

Navigating Constraints: The Role of Creative Problem-Solving in Fostering Frugal Innovation Among Cape Town's SMEs

Thabo Mokoena

Independent Researcher / SME Innovation Strategist

Abstract

Resource scarcity is traditionally viewed as a significant barrier to firm performance and growth. However, in the context of emerging markets, severe resource constraints frequently act as a catalyst for entrepreneurial ingenuity. This study examines the intricate relationship between resource scarcity, creative problem-solving, and the development of frugal innovation within Small and Medium Enterprises (SMEs) in Cape Town, South Africa. Grounded in the theory of entrepreneurial bricolage and the Resource-Based View (RBV), this research employs a sequential explanatory mixed-methods design. Quantitative data was collected via a survey of 152 SME owners and managers across the manufacturing, technology, and service sectors, followed by qualitative insights gathered through 15 in-depth, semi-structured interviews. The quantitative analysis reveals a statistically significant positive relationship between perceived resource scarcity and the output of frugal innovations, a relationship that is fully mediated by the organization's creative problem-solving capacity. Furthermore, thematic analysis of the qualitative data identifies three primary mechanisms through which Cape Town SMEs achieve frugal innovation: agile material substitution, operational process simplification, and the establishment of localized resource-sharing networks. This paper contributes to the broader literature on innovation management by providing robust empirical evidence from a Sub-Saharan African economic hub, demonstrating that systemic constraints can foster sustainable, highly efficient solutions. The findings offer actionable implications for SME leaders, investors, and policymakers striving to cultivate economic resilience and innovation in resource-scarce environments.

Keywords: Frugal Innovation, Resource Scarcity, Creative Problem-Solving, SMEs, Entrepreneurial Bricolage, Cape Town, Emerging Markets.

1. Introduction

Small and Medium Enterprises (SMEs) constitute the backbone of the South African economy, contributing significantly to gross domestic product (GDP) and serving as the primary engine for job creation (Booyens, 2011). In Cape Town, a leading economic and technological hub in Sub-Saharan Africa, SMEs operate in a highly dynamic yet paradoxically constrained environment. These enterprises frequently grapple with systemic challenges, including limited access to financial capital, infrastructural deficits (such as localized power outages or "load shedding"), and a shortage of highly specialized technical skills. Traditional innovation paradigms, which often rely on substantial Research and Development (R&D) budgets and abundant resources, fall short in explaining how these firms not only survive but often thrive and innovate.

The concept of *frugal innovation*—the process of reducing the complexity and cost of a good and its production while maximizing value—has emerged as a critical framework for understanding innovation in emerging markets (Zeschky, Widenmayer, & Gassmann, 2011).

Unlike cost-cutting, frugal innovation involves a fundamental redesign of products, services, or processes to address the specific needs of low-income or resource-constrained consumers without sacrificing core functionality (Radjou, Prabhu, & Ahuja, 2012). While the phenomenon of frugal innovation has been extensively documented in large multinational corporations operating in India and China, empirical studies focusing on the micro-level dynamics of SMEs in African urban centers remain comparatively sparse.

This paper addresses this gap by investigating how resource scarcity drives creative problem-solving, which in turn leads to frugal innovation within Cape Town's SME sector. By shifting the perspective of resource scarcity from a structural liability to an innovation catalyst, this study seeks to answer the following research questions:

1. What is the impact of financial and material resource scarcity on the generation of frugal innovations in Cape Town SMEs?
2. How does creative problem-solving mediate the relationship between resource constraints and frugal innovation?
3. What specific operational strategies do these SMEs employ to manifest frugal innovations?

By answering these questions, the study aims to enrich the theoretical discourse surrounding entrepreneurial bricolage and provide practical frameworks for SME managers aiming to leverage constraints as a competitive advantage.

2. Literature Review

2.1 The Paradigm of Frugal Innovation

Frugal innovation fundamentally challenges the dominant logic of resource-intensive, "more-for-more" innovation models typical of advanced economies. Hossain (2018) defines frugal innovation as a design philosophy that strips away non-essential features to offer core functionalities at a fraction of the traditional cost, targeting underserved or marginalized markets. In the context of emerging economies, frugal innovation is not merely an alternative strategy but a survival imperative (George, McGahan, & Prabhu, 2012). It encompasses three core dimensions: substantial cost reduction, concentration on core functionalities, and optimized performance level. For SMEs, frugal innovation allows for the circumvention of established R&D barriers, enabling the rapid deployment of functional, localized solutions (Pansera & Sarkar, 2016).

2.2 Resource Scarcity: Barrier or Catalyst?

The Resource-Based View (RBV) traditionally posits that a firm's sustained competitive advantage is derived from resources that are valuable, rare, inimitable, and non-substitutable. Consequently, a lack of resources should theoretically impede a firm's ability to innovate and compete. However, contemporary literature on entrepreneurship suggests a paradoxical relationship where scarcity triggers ingenuity. When resources are abundant, firms often engage in linear, predictable problem-solving. Conversely, severe constraints force cognitive reframing, compelling individuals to view everyday objects and existing processes through a lens of multidimensional utility.

2.3 Creative Problem-Solving and Entrepreneurial Bricolage

The mechanism bridging resource scarcity and frugal innovation is creative problem-solving, theoretically anchored in the concept of *entrepreneurial bricolage*. Baker and Nelson (2005)

conceptualize bricolage as "making do by applying combinations of the resources at hand to new problems and opportunities." In resource-constrained environments, SMEs cannot afford to acquire new, purpose-built resources. Instead, they must creatively recombine what is already available—be it discarded materials, overlooked human capital, or informal institutional networks.

Creative problem-solving in this context requires high cognitive flexibility and a tolerance for ambiguity. It involves redefining the boundaries of an asset's utility. For SMEs in Cape Town, where external shocks such as infrastructural instability demand constant adaptation, creative problem-solving becomes an institutionalized routine rather than isolated flashes of inspiration. Therefore, we hypothesize that while resource scarcity initiates the pressure to adapt, it is the internal capability for creative problem-solving that directly translates this pressure into tangible frugal innovations.

Hypothesis 1 (H1): Perceived resource scarcity is positively related to the generation of frugal innovation in SMEs. **Hypothesis 2 (H2):** Creative problem-solving capacity mediates the relationship between resource scarcity and frugal innovation.

3. Methodology

3.1 Research Design

To provide a comprehensive understanding of the phenomenon, this study utilized a sequential explanatory mixed-methods design. The initial quantitative phase aimed to establish the statistical relationships between resource scarcity, creative problem-solving, and frugal innovation. The subsequent qualitative phase was designed to explore the specific mechanisms and lived experiences of SME owners in Cape Town, adding depth and context to the quantitative findings.

3.2 Sampling and Data Collection

The target population consisted of registered SMEs operating within the greater Cape Town metropolitan area, specifically focusing on the manufacturing, technology, and specialized service sectors.

Phase 1: Quantitative Survey A stratified random sampling technique was used to distribute an online survey to 300 SME managers and founders. A total of 152 valid responses were retained for analysis (a 50.6% response rate). The sample criteria required that the business had been operational for at least three years and employed between 5 and 200 people.

Phase 2: Qualitative Interviews Following the survey analysis, 15 participants who indicated high levels of both resource constraints and innovative output were purposefully selected for in-depth, semi-structured interviews. Interviews lasted approximately 45 to 60 minutes and were transcribed verbatim for thematic analysis.

3.3 Measurement Instruments

Variables for the quantitative survey were measured using adapted scales from existing literature, rated on a 7-point Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree).

- **Resource Scarcity (RS):** Adapted from Baker and Nelson (2005), measuring perceived constraints in financial capital, physical assets, and skilled labor (5 items, Cronbach's $\alpha = .84$).

- **Creative Problem-Solving (CPS):** Adapted to measure the frequency and capacity of teams to reframe challenges and utilize unconventional methods (4 items, Cronbach's $\alpha = .88$).
- **Frugal Innovation (FI):** Adapted from Zeschky et al. (2011), assessing the firm's success in developing low-cost, high-value products or operational processes (6 items, Cronbach's $\alpha = .91$).

3.4 Data Analysis

Quantitative data was analyzed using SPSS Version 28. Descriptive statistics and Pearson correlation coefficients were generated. The mediation effect (Hypothesis 2) was tested using the PROCESS macro (Model 4) with 5,000 bootstrap samples. Qualitative data from the interviews underwent reflexive thematic analysis to identify recurring patterns regarding the implementation of frugal practices.

4. Results

4.1 Quantitative Findings

Table 1 presents the demographic profile of the participating SMEs. The sample was diverse, with a notable concentration in the manufacturing and technology sectors, which are prominent in the Cape Town economic landscape.

Table 1: Demographic Profile of Participating SMEs (N = 152)

Characteristic	Category	Frequency	Percentage (%)
Firm Age	3 - 5 Years	48	31.6
	6 - 10 Years	65	42.8
	> 10 Years	39	25.6
Industry Sector	Manufacturing / Hardware	62	40.8
	Information Technology	51	33.5
	Specialized Services	39	25.7
Number of Employees	5 - 20 (Micro/Small)	88	57.9
	21 - 50 (Small)	42	27.6
	51 - 200 (Medium)	22	14.5

Descriptive Statistics and Correlations The mean score for Resource Scarcity was high ($M = 5.42$, $SD = 1.15$), indicating that the sampled SMEs operate under significant constraints. Resource Scarcity positively correlated with Creative Problem-Solving ($r = .46$, $p < .01$) and Frugal Innovation ($r = .38$, $p < .01$). Creative Problem-Solving exhibited a strong positive correlation with Frugal Innovation ($r = .65$, $p < .01$).

Hypothesis Testing and Mediation Analysis A regression analysis confirmed H1, showing that Resource Scarcity is a significant predictor of Frugal Innovation ($\beta = .38$, $t = 5.04$, $p < .001$). To test H2, a mediation analysis was conducted. When Creative Problem-Solving was introduced into the model, the direct effect of Resource Scarcity on Frugal Innovation was reduced but remained significant ($\beta = .14$, $t = 2.12$, $p < .05$), while Creative Problem-Solving strongly predicted Frugal Innovation ($\beta = .56$, $t = 8.15$, $p < .001$). The indirect effect was significant (Effect = .24, 95% CI [.15, .34]), indicating partial mediation. This suggests that while scarcity directly forces frugal outcomes, the primary mechanism is the firm's activation of creative problem-solving capacities. H2 is therefore supported.

4.2 Qualitative Findings

Thematic analysis of the 15 semi-structured interviews yielded three dominant themes explaining *how* Cape Town SMEs enact frugal innovation in response to constraints.

Theme 1: Agile Material Substitution A recurring theme was the deliberate substitution of expensive, imported materials with locally sourced, often unconventional alternatives. For example, a local hardware manufacturing SME detailed how the prohibitive cost of imported synthetic polymers led them to collaborate with local agricultural processors to utilize bio-waste as a composite material.

"When the exchange rate plummeted, buying standard materials meant we'd have to close shop. We looked at what was cheap and abundant in the Western Cape. We started using processed organic waste as a filler for our molds. It dropped costs by 40% and actually made the product lighter and stronger." (Participant 04, Manufacturing)

Theme 2: Operational Process Simplification Constraints, particularly related to energy infrastructure (load shedding), forced SMEs to strip their operational processes down to their absolute core. Firms reported redesigning their service delivery or production lines to minimize reliance on continuous electrical power, resulting in leaner, more efficient operations.

"Load shedding forced our hand. We couldn't afford a massive industrial generator. So, we completely mapped our software development and deployment cycle. We decoupled the processes so developers could work offline asynchronously, and we built a localized intranet server that runs on a basic solar setup. We actually deploy faster now than we did with perfect grid power." (Participant 11, Tech)

Theme 3: Localized Resource-Sharing Networks Resource scarcity drove SMEs out of operational silos and into collaborative networks. Bricolage was observed not just at the firm level, but at the community level. SMEs located in shared industrial parks in Cape Town frequently bartered skills, shared machinery downtime, and engaged in joint procurement to achieve economies of scale.

"I have a CNC machine that I only need for three hours a day. The guy next door has a specialized 3D printer. Neither of us has the cash to buy what the other has. So, we trade time. It's informal, but it's the only way we both fulfill our client orders without going into debt." (Participant 08, Manufacturing)

5. Discussion

5.1 Theoretical Implications

The findings of this study offer several critical contributions to the literature on innovation management and entrepreneurship. Firstly, it empirically validates the tenets of entrepreneurial bricolage (Baker & Nelson, 2005) in a modern African urban context, proving that resource scarcity is not merely a boundary condition but a generative force for innovation. The partial mediation model demonstrates that scarcity alone is insufficient; it is the cognitive shift toward creative problem-solving that transforms a constraint into a frugal innovation.

Secondly, this study expands the understanding of frugal innovation. Much of the existing literature frames frugal innovation as an intentional corporate strategy deployed by large multinationals (e.g., GE's MAC 400 ECG machine) (Radjou et al., 2012). This research highlights that for Cape Town SMEs, frugal innovation is an emergent, bottom-up phenomenon born out of necessity. The identification of localized resource-sharing as a mechanism of frugal

innovation suggests that bricolage can extend beyond the boundaries of a single firm, operating as a networked, communal response to systemic scarcity.

5.2 Practical Implications

For SME owners and managers, the findings suggest that cultivating an organizational culture that tolerates ambiguity and rewards creative problem-solving is just as critical as seeking external funding. Managers should actively train their teams in constraint-based thinking—encouraging them to view limitations as design parameters rather than insurmountable roadblocks.

For policymakers and local government entities in Cape Town, the results indicate that providing massive capital injections is not the only way to spur innovation. Policies that facilitate resource-sharing networks, such as establishing localized innovation hubs, shared manufacturing spaces, and platforms for SME skill-bartering, can significantly enhance the frugal innovation output of the region. Furthermore, infrastructural challenges, while detrimental, are inadvertently breeding a highly resilient class of entrepreneurs whose solutions are inherently sustainable and cost-effective.

6. Conclusion

6.1 Summary of Findings

This paper investigated the relationship between resource scarcity and frugal innovation among SMEs in Cape Town, positioning creative problem-solving as the crucial bridging mechanism. The mixed-methods approach provided a robust confirmation that resource constraints drive the development of low-cost, high-value solutions. Quantitatively, creative problem-solving was shown to mediate this relationship. Qualitatively, the study uncovered that Cape Town SMEs achieve this through agile material substitution, operational process simplification, and the formation of localized resource-sharing networks. Ultimately, this research underscores that in the face of severe constraints, human ingenuity remains the most valuable asset a firm possesses.

6.2 Limitations and Future Research

While this study provides valuable insights, it is subject to certain limitations. The sample was restricted to the Cape Town metropolitan area; thus, the findings may not be entirely generalizable to rural contexts or other emerging market cities with different institutional environments. Additionally, the cross-sectional nature of the quantitative data limits the ability to draw definitive causal inferences over time.

Future research should consider longitudinal studies to track how frugal innovations developed under constraints evolve as a firm gains access to more resources. Do firms maintain their frugal mindset, or do they revert to traditional, resource-intensive innovation models? Furthermore, comparative studies between SMEs in different African technological hubs (e.g., Nairobi, Lagos, and Cape Town) could elucidate how different localized constraints uniquely shape the nature of creative problem-solving and frugal innovation.

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