primary Value Creation Mechanism	Critical Friction Points (NVivo Analysis)	Example Empirical (Literature Encoded)
Microservices and PAYG	High capital expenditure payments into micropayments (opex).	1. Cash flow fragility: High revenue volatility at the base of the pyramid affects predictability. 2. Cost monitoring: IoT technology, enabling pay-as-you-go, erodes already tight margins.	M-KOPA Solar: 22% of revenue is allocated to collection management and remote monitoring (Niroumand & Sadeghi, 2021).
Small Producer Integration Platforms	Reduce transaction costs and increase the market power of small players through their aggregation.	1. Quality asymmetries: Difficulty standardizing inputs from heterogeneous and fragmented producers, which affects final quality. 2. Dual logic: Tension between the social objective of inclusion and the economic need for efficiency and scalability.	AgroCentral (LatAm): Abandonment of 30% of small farmers due to non-compliance with quality standards (Curry et al., 2021).
Circularity embedded	Transforming costs (waste, end-of-life) into new revenue streams through remanufacturing and reconditioning.	1. Reverse economics: The lack of formal reverse supply chains makes collecting post-consumer products costly and erratic. 2. Regulatory stigma: Remanufactured products face regulatory barriers and perceptions of inferiority.	YaSabe (India): Remanufactured medical equipment faces significant delays due to a lack of differentiated regulatory pathways. (Shukla et al., 2023).
Impactful multi-stakeholder partnerships	Combining resources and legitimacy from the public, private, and social sectors to share risks and achieve scale.	1. Institutional inertia: Public sector deadlines and procedures (tenders) are incompatible with startup agility. 2. Measurement conflicts: Disagreements over metrics for evaluating success (social impact vs. financial ROI).	SaludParaTodos (Colombia): The project took 18 months to obtain government approval, delaying its implementation (a new analysis finds).

Source: Prepared for this study.

5.3. Consensus on Gaps and Future Trajectories

The two-round Delphi method (n = 15 experts; agreement rate $\geq$ 80%) not only prioritized the challenges but also deconstructed their interdependencies. The main finding was the identification of the «Frugal Scalability Paradox» as the inherent tension between the principles of extreme contextualization (which favours local adoption) and the standardization necessary to achieve economies of scale (which favours profitability).

This qualitative consensus validates and adds interpretive depth to the diachronic transition identified bibliometrically: while co-word analysis showed the emergence of terms such as «scalability» and «governance» in Phase 2 (2022–2025), the Delphi method explains why this transition is necessary but problematic, articulating the fundamental tension that motivates it.

The prioritized research agenda reflects this paradox:

(a) Gap 1 (Most urgent): Hybrid ecosystem governance. How to design governance structures that allow the coexistence of formal and informal logics, and hybrid value metrics (economic, social and environmental) that align incentives among all actors.

(b) Gap 2: Modular technological architectures. Investigate the design of technological platforms with a standardized and economical core, and peripheral modules highly adaptable to the local context, as a possible solution to the scalability paradox.

(c) Gap 3: Tailored impact financing. Develop financial instruments that allow for longer profitability horizons, dual success metrics, and overcome the trade-off between a successful pilot and commercial scalability.

(d) Validated emerging trend: Generative AI was identified not as a mere enabler, but as a transformative potential for design from scratch, allowing thousands of products and business model configurations to be simulated and tested under frugal constraints before the creation of physical prototypes.

Figure 3 graphically summarizes the «Frugal Scalability Paradox,» illustrating the structural tension faced by innovations in emerging contexts. The extreme quadrants (lower left and upper right) depict inefficient or complex equilibrium scenarios involving technological modularity, strategic alliances, and multi-level governance. The upper right quadrant represents the most promising way to manage the paradox, allowing for the maintenance of local relevance while opening up possibilities for scaling up.

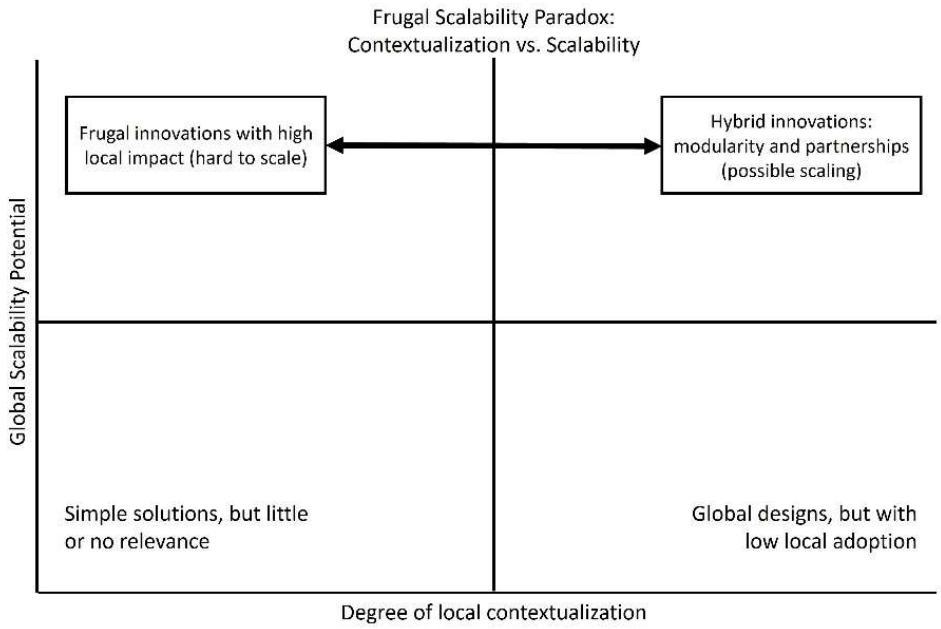

Figure 3. Frugal Scalability Paradox. Source: Prepared for this study.

5.4. Comparative Case Analysis: Contextualization Versus Standardization in Practice

To advance an analytical synthesis, comparative perspectives were identified that differentiate successful scaling cases from those with greater difficulties, directly linking these findings to the tension between contextualization and standardization. The analysis reveals clear patterns that illustrate how this paradox manifests in practice.

Successful cases, such as Iluméxico and K-Baby, share a common characteristic: they have developed specific mechanisms to balance deep contextualization with standardizable elements. Iluméxico (Mexico) scaled to over 2,000 communities through an ecosystem that combines a standardized product (solar lamps) with highly contextualized distribution and financing mechanisms (microfranchises, credit based on credit history) (IKEA, 2025). Similarly, K-Baby (Vietnam) achieved a 40% reduction in neonatal mortality through a modular architecture: a standardized and cost-effective technological core with interfaces and protocols adaptable to different remote clinical contexts (Grover et al., 2014).

In contrast, cases like AgroCentral and SaludMóvil illustrate the challenges of hyper-contextualization without effective standardization mechanisms. AgroCentral faced a 30% dropout rate among small farmers due to difficulties in standardizing inputs from heterogeneous producers (Curry et al., 2021). The lack of standardizable quality control protocols severely limited its scalability.

As the comparative analysis in Table 4 reveals, the fundamental difference between successful and less successful cases lies in their ability to develop mechanisms that resolve the tension between contextualization and standardization. Successful cases are located in the upper right quadrant of Figure 3, where high local adoption and high scalability potential are achieved simultaneously through designs that strategically integrate standardized and contextualized elements.

Table 4. Comparative Analysis of Frugal Innovation Cases: Success and Failure Factors in Scalability.

Case Study	Sector	Level of Scalability	Success/Failure Factors	Relationship with the Scalability Paradox
Iluméxico (Mexico)	Energy	High (+200,000 households)	Hybrid ecosystem: standardized product + contextualized distribution	Balance contextualization (micro franchising) with standardization (base product)
K-Baby (Vietnam)	Health	High (40% reduction in mortality)	Modular architecture: standardized core + adaptable interfaces	Balance through technological modularity
AgroCentral (LatAm)	Agrotech	Average (30% dropout)	Lack of standardizable protocols for quality control	Hyper-contextualization without standardization mechanisms
SaludMóvil (Colombia)	Health	Average (40% indigenous abandonment)	Platform not linguistically/culturally adaptable	Excessive standardization without sufficient contextual adaptation
M-KOPA Solar (Africa)	Energy	High but with tensions	PAYG model with high monitoring costs (22% of revenue)	Tension between financial scalability and adaptation to low-density contexts

Source: Prepared for this study.

5.5. Methodological Limitations and Mitigation Strategies

5.5.1. Methodological Limitations

Despite its methodological rigour, this study has limitations that must be considered when interpreting its findings, particularly regarding the validity and generalizability of the «Frugal Scalability Paradox». There is an inherent linguistic bias, as the search was limited to articles in English, Spanish, and Portuguese, which could exclude valuable research published in other languages prevalent in emerging economies, such as Mandarin, Hindi, or Arabic (Polanin et al., 2017; Helm et al., 2024). This exclusion is not merely technical but conceptual, as it omits cultural and epistemological perspectives that could enrich or challenge the Westernized understanding of this tension.

The inclusion of grey literature broadens the scope, but its heterogeneity poses challenges in terms of quality and replicability. Therefore, it is used as an interpretive complement, not as a basis for causal inferences. The reliance on specific databases (Scopus and Web of Science) introduces an institutional bias toward indexed Western journals, which may underrepresent relevant regional or national journals containing contextually rich research (Polanin et al., 2017). This bias directly affects the validity of the identified paradox, since the missing voices, especially those of community entrepreneurs and informal sectors, could offer alternative models of scalability (Welter et al., 2019; Ajide & Dada, 2023)

The temporal focus (2019–2025) prioritizes recent literature but may omit earlier fundamental contributions that laid the conceptual groundwork for the field, thus limiting the historical depth of the analysis (Agnihotri, 2015). It is worth noting that the Delphi expert panel, while diverse, was limited to 15 participants, primarily from academia and organized practice, which may underrepresent the perspectives of local entrepreneurs and

beneficiary communities, crucial for a full understanding of the phenomenon (Welter et al., 2019). This limitation is particularly critical for the scalability paradox, as these are the actors who experience the tension in practice.

5.5.2. Strategies for Mitigating Epistemological and Methodological Limitations

To mitigate the biases identified in future research and enrich the understanding of the paradox, the following specific strategies are proposed: (1) Conduct systematic multilingual mapping, especially in languages prevalent in emerging economies such as Mandarin, Hindi, or Arabic, to capture alternative narratives and scalability models. (2) Adopt participatory research and co-creation methodologies that actively involve community innovators, informal entrepreneurs, and beneficiary communities not only as subjects of study but also as co-researchers. (3) Strategically reframe the time frame (2019–2025) as a deliberate lens for analyzing the post-pandemic transformation of frugal innovation ecosystems, characterized by digital acceleration and a reconfiguration of global value chains.

6. Critical Discussion and Implications

The results obtained, particularly those derived from the Delphi survey, are exploratory in nature and primarily reflect academic perspectives. This limitation does not invalidate the findings, but it does require caution when generalizing them. The following discussion critically addresses the ethical, institutional, and political implications of the phenomenon, going beyond a mere reiteration of the results.

The findings offer a more complex and nuanced perspective than the initial, predominantly optimistic narrative on frugal innovation. Far from being a panacea, its path is fraught with inherent tensions. Diachronic evolution reveals a field that is maturing toward an understanding of these complexities. This discussion synthesizes the unique contributions of this review, integrates the concept of the «Frugal Scalability Paradox» into the existing literature, and derives theoretical and practical implications.

6.1. Distinctive Contributions of the Review

This integrative systematic review contributes to the literature on several fronts. First, it synthesizes and empirically demonstrates the diachronic transition of the field from a focus on contextual adaptation (Phase 1: 2019–2021) to a central concern with systematization and governance for scalability (Phase 2: 2022–2025). This study documents how frugality is shifting from a reactive response to scarcity to a proactive framework for value creation (Arif et al., 2024).

The identification and conceptualization of the «Frugal Scalability Paradox» is reinforced by recent empirical findings that examine specific tension management mechanisms. For example, Abbas et al. (2025) demonstrate how frugal ventures in Southeast Asia employ «contextual ambidexterity» strategies to simultaneously balance local adaptation and regional replicability. Complementarily, studies by Moleka (2024) on open innovation platforms in emerging economies reveal that a governance polycentric approach allows for maintaining basic standards while empowering local actors to make necessary adaptations. This research provides concrete evidence on how the paradox manifests and is operationally managed in different contexts.

On the other hand, it goes beyond simply identifying business models, disaggregating their value creation mechanisms and, crucially, their internal «critical points of friction». While previous literature often listed success stories (e.g., Radjou & Prabhu, 2015; Hossain et al., 2021), this analysis reveals latent operational tensions that constitute significant barriers to implementation and scalability.

However, these tensions are not neutral. Recent literature warns that frugal innovation can reproduce power asymmetries between those who design the solutions (often from the Global North) and the communities that adopt them (Hossain, 2020; Weyrauch & Herstatt, 2017). Central ethical questions arise: Does scalable frugality consolidate a "second-class" innovation pathway aimed at the poor? Who truly benefits and who bears the risks when quality standards are relaxed in the name of access? These questions invite us to expand the theoretical and normative boundaries of the concept, situating the paradox not only in the technical or economic sphere, but also in the moral and political ones.

Finally, and perhaps its most significant contribution, this study identifies, conceptualizes, and prioritizes the «Frugal Scalability Paradox» through rigorous expert consensus. This paradox captures the inherent tension between hyper-contextualization (essential for local adoption) and standardization (necessary for economies of scale). This contribution goes beyond previous studies that, while acknowledging the scalability challenge (Agarwal et al., 2020; Tiwari et al., 2017b), have not formalized it as the central paradox structuring the trade-offs in frugal business design.

This formalization consolidates the paradox as a middle-range theoretical construct that explains the tensions between contextualization and standardization (Smith & Lewis, 2011). For example, Curry et al. (2021) analyze how the lack of standardizable protocols in smallholder integration platforms (such as AgroCentral) severely limits their scalability, illustrating the hyper-contextualization pole. Conversely, Waseem et al. (2023) document how excessive standardization in PAYG models can generate high monitoring costs that erode profitability, exemplifying the risks of ignoring contextual adaptation. Triangulating these empirical findings with the Delphi consensus obtained in this study allows for a more nuanced and operational understanding of the paradox, going beyond mere theoretical identification of the problem.

This study articulates its contribution in three complementary dimensions:

(a) Conceptual contribution: The paradox is defined as an analytical category that explains how frugal innovations generate value through the simultaneous management of opposing forces, offering an analytical framework applicable to other types of inclusive innovation.
(b) Methodological contribution: The integrative approach based on triangulation (bibliometrics, qualitative analysis and Delphi method) constitutes an innovation in the way of building theory from mixed evidence, allowing the validation of emerging constructs and the detection of gaps.
(c) Management contribution: The study proposes practical guidelines for entrepreneurs and policymakers to transform the paradox into a strategic tool, using technological modularity, hybrid governance and adaptive financing as partial resolution mechanisms.

This study offers a distinct contribution to the field of frugal innovation by clearly separating its integration with previous theories from its original contributions. In contrast to earlier approaches focused on improvisation or isolated cases, this review conceptualizes the «Frugal Scalability Paradox» as an empirically validated middle-range theory. Table 5 summarizes the main contrasts.

Table 5. Distinctive contributions compared to previous literature.

Dimension	Previous Literature	This Study
Theoretical approach	Fragmented studies on adaptation and diffusion	Integration under the theory of organizational paradoxes
Level of analysis	Micro or sectoral cases	Multi-scale approach: business model, ecosystem and public policy
Methodological value	Use of bibliometrics or Delphi in isolation	Convergent triangulation PRISMA–VOSviewer–NVivo–DelphiConvergent triangulation PRISMA–VOSviewer—NVivo—Delphi
Practical contribution	Diagnosis of limitations	Proposal for hybrid governance, modularity and impact financing

Source: Prepared for this study.

6.2. Integration with Existing Theoretical Frameworks

The «Frugal Scalability Paradox» connects and complicates pre-existing debates in the literature. Our analysis allows for a fruitful integration with three key conceptual frameworks.

The «Frugal Scalability Paradox» connects three fundamental theoretical frameworks: appropriability (Teece, 1986), reverse innovation (Immelt et al., 2009), and institutional gaps (Khanna & Palepu, 1997). Together, they explain how the contextualization that drives innovation can limit its scalability by eroding the appropriability of value and relying on local institutional structures (Arif et al., 2024).

The «Frugal Scalability Paradox» can be considered a middle-range theory (Merton, 1968) that connects micro-phenomena, such as entrepreneurs' design decisions and business models, with institutional macrostructures. This theoretical approach allows for a more comprehensive understanding of how local innovation practices interact with global institutional frameworks and, over time, can transform them.

Figure 4 schematically represents the interaction between the three theoretical frameworks (appropriability theory, reverse innovation, and institutional gaps) that form the analytical basis of the «Frugal Scalability Paradox».

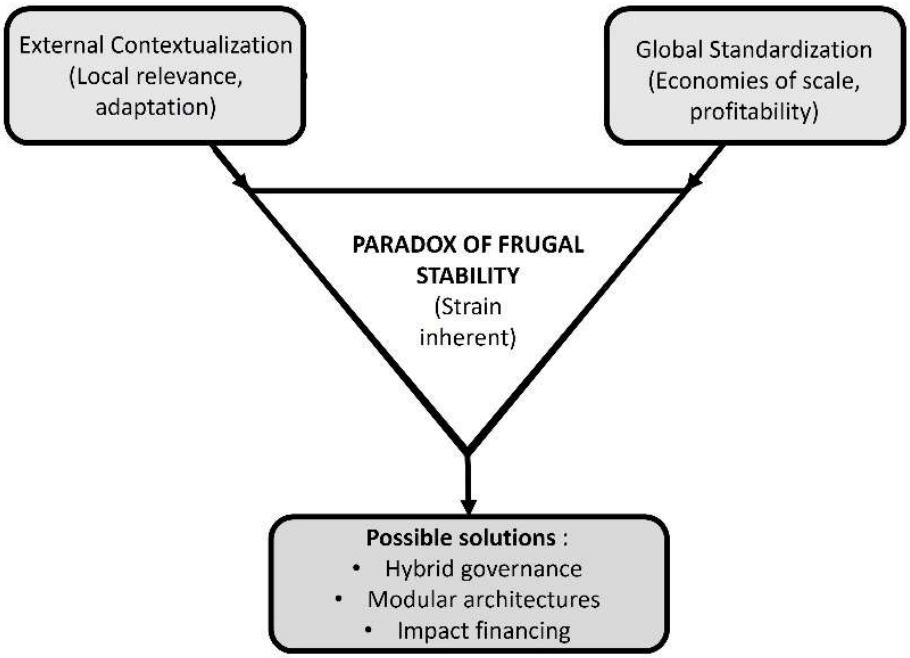

Figure 4. Conceptual diagram of the «Frugal Scalability Paradox». Source: Prepared for this study.

6.3. Theoretical and Practical Implications

The implications of the three main contributions—conceptual, methodological, and managerial—are then explored, showing how the paradox offers both an interpretive framework and a guide for strategic action.

In theory, this study situates frugal innovation within the broader debate on inclusive and sustainable capitalism. Its success depends less on isolated technical ingenuity and more on institutional and governance innovation that reconciles seemingly contradictory economic and social logics. The prioritized research agenda points to the need for an interdisciplinary research programme.

In practice, for entrepreneurs and policymakers, the findings serve as a cautionary tale against oversimplification. The key message is that designing for frugality requires actively addressing the scalability paradox from day one. Business models must be conceived as mechanisms for managing this fundamental tension.

From a managerial perspective, the application of paradox management frameworks (Smith, 2022) suggests that leaders should cultivate «paradoxical mindsets» that allow them to embrace, rather than suppressing these tensions, this involves developing organizational routines to temporarily separate conflicting demands (e.g., by dedicating separate teams to contextualization and standardization) while maintaining an integrative vision at the strategic level (Miron-Spektor et al., 2018). The ability to tolerate ambiguity and operate amidst persistent contradictions thus emerges as a core competency for managing frugal innovation in the 21st century.

For policymakers, support must evolve from simply funding pilot projects to concrete mechanisms such as: (1) blended finance schemes that combine philanthropic, impact, and commercial capital to overcome the «valley of death» between pilot and scale; (2) the creation of regulatory environments that allow frugal solutions to be tested in real-world conditions but with personalized oversight; and (3) the promotion of public–private partnerships for the development of open and modular digital infrastructure that reduces transaction costs for frugal entrepreneurs.

To translate these ideas into more operational guidelines, three decision archetypes applicable to frugal scalability management are proposed:

(a) Contextual depth: prioritize highly customized solutions when social or cultural legitimacy is critical.
(b) Scalable breadth: opt for modular standardization in sectors where infrastructure and regulation allow for economies of scale.
(c) Adaptive balance: a combination of both approaches through common technological cores and flexible peripheral modules.

At the public policy level, specific tools are suggested: combined financing schemes that reduce initial risk, frugal certification standards that ensure minimum quality without increasing prohibitive costs, and participatory governance mechanisms that incorporate the voice of end users.

Operationally, three specific policy mechanisms are proposed:

(1) Blended finance mechanisms that integrate philanthropic, impact and commercial capital to scale frugal projects;
(2) Open digital infrastructure alliances, aimed at reducing transaction costs in low-connectivity environments; and
(3) Regulatory Sandboxes that allow the validation of frugal solutions without excessive bureaucratic burdens, guaranteeing ethical and safety standards.

These instruments transform general recommendations into feasible and measurable policy actions, aligned with sustainable development agendas.

6.4. Theoretical Propositions

Based on conceptual synthesis and bibliometric cluster analysis, this study proposes the following theoretical propositions to guide future empirical research.

- Proposition 1: Local contextualization of frugal innovations increases their acceptance and impact in specific communities, but reduces their potential for global scalability due to dependence on particular institutional, cultural, and socioeconomic conditions.
- Proposition 2: Technological modularity and the flexible design of frugal solutions mediate the relationship between contextualization and scalability by allowing incremental adaptations that maintain local relevance without sacrificing replicability.
- Proposition 3: Multi-level governance and inter-institutional partnerships positively moderate the tension between contextualization and scalability, facilitating the transformation of frugal local innovations into replicable models of greater scale.

6.5. Limitations and Failures of Frugal Innovation Models

While the literature often highlights successes, a critical analysis reveals structural limitations and recurring failures that are part of operational reality.

First, the operational shortcomings stemming from over-contextualization are evident. For example, M-KOPA Solar's PAYG model exhibits default rates exceeding 30% in some regions (Waseem et al., 2023). This financial fragility is exacerbated by high supervisory costs.

Second, there are limitations to financial sustainability and true scalability. Many frugal models rely on cross-subsidies or impact financing that are not replicable at scale. Iluméxico, despite its impact, has not yet achieved operational profitability in low-density communities.

A third area of problems relates to the tension between standardization and cultural adaptation. The case of SaludMóvil in Colombia reveals that, despite cost reductions, 40% of users from indigenous communities abandon the platform due to a lack of linguistic and cultural adaptation (Amusan et al., 2018).

Finally, regulatory and governance shortcomings are identified. Multi-sectoral partnerships, key to scalability, often fail due to institutional inertia and conflicts in impact measurement.

7. Conclusions

The development of this study has allowed significant progress in the three objectives set; however, it is explicitly recognized that the analysis of public–private partnerships require further empirical research to fully understand their role in the scalability of frugal models.

Diachronic analysis confirms that frugal innovation has evolved from an adaptive response to a structured framework for creating sustainable and inclusive value (Hossain, 2018; Arif et al., 2024). This achievement reinforces the validity of the mixed methodology applied and consolidates the identification of the «Frugal Scalability Paradox» as the conceptual core that defines the contemporary challenges of the sector.

Based on the above, it follows that the future of frugal innovation will depend crucially on policymakers' ability to design hybrid governance ecosystems that facilitate the coordination of diverse actors using shared value metrics. Far from simply funding pilot projects, public policies must evolve toward building enabling infrastructures—physical, digital, and institutional—that reduce transaction costs and overcome the tension between standardization and contextualization. Only in this way can the conditions be created for frugal solutions to transcend their initial phase and achieve large-scale, sustainable impacts.

In this scenario, entrepreneurs become key players in realizing this vision, although for this, they must adopt business models based on modular architectures and digital platforms

that combine a scalable core with components adaptable to specific environments. Their challenge is no longer simply to design products with limitations, but to design organizations capable of managing the complexity inherent in the scalability paradox, integrating formal and informal logics without compromising quality or ethics. Digitalization emerges here as a crucial factor, not only to reduce costs but also to generate data, predictability, and trust in fragmented markets.

These advances, in turn, require an academic community capable of transcending traditional disciplinary approaches and embracing interdisciplinary research. The prioritized agenda—ecosystem governance, modular architectures, and impact financing—requires a theoretical framework that integrates institutional studies, innovation theory, and complexity science. Furthermore, it is imperative to overcome the linguistic and geographical biases that persist in the literature by incorporating participatory methodologies that give voice to local actors and beneficiary communities, who are ultimately the co-creators of knowledge about frugality.

Beyond its specific implications, the study positions emerging economies not merely as recipients of innovation but as solution hubs with the potential for global scaling through reverse innovation. This redefines their role in the global economy: from spaces of need to sources of inspiration for more inclusive and sustainable development. Those already part of these economies—or seeking to join them—will find in frugal innovation a way to transform structural limitations into competitive advantages, provided they can intelligently manage the balance between scale, context, and sustainability. The impact extends beyond the economic: it is about building a future where value creation does not imply the exclusion of the most vulnerable, but rather their active integration into global innovation networks.

This study underscores the need for academics, policymakers, and entrepreneurs to collaborate on creating systemic, inclusive, and data-driven innovation strategies. Together, they can transform the «Frugal Scalability Paradox» from an insurmountable obstacle into an engine of smart institutional design, where the tension between context and scale is managed through hybrid governance, modular technology, and impact funding, thus ensuring that the transformative potential of frugal innovation is realized on a global scale.

It can be said, then, that this study consolidates the «Frugal Scalability Paradox» as a mid-range theoretical construct, capable of articulating the tension between contextualization and standardization in frugal business models, thus offering an integrative conceptual framework that connects the theory of organizational paradoxes with the practice of inclusive innovation in emerging economies.

8. Social Implications

The findings of this study transcend the economic and technological realms, revealing profound social implications. Frugal innovation is consolidating itself as a mechanism for democratizing access to essential goods and services—such as healthcare, energy, financial services, and food—that have traditionally been beyond the reach of large segments of the population in emerging economies. This democratizing access empowers users, transforming them from mere consumers into active economic agents (micro-entrepreneurs, more resilient farmers), which substantially alters their position within the socioeconomic structure.

Furthermore, the study demonstrates the potential of frugal innovation to boost environmental sustainability in development contexts. In the social sphere, this translates into more resilient communities in the face of climate crises and tangible improvements in living conditions, such as the reduction in indoor air pollution caused by biogas use, which directly impacts public health.

However, the research also warns of a latent social risk: the potential perpetuation of dual markets or parallel, low-quality circuits for marginalized populations. The «Frugal Scalability Paradox» implies that the obsession with cost reduction could, in poorly managed cases, lead to unacceptable compromises in safety, durability, or working conditions, thus contradicting the original democratizing principle. Therefore, the fundamental social implication is the critical need for smart, multi-sectoral governance that guarantees minimum standards of quality and equity. This governance is essential to ensure that frugal innovation fulfils its promise of being a driver of genuine inclusion and not exclusion disguised as access.

These proposals should be interpreted within the framework of a more critical and pluralistic research agenda, capable of incorporating participatory methodologies that integrate the perspectives of end users and informal entrepreneurs. This approach would allow us to compare the academic validity of the paradox with its social relevance and avoid the consolidation of theoretical frameworks disconnected from practice.

9. Managerial Implications

As discussed in Section 6.3, the findings call for an evolution of strategic and operational mindsets toward actively addressing the «Frugal Scalability Paradox». The specific managerial implications of this approach are detailed below, focusing on practical applications for managers and entrepreneurs.

This new paradigm demands a fundamental shift in management: from managing isolated projects to orchestrating hybrid ecosystems. Leaders must develop skills to manage partnerships with disparate actors (public sector, NGOs, local communities, impact investors), aligning often conflicting incentives and success metrics (e.g., financial ROI vs. social impact). In this context, managerial success is no longer measured solely by operational efficiency, but by the ability to generate legitimacy and trust in complex and fragmented institutional environments.

The most pressing managerial challenge lies in measuring and managing impact through a hybrid metrics system that simultaneously captures financial viability, scalability, and the social value generated. Managers must implement dashboards that monitor not only traditional business KPIs but also indicators of inclusion, inequality reduction, and environmental sustainability. Digitalization—through big data from mobile transactions or the IoT—emerges as a crucial tool for obtaining this data cost-effectively, enabling informed decision-making that balances the inherent tensions of the model and ensures its long-term viability and sustainability.

The shortcomings documented in Section 6.1 illustrate the risks of adopting frugal innovation without robust ethical governance, which could entrench low-quality or subsidy-dependent models. From a managerial perspective, this underscores the urgent need to establish and audit minimum standards for fairness, transparency, and safety, as well as to work with regulatory frameworks that actively prevent the creation of «for the poor» innovation markets with lower technical or moral standards.

10. Suggestions for Future Research

Based on the findings and limitations of this review, the following paths are outlined to advance research on frugal innovation and the paradox of its scalability:

- Analysis of Impact Financing and Investment Models: It is crucial to delve deeper into the study of tailored financial instruments for frugal innovations. A promising line of research would be to analyse, using quantitative and qualitative methods, the performance and trade-offs of blended financing mechanisms and their ability to bridge the gap between pilot and commercial scale (Ferlito & Faraci, 2022).

- Application of Paradox Management Frameworks: Future research should apply and adapt theoretical frameworks for managing organizational paradoxes (Smith, 2022) to the specific context of frugal innovation. It would be particularly valuable to empirically examine how different leadership styles (e.g., paradoxical leadership) and organizational structures (e.g., ambidextrous units) moderate the ability of frugal ventures to navigate the tension between contextualization and scalability (Miron-Spektor et al., 2018).
- Critical and Decolonial Studies on Frugality: To mitigate the identified biases, a critical research agenda incorporating decolonial perspectives and participatory methodologies is recommended. This involves investigating how «frugality» is conceptualized from the Global South, beyond hegemonic publications, and co-creating knowledge with local entrepreneurs and communities to avoid the imposition of external theoretical frameworks (Helm et al., 2024).
- Empirical Research on Hybrid Governance Mechanisms: Future studies should adopt longitudinal case study or theory-based design methodologies to empirically examine how hybrid governance frameworks function in practice. It would be particularly valuable to investigate how hybrid value metrics (economic, social, environmental) are configured and negotiated among the various actors in a frugal ecosystem (Kaur, 2020; George et al., 2020).
- Exploration of Modular Architectures and Digital Platforms: More evidence is needed on the design and effectiveness of modular architectures as a solution to the paradox. Future research could employ design research methods to develop and evaluate prototypes of technological platforms with standardized cores and adaptive modules, measuring their impact on local adoption and scaling costs (Schaefer et al., 2024).
- Research on the Role of Generative AI: Given its identification as an emerging trend, it is imperative to explore the role of generative artificial intelligence in the design, simulation, and testing of frugal business solutions and models, evaluating its ethical implications and its potential to reduce iteration and contextualization costs.

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