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Innovating under constraints: a bibliometric and systematic review of frugal and inclusive innovations in start-up ecosystems

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Abstract: Amid mounting global challenges, start-ups are increasingly adopting resource-constrained innovation models such as frugal, inclusive, reverse, and constraint-driven entrepreneurship. This study conducts a systematic literature review and bibliometric analysis to explore the evolution and convergence of these models within entrepreneurial ecosystems. Based on 347 peer-reviewed studies (2000–2025), the research reveals how scarcity fosters bricolage, resilience, and accessible innovation, particularly in emerging markets. It identifies key intellectual clusters and thematic patterns shaped by institutional voids, grassroots innovation, and social entrepreneurship. Keyword analysis indicates a shift from foundational frameworks to digital and impact-oriented innovation, underpinned by diverse epistemological paradigms. Using Bibliometrix and VOSviewer, the article maps the intellectual landscape, co-citation networks, and thematic clusters. The findings underscore the strategic role of constraints in driving innovation and advocate for interdisciplinary approaches. Moreover, it highlights the rising contribution of Global South institutions in shaping inclusive innovation discourse and calls for deeper empirical integration and theoretical synthesis.

Keywords: frugal innovation; inclusive innovation; entrepreneurship; start-up; sustainability; resource constraints.

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1 Introduction

The exploration of constrained innovation strategies within entrepreneurial ecosystems has garnered increasing academic attention over the past two decades. Amid mounting global challenges-ranging from financial crises and climate change to digital inequality and public health disruptions-new models of innovation that emphasise accessibility, affordability, and adaptability have emerged as key levers of transformative change (George and Wooden, 2023; Bhatti et al., 2024; Ledingham et al., 2024) Notably, approaches such as frugal innovation, inclusive innovation, reverse innovation, and entrepreneurship under resource constraints are increasingly seen as central to advancing equitable and sustainable economic growth, especially within start-up ecosystems (Díaz López et al., 2023; Le Bas, 2023; Natasha, 2025). The convergence of innovation paradigms such as frugal and sustainable innovation with entrepreneurship underscores the need for an integrated assessment of how start-ups transform scarcity into drivers of creativity, business model innovation, and socio-economic resilience. Frugal innovation enables cost-effective, inclusive, and sustainable solutions in resource-limited contexts (Santos et al., 2022; Lai et al., 2025). SMEs, in particular, harness it to build resilience during crises by leveraging leadership, knowledge diversity, and competitive intelligence.

Additionally, intellectual capital plays a vital role in fostering open frugal innovation and adaptive capabilities (Nguyen et al., 2025; Yang et al., 2025).

Frugal innovation-often dubbed as 'jugaad' in the Indian context-has emerged as a pioneering concept rooted in the ability to 'do more with less' (Tylżanowski, 2021). It emphasises the creation of significantly more value at a lower cost by using fewer resources, making it especially relevant for underserved and resource-constrained regions (Winkler et al., 2020; Bahl et al., 2021). Unlike traditional R&D-intensive innovation models prevalent in the West, frugal innovation thrives on simplicity, local adaptation, and customer-centric thinking (Winkler et al., 2020; Kumar et al., 2025a).

It is not merely a cost-cutting strategy but a philosophical and operational rethinking of how innovation is conceived and delivered (Tylżanowski, 2021). Closely aligned with frugal innovation is the concept of inclusive innovation, which emphasises the democratisation of innovation processes by actively engaging marginalised communities in co-creating solutions that address their specific needs (Onsongo and Knorringa, 2020). Inclusive innovation seeks to extend the benefits of innovation to marginalised communities, involving them not just as beneficiaries but as co-creators and stakeholders in the innovation lifecycle (Heeks et al., 2014; Hoffecker, 2021; Nguyen et al., 2025). This framework is particularly relevant to start-up enterprises operating in emerging economies where institutional voids persist, and market-based solutions are often inaccessible to the poorest segments (George et al., 2021). Inclusive innovation often overlaps with social innovation and impact entrepreneurship, as it targets not only economic outcomes but also aims to generate positive social and environmental externalities (Foster and Heeks, 2013; Foster, 2021). In entrepreneurial settings, inclusive innovation thus catalyses empowerment, fosters human capital development, and builds socio-technical systems that are aligned with localised needs and aspirations.

Traditionally, innovation has flowed from the Global North to the Global South, reinforcing hierarchical patterns of knowledge and technology transfer. A study conducted by Moleka (2024) and Park et al. (2025). Reverse innovation disrupts this order by positioning emerging markets as fertile grounds for inventive problem-solving and low-cost, high-impact solutions (Zeschky et al., 2014; Kumar et al., 2023, 2025a). This concept has found significant traction in healthcare, education, and ICT sectors, particularly within entrepreneurial contexts where lean start-up methodologies intersect with frugal and agile product development cycles (Iqbal et al., 2021). By reversing the innovation flow, reverse innovation challenges long-held assumptions about where knowledge is created, who owns it, and how it diffuses across geographies (Malodia et al., 2023; Zahoor et al., 2024).

Resource constraints, often viewed as a barrier to business success, have increasingly been reframed in academic literature as a catalyst for innovation (Zahoor et al., 2023). Resource-scarce environments require entrepreneurs to adopt bricolage – a process through which existing resources are recombined in novel ways to solve emerging problems (Yan et al., 2020). This concept is especially pertinent in start-up ecosystems where entrepreneurs, lacking access to formal capital markets or institutional support, must rely on improvisation, social capital, and creative adaptation to thrive (Ciambotti et al., 2021). Rather than stifling innovation, scarcity forces start-ups to innovate more efficiently and sustainably, leading to business models that are often more resilient, scalable, and contextually relevant (Rinthaisong and Duangtong, 2024). The intersection of these four constructs – frugal innovation, inclusive innovation, reverse innovation, and

entrepreneurship under resource constraints-creates a rich and multifaceted research domain (Pankaj et al., 2023; Pansera, 2023; Pedroso et al., 2023).

Despite the conceptual overlaps among them, academic inquiry into this nexus remains relatively fragmented. Several studies have explored each of these constructs individually, yet a comprehensive synthesis of how they intersect within entrepreneurial ecosystems is lacking (George et al., 2012; Weyrauch and Herstatt, 2017). The pandemic exposed vulnerabilities in traditional supply chains, healthcare systems, and educational infrastructures, prompting a wave of frugal and inclusive innovations by grassroots entrepreneurs (Chin et al., 2025). For example, 3D-printed ventilators, mobile telemedicine vans, and contactless delivery start-ups-often launched under severe resource constraints-emerged as life-saving solutions in many developing countries. These developments have reignited scholarly interest in the resilience, agility, and societal value of constraint-driven entrepreneurship (Scheidgen et al., 2025).

Given the increasing scholarly and practical relevance of this topic, this study aims to conduct a comprehensive systematic literature review (SLR) and bibliometric analysis to map the intellectual structure, identify key trends, and uncover future research avenues in this evolving domain. By integrating qualitative and quantitative methodologies, the present research offers a dual contribution: a rigorous synthesis of the literature and an empirical visualisation of its thematic and structural patterns using tools like Bibliometrix (RStudio) and VOSviewer.

The research is guided by the following questions:

RQ1 What are the prevailing publishing and citation trends concerning innovation under resource constraints in entrepreneurial ecosystems?

RQ2 Which authors, institutions, and countries are the most prolific and influential in this field?

RQ3 What are the most cited articles, and what intellectual structures do they form?

RQ4 Which thematic clusters and keyword trends dominate this area of research?

RQ5 How has research on frugal and inclusive evolved over time within the context of start-ups?

RQ6 What are the emerging research directions and underexplored domains for future inquiry?

This study analyses bibliometric data from Scopus and Web of Science to explore four interrelated innovation paradigms-frugal, inclusive, reverse, and constraint-driven innovation-within entrepreneurship. Peer-reviewed articles (2000–2025) will be selected using clear inclusion-exclusion criteria. Bibliometrix will be used to analyse metadata (titles, abstracts, keywords, citations), while VOSviewer will visualise co-citation networks, keyword patterns, and author collaborations.

Unlike previous fragmented studies, this research adopts a holistic approach to examine how entrepreneurs innovate in resource-constrained environments. It aims to consolidate theoretical frameworks, identify key themes, and offer practical insights for policymakers, investors, and ecosystem enablers. As constraints become a defining feature of the global landscape, innovation under limitation emerges as a strategic imperative.

2 Review of literature

The emergence of constraint-driven innovation-encompassing frugal innovation, inclusive innovation, reverse innovation, and entrepreneurial adaptation under resource constraints-has evolved into a rich and expanding academic domain (Wimschneider-Weikl and Agarwal, 2023). As global economies contend with mounting inequalities, technological gaps, and climate instability, scholars have begun exploring how start-ups and entrepreneurial actors navigate resource-scarce environments with creativity and resilience (George et al., 2012). The conceptualisation of frugal innovation dates back to emerging-market ingenuity practices, particularly in India and Africa, where grassroots innovators and entrepreneurs devised cost-effective, high-quality solutions for mass consumption. Özder (2023) define frugal innovation as the capacity to reduce complexity and cost while maximising value, particularly in underserved markets. This notion gained prominence with the success of products like the Tata Nano and low-cost water purifiers, which exemplified affordability and functionality tailored to low-income consumers (Winkler et al., 2020; Nguyen et al., 2025). Scholars such as (Tiwari and Herstatt, 2020) emphasised that frugal innovation is not a 'poor man's substitute', but a paradigm capable of reversing traditional R&D logic by simplifying solutions for broader accessibility.

Academic studies on frugal innovation have increasingly linked it to entrepreneurial ecosystems, especially in the Global South. Santos et al. (2020) argue that entrepreneurs in these regions often rely on informal mechanisms-such as local knowledge, community labour, and makeshift technologies-to prototype and scale innovations. These methods contrast starkly with the structured, capital-intensive innovation strategies of large firms in developed economies. The studies by Winkler et al. (2020) and Bhatti et al. (2021b) proposed multi-dimensional frameworks to assess frugal innovation through affordability, robustness, scalability, and user-centricity.

In parallel, inclusive innovation has emerged as a distinct yet overlapping paradigm that seeks to ensure the socially equitable distribution of innovation outcomes. Foster (2021) and Heeks et al. (2014) defined inclusive innovation as innovation that is not only accessible to marginalised groups but also actively involves them in the innovation process. Reverse innovation is particularly salient in entrepreneurial contexts where low-cost, high-efficiency business models emerge under institutional constraints (Corsini et al., 2021). It highlights a shift from the view of the Global South as passive technology recipients to active innovators capable of global diffusion.

Several scholars have attempted to map the institutional, organisational, and cultural factors enabling reverse innovation. A typology distinguishing between 'local innovation for local use' and 'local innovation for global diffusion' was developed, with the latter frequently driven by entrepreneurial ventures due to their agility and propensity for experimentation (Petraite et al., 2022). The synergy between frugal and reverse innovation has been emphasised, with the two proposed as interdependent rather than mutually exclusive (Bhatti et al., 2021a). The underlying theme binding these forms of innovation is resource constraint-a ubiquitous condition in entrepreneurial environments, particularly in the early stages of venture development. Entrepreneurship in resource-constrained settings often requires bricolage, where entrepreneurs creatively recombine available resources to develop improvised solutions (Iqbal et al., 2021). The importance of bricolage in social entrepreneurship has been highlighted as a significant factor contributing to innovative problem-solving and resource mobilisation (Desa et al.,

2023), while Constraint-driven entrepreneurs often outperform their resource-rich counterparts in terms of adaptability and risk mitigation, as has been proposed in prior research (van Mil et al., 2020). These perspectives view scarcity not as a barrier but as a condition that fosters experimentation, resilience, and local embeddedness.

Entrepreneurs often operate in 'institutional voids'-contexts characterised by limited access to formal infrastructure, regulation, or support systems (George et al., 2020). While the theoretical development of each innovation type has matured, bibliometric studies examining their convergence remain limited. Most existing literature reviews are narrative in nature, offering conceptual overviews without empirical validation of publication trends, thematic clusters, or citation networks. Although a review of 81 papers on frugal innovation identified five key research directions, it did not examine co-citation or author collaboration networks (Leliveld et al., 2023). Similarly, the politics of inclusive innovation have been examined with a particular emphasis on policy implications, rather than on patterns of scholarly output (Pansera et al., 2020). Frugal innovation in healthcare entrepreneurship has been explored through bibliometric mapping in recent research (Khan et al., 2023). However, their scope was confined to a single sector. Similarly, previous studies have offered case-based insights into reverse innovation; however, they lacked broader quantitative assessments (Corsini et al., 2021; Jang and von Zedtwitz, 2023). There is therefore a significant gap in bibliometric synthesis that integrates all four variables-frugal, inclusive, and reverse innovation, as well as resource constraints-in entrepreneurial contexts.

Frugal innovation literature is predominantly authored by scholars affiliated with Western institutions, a trend that may bias theoretical frameworks and contribute to the underrepresentation of indigenous innovation perspectives (Bhatti et al., 2021b). Studies such as 'thriving on constraints' (Rahman et al., 2025), 'frugal innovation in rural Indian entrepreneurship' (Zutshi et al., 2025) and 'ethical consumerism and frugal strategies' (Mishra and Jain, 2025) offer contextually grounded insights into how local entrepreneurs navigate scarcity while addressing social needs. Digital transformation also plays a growing role in mediating constrained innovation. A recent study by Kumar et al. (2025a, 2025b) and Rahmi et al. (2025) investigated how digital tools support frugal and inclusive entrepreneurship in higher education, emphasising experiential learning, local partnerships, and remote collaboration. Similarly, Dua et al. (2025) explored how start-ups use lean organisational structures to innovate under tight resource constraints. The role of artificial intelligence (AI) in augmenting human capital and decision-making in early-stage start-ups has also begun to attract attention (Kumar et al., 2023, 2025a; Nguyen et al., 2025).

Despite this growing body of work, several scholars have called for more systematic reviews to consolidate fragmented insights and map intellectual trends. According to Bhatti et al. (2021b), the field suffers from 'conceptual proliferation without integrative synthesis', making it difficult to assess cumulative knowledge or identify underexplored areas. Bibliometric methods-employing tools like VOSviewer and Bibliometrix-offer a powerful approach to address this gap by revealing author co-citation networks, thematic evolution, keyword trends, and collaboration patterns (Donthu et al., 2022; Kumar et al., 2023).

The literature on frugal, inclusive, and reverse entrepreneurship innovation is rich in conceptual propositions and contextual case studies. However, the absence of a comprehensive, data-driven synthesis constrains the field's maturity. This study aims to

address this gap through an integrated bibliometric and SLR that examines the intersection of constrained innovation and start-up entrepreneurship. By analysing data from leading academic databases over the past two decades, the study offers new insights into the intellectual structure, geographic distribution, and emerging themes in this rapidly evolving domain.

3 Methodology

This study adopts a hybrid bibliometric – systematic review methodology to elucidate the intellectual structure, research trajectories, and emergent thematic domains within the domain of frugal and inclusive innovation in start-up ecosystems. Anchored by six guiding research questions (RQ1–RQ6), the methodological framework integrates quantitative performance analyses-encompassing publication trends, citation patterns, and collaborative networks-with qualitative content analysis to ensure both breadth and depth of insight. The Scopus database was chosen as the primary source due to its extensive coverage of peer-reviewed literature in business, management, and innovation studies, thereby ensuring both comprehensiveness and quality control in data retrieval. A Boolean search string was employed ('frugal innovation' OR 'inclusive innovation' OR 'reverse innovation' OR 'resource constraints') AND ('start-up*' OR 'startup*' OR 'entrepreneur*'). This query was applied to publications indexed between 2000 and 2024, capturing the evolution of scholarly discourse over nearly a quarter of a century.

Table 1 represents the inclusion and exclusion criteria of the articles selected for the further analysis. Data were extracted in CSV and BibTeX formats for compatibility with both tools. The analysis was triangulated to ensure accuracy and eliminate duplication of metadata.

Table 1 Inclusion and exclusion criteria for article selection

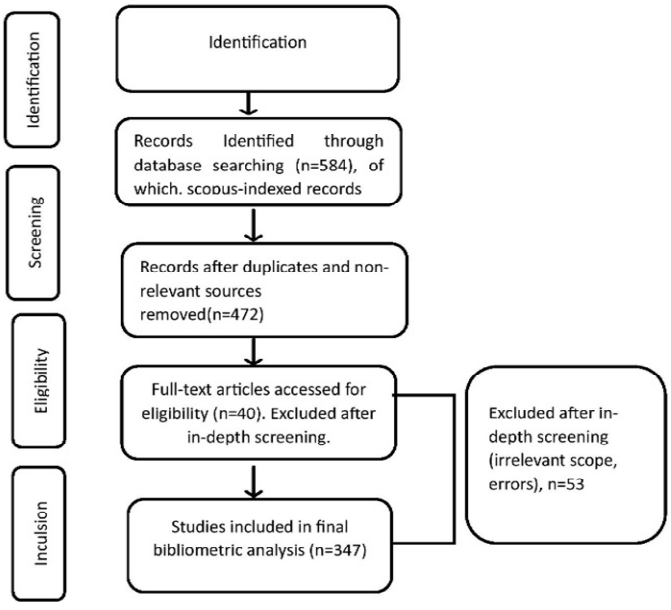
Criteria	*Inclusion criteria*	*Exclusion criteria*
Topic focus	Articles explicitly addressing frugal innovation, inclusive innovation, or reverse innovation, within the context of start-ups.	Articles focused on innovation in large corporations, MNCs. Or sectors unrelated to resource-constrained environments.
Types of publication	Peer-reviewed journal articles.	Conference proceeding, book chapters, dissertations, white papers, reports, or editorials.
Language	Articles published in English.	Articles published in any non-English language.
Publication period	Articles published between 2000 and 2024.	Articles published before 2000 or after 2024.
Conceptual relevance	Studies exploring resource-constrained entrepreneurship, grassroots innovation, affordability-driven product/service development, or inclusive growth models.	Studies discussing innovation or entrepreneurship in general without a specific lens on resource constraints or inclusivity.

Source: Author development

Figure 1, the PRISMA flow diagram, illustrates a transparent and replicable process for literature selection in this bibliometric analysis. Out of 584 initial records (including 33 from Scopus), 472 remained after removing duplicates and irrelevant entries. Title and

abstract screening narrowed the dataset to 400, followed by full-text assessment that excluded 53 articles for thematic or methodological issues. The final sample included 347 peer-reviewed publications. This rigorous, multi-phase process ensures analytical robustness and aligns with standards of high-impact, Scopus-indexed journals. Document type analysis further highlights key channels of scholarly dissemination.

Figure 1 Prisma-based flow diagram for article identification and inclusion in this bibliometric study



Source: Author development

4 Data analysis

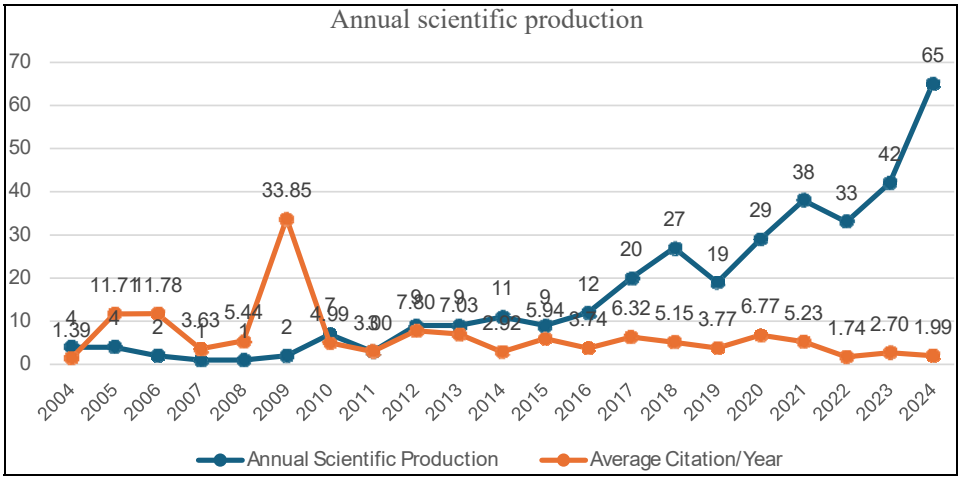
4.1 Main information

This bibliometric analysis synthesises key statistical characteristics from a dataset of 347 publications (2004–2024) drawn from 205 scholarly sources. The field demonstrates a robust annual growth rate of 14.96%, indicating accelerating academic engagement, with an average document age of 5.67 years, reflecting its emergent and dynamic nature. Scholarly influence is underscored by an average of 36.21 citations per document and a cumulative 22,309 references. The corpus comprises a varied mix of document types, including 262 journal articles, 42 book chapters, 20 conference papers, nine books, eight review articles, four editorials, and single instances of both a conference review and an erratum. Content analysis identified 495 keywords plus and 984 author keywords, offering substantial thematic depth for co-word and conceptual structure analyses. Collectively, these metrics delineate the field's scope, intellectual evolution, and research maturity.

4.2 Annual scientific production

The Figure 2 illustrates the evolution of scholarly interest in frugal, inclusive, and reverse innovation within start-up ecosystems from 2004 to 2024, using two key indicators: annual scientific production and average citations per year. The annual publication output remained relatively low from 2004 to 2014, fluctuating between 1 to 11 publications annually, indicating that the field was still in its formative stages. A noticeable growth in research activity began around 2015, with a consistent upward trend thereafter. The number of publications surged significantly in recent years, reaching 27 in 2019, 38 in 2021, 42 in 2023, and peaking at 65 in 2024, underscoring a growing academic and institutional interest in innovation under constraints, particularly in emerging markets and sustainable development contexts. In contrast, the trend in average citations per year has been more volatile. A sharp peak occurred in 2009 with an average of 33.85 citations, likely due to a highly influential publication. From 2010 to 2016, citation averages remained modest yet stable, ranging between 2.92 to 7.80. However, despite the rising volume of publications post-2017, average citations per year began to decline, dropping to between 1.74 and 1.99 from 2021 to 2024.

Figure 2 Annual scientific production and avg. citation per year (see online version for colours)



Source: Author development

This suggests that while scholarly production has expanded significantly, many recent publications have not yet accumulated substantial citations-an expected trend due to the natural time lag in citation cycles. Overall, the findings reflect an evolving and maturing field, where increasing research output is laying the foundation for future influence, even as citation metrics are still catching up. Importantly, this pattern does not necessarily denote reduced research quality but highlights the temporal lag in scholarly recognition. These findings support research question 1 (RQ1) by tracing the historical trajectory and influence of key contributions, reinforcing the need to distinguish between foundational literature and emerging studies-a distinction further explored through keyword and co-citation analyses in subsequent sections.

Table 2 presents a temporal citation analysis, revealing that 2009 stands out as the most influential year, with the highest average total citations per article (575.50) and the

highest citation rate per year (33.85). This indicates the publication of foundational studies that introduced significant frameworks in frugal and inclusive innovation. Similarly, 2005 and 2006, despite fewer publications, show exceptionally high citation density, suggesting the early establishment of strong theoretical or policy foundations in the field.

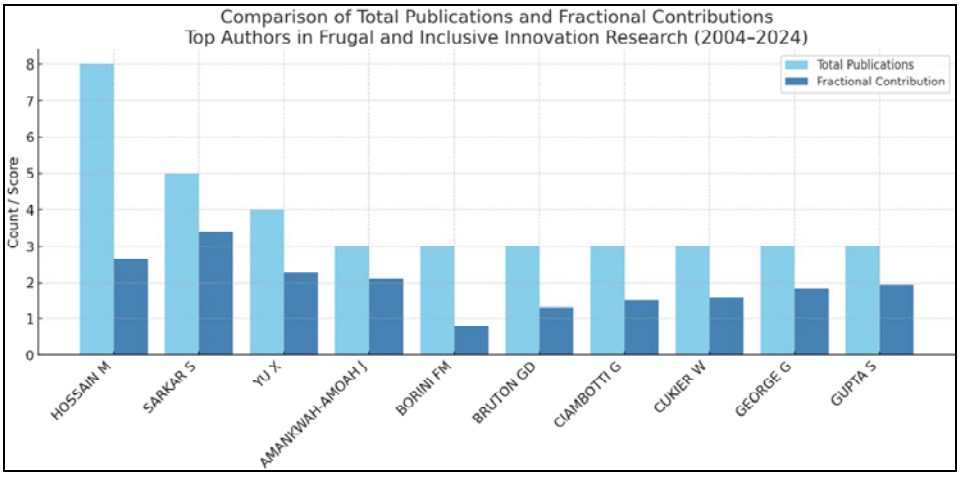
Table 2 Temporal citations analysis

Year	*Peak citation year*	*Most influential articles*
2009	Highest average citations per year (33.85)	Indicates foundational or seminal works
2005 and 2006	Mean total citations per article > 235	Highly influential early works

4.3 Most relevant authors

Figure 3 highlights the top 10 contributors in frugal and inclusive innovation within start-up ecosystems, based on Scopus-indexed publications. Hossain, M. leads with eight papers, followed by Sarkar, S. (5) and Yu, X. (4), indicating strong research focus in innovation under constraints. Seven other authors have each published three papers, reflecting a diverse but cohesive scholarly community. However, total publications alone do not capture depth; fractional authorship offers nuance. For instance, Borini, F.M.'s three papers yield a score of 0.78, while George, G.'s three contribute a higher 1.83, showing greater individual input. This analysis supports RQ2 by identifying both prolific and intellectually influential authors.

Figure 3 Most productive authors (see online version for colours)



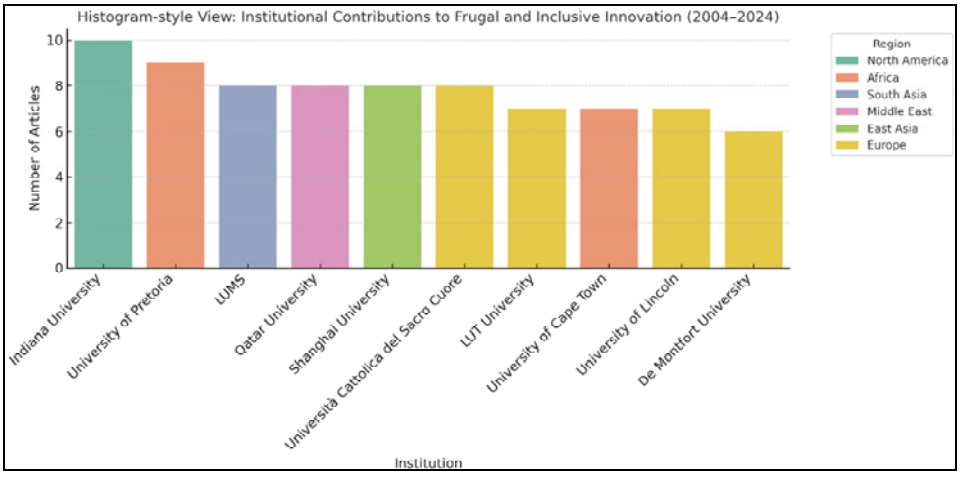
Source: Author development

4.4 Most relevant institutional affiliations

Figure 4 identifies the institutions with the highest publication output in the domain of frugal, inclusive, and reverse innovation within start-up ecosystems. The institutional

analysis shows Indiana University leading with ten publications, followed by the University of Pretoria with 9, reflecting strong global interest in innovation under constraints. Key contributions also come from institutions across Asia, Africa, the Middle East, and Europe. The prominence of universities from emerging economies highlights a focus on context-specific challenges like affordability and social impact, positioning them as strategic partners for future collaborative research.

Figure 4 Most relevant affiliations (see online version for colours)



Source: Author development

4.5 Institutional productivity analysis

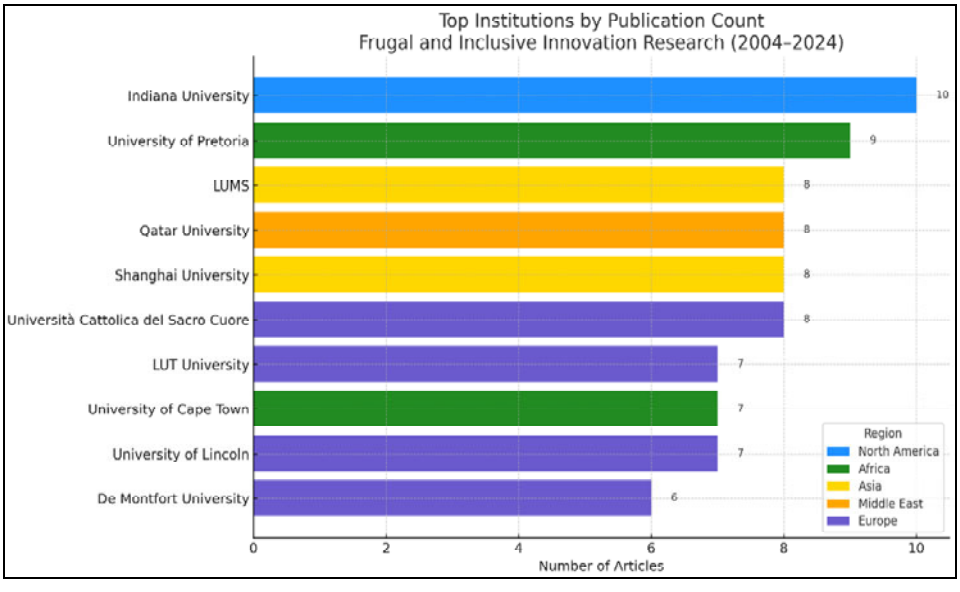
Figure 5 presents the top 10 most productive institutions in frugal, inclusive, and reverse innovation research within start-up ecosystems (2004–2024), ranked by peer-reviewed publication output. Indiana University leads with 10 publications, underscoring its sustained focus on innovation in emerging markets. Notable contributions from African institutions – University of Pretoria (9) and University of Cape Town (7) – highlight a regional emphasis on inclusive development. Asian and Middle Eastern universities, including LUMS (Pakistan), Qatar University, and Shanghai University, reflect the salience of frugal innovation in resource-constrained contexts. European representation, led by Università Cattolica, University of Lincoln, and De Montfort University, signals growing engagement from developed economies. In alignment with RQ6, this institutional diversity underscores the field's global scope and its potential for cross-border collaboration in entrepreneurship, sustainability, and inclusive innovation.

4.6 Four foundational research paradigms

The mapping reveals a geographically and philosophically diverse research landscape in frugal, inclusive, and reverse innovation within start-up ecosystems. Developed-country institutions such as Harvard Business School and the University of Cambridge predominantly operate within positivist and post-positivist paradigms, emphasising empirical validation and mixed-method designs. In contrast, leading institutions from

emerging economies, including IIM Ahmedabad, IIT Delhi, and Tsinghua University, tend to align with Positivist approaches, reflecting a focus on measurable and scalable innovation models suited to resource-constrained contexts. Constructivist orientations emerge in the work of institutions such as the National University of Singapore and HEC Paris, which engage with interpretive, co-created knowledge frameworks, particularly in cross-cultural and grassroots innovation research. Critical Theory perspectives, represented by the University of Cape Town and the University of São Paulo, foreground socially transformative and equity-driven agendas, often rooted in regional development priorities. As reveals in Figure 6 collectively, this distribution illustrates how institutional geography and philosophical alignment jointly shape the theoretical and methodological contours of the field, highlighting opportunities for paradigm-bridging collaborations.

Figure 5 Top productive institutions (see online version for colours)



Source: Author development

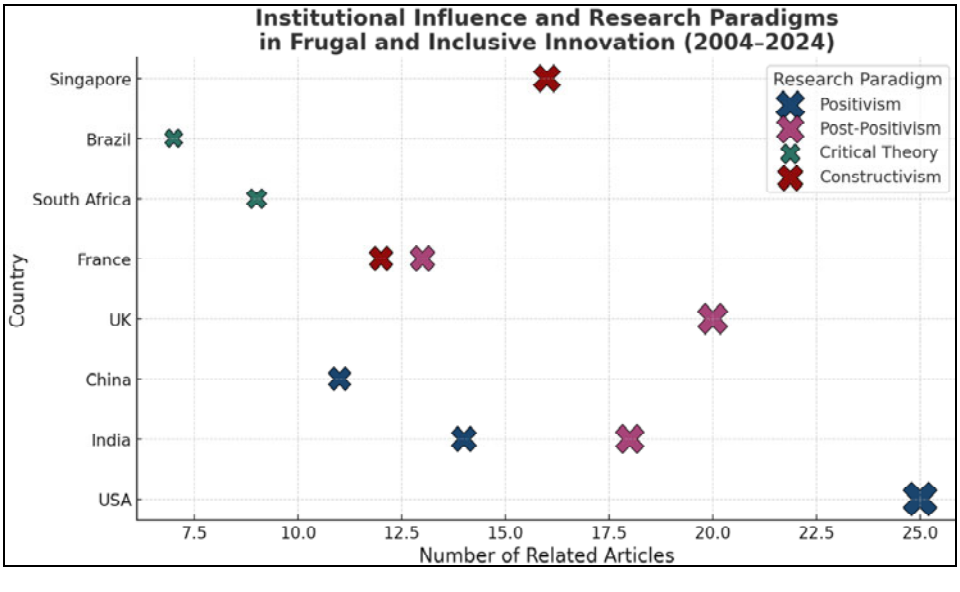
4.7 Most influential articles

Table 3 presents the most influential scholarly articles in the field of entrepreneurship, innovation, and resource-constrained environments, based on total citations, average citations per year, and normalised citation scores. Mair and Marti (2009) leads the list with 1,073 citations, underscoring its foundational role in the study of institutional voids and social entrepreneurship. George (2005) and George et al. (2012) follow closely with 910 and 658 citations, respectively, contributing significantly to the understanding of slack resources and inclusive growth.

4.8 Co-citation network map

The co-citation network map represented by Figure 7 illustrates the intellectual structure of literature on innovation and entrepreneurship under resource constraints. The size of each node represents the co-citation frequency-larger nodes like Mair and Marti (2009) and George (2005) indicate foundational works that form the conceptual backbone of the field. The colour of each cluster reflects thematic groupings generated by VOS viewer's clustering algorithm. For instance, the purple cluster centres on institutional theory and resource-based views, with seminal works exploring slack resources and entrepreneurship in institutional voids. The blue-green cluster captures themes of frugal innovation, sustainability, and inclusive business models, with key contributions such as Rosca et al. (2017) and Dy et al. (2016). The yellow-green cluster represents an emerging focus on digital entrepreneurship, social impact, and post-pandemic innovation contexts. The colour gradient also reflects average publication year-older works appear in purple/blue, while newer ones shift toward green and yellow, signalling the field's evolution over time. Link thickness between nodes shows the strength of co-citation relationships-thicker lines suggest stronger intellectual ties or thematic overlap.

Figure 6 Institutional influence and research paradigms (see online version for colours)



Source: Authors' development

Overall, the network highlights a well-structured and evolving body of research, where core theories in entrepreneurship are continually extended by newer studies addressing contemporary global challenges such as sustainability, inclusion, and innovation under constraints.

Table 3 Most influential articles

Paper	*Titles*	*Journal*	*Total citations*	*TC per year*	*Normalised TC*
Mair and Marti (2009)	Entrepreneurship in and around institutional voids: a case study from Bangladesh	*Journal of Business Venturing*	1,073	63.12	1.86
George (2005)	Slack resources and the performance of privately held firms	*Academy of Management Journal*	910	43.33	3.7
George et al. (2012)	Innovation for inclusive growth: towards a theoretical framework and a research agenda	*Journal of Management Studies*	658	47	6.02
Kim et al. (2006)	Access (not) denied: the impact of financial, human, and cultural capital on entrepreneurial entry in the United States	*Small Business Economics*	470	23.5	2
Desa and Basu (2013)	Optimization or Bricolage? Overcoming resource constraints in global social entrepreneurship	*Strategic Entrepreneurship Journal*	411	31.62	4.5
De Massis et al. (2018)	Innovation with limited resources: management lessons from the German Mittelstand	*Journal of Product Innovation Management*	331	41.38	8.03
Brouthers et al. (2015)	SME entrepreneurial orientation, international performance, and the moderating role of strategic alliances	*Entrepreneurship Theory & Practice*	302	27.45	4.62
Dy et al. (2016)	A web of opportunity or the same old story? Women digital entrepreneurs and intersectionality theory	*Human Relations*	291	32.33	5.12
Martin and Javalgi (2016)	Entrepreneurial orientation, marketing capabilities and performance: the moderating role of competitive intensity on Latin American international new ventures	*Journal of Business Research*	284	28.4	7.59
Rosca et al. (2017)	Business models for sustainable innovation-an empirical analysis of frugal products and services	*Journal of Cleaner Production*	232	25.78	4.08

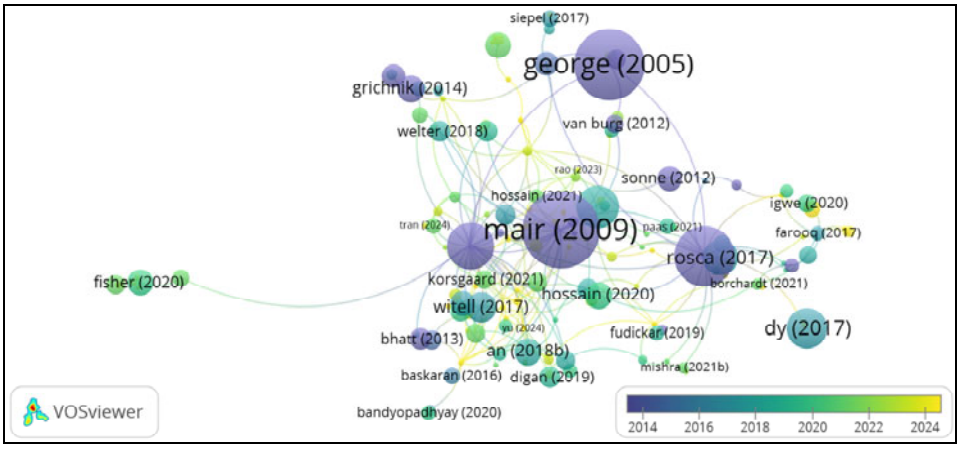
Source: Authors' development

4.9 Thematic map of research

Figure 8 presents the thematic map illustrating the conceptual landscape of research on innovation and entrepreneurship under resource constraints, organised according to each theme's relevance (centrality) and level of development (density). In the top-right quadrant, motor themes such as resource constraint, entrepreneurship, frugal innovations, and sustainable development appear as both well-developed and central, reflecting their

foundational role in the literature. These themes are frequently discussed and form the intellectual core of the field. The bottom-right quadrant highlights basic and transversal themes like inclusive innovations, SMEs, sustainability, and geographic contexts such as Kenya and industry, suggesting they are relevant yet still developing in complexity. The top-left quadrant contains niche themes like innovation strategy, international trade, and managers, which are highly developed but more specialised and less connected to mainstream discourse. The bottom-left quadrant includes emerging or declining themes such as digital technologies, corporate development, and social impact. These are less integrated and may represent either early-stage research areas or waning scholarly interest. The node sizes indicate frequency, with larger nodes such as entrepreneurship and resource constraint signalling dominant topics. This map reveals a mature, expanding field with core research focused on frugal and inclusive innovation in resource-limited environments.

Figure 7 Co-citation network (see online version for colours)



Source: VOSviewer and authors' development

4.10 Thematic analysis through co-occurrence of keywords

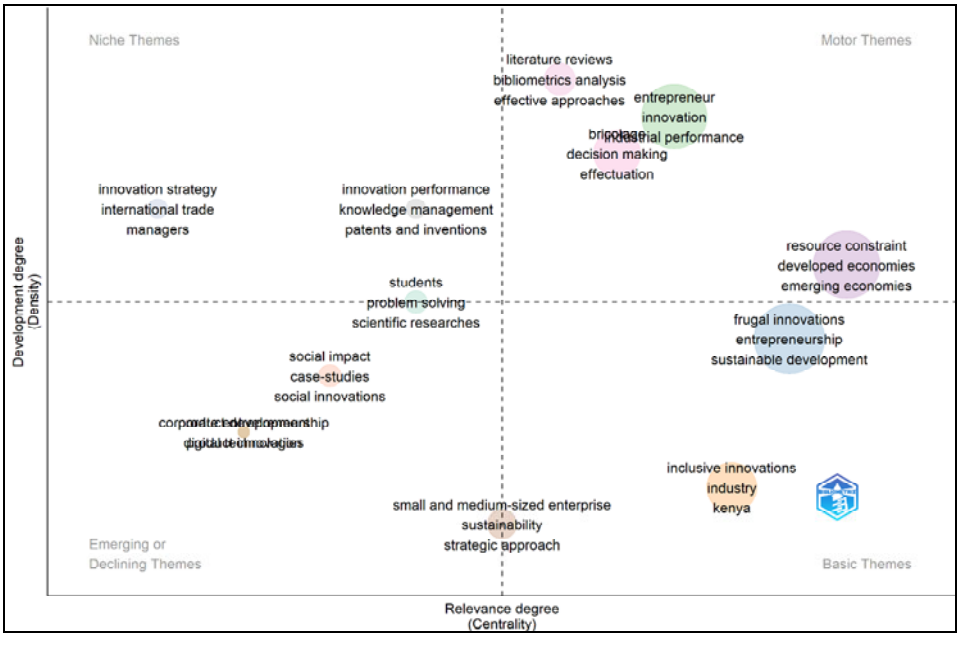
In Figure 9, keyword co-occurrence network map reveals five major thematic clusters that structure the literature on innovation and entrepreneurship under resource constraints. At the centre lies the purple cluster, which represents the core conceptual foundation of the field. The keyword co-occurrence map identifies five key research themes: core concepts in entrepreneurship, frugal innovation in emerging markets, social and inclusive innovation, entrepreneurial strategies under constraints, and grassroots innovation targeting bottom-of-the-pyramid contexts.

The blue cluster captures the theme of 'frugal innovation and sustainability in emerging markets'. This cluster includes terms like frugal innovations, sustainable development, developing countries, and emerging markets, emphasising innovation practices tailored for affordability, resource efficiency, and environmental sustainability, particularly in low-income contexts.

The green cluster reflects the theme of 'inclusive and social innovation in development contexts'. It centres on keywords such as social entrepreneurship, inclusive

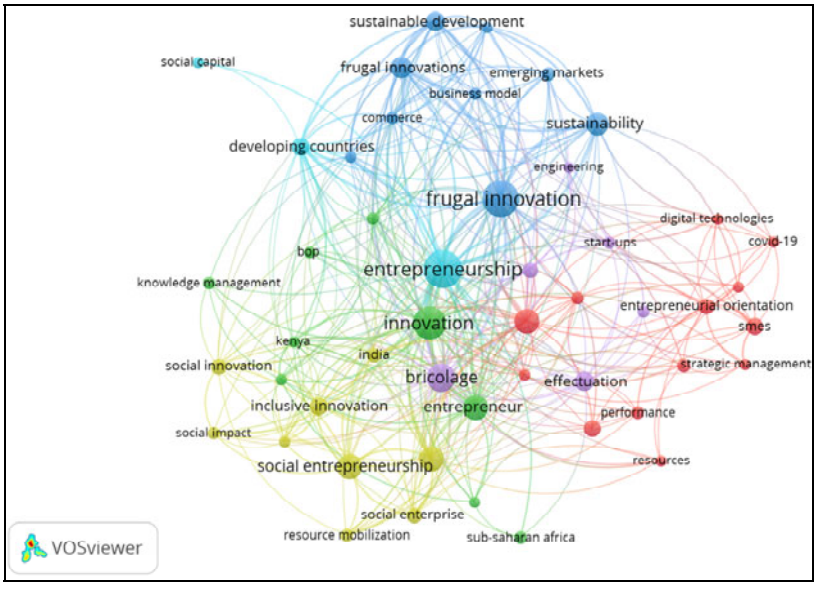
innovation, social impact, and Sub-Saharan Africa, indicating a strong focus on innovation driven by social purpose, community development, and bottom-up initiatives.

Figure 8 Thematic map of research (see online version for colours)



Source: Author development

Figure 9 Authors' keywords co-occurrences analysis (see online version for colours)



Source: Authors' development

The red cluster denotes 'entrepreneurial capabilities and strategic management', comprising terms like entrepreneurial orientation, SMEs, start-ups, strategic management, and digital technologies. This cluster highlights the strategic behaviour and resource mobilisation strategies of firms operating under constraints, especially in digitally evolving environments and post-COVID contexts.

The yellow cluster addresses 'grassroots innovation and bottom-of-the-pyramid (BoP) strategies', with terms such as BoP, India, knowledge management, and social capital. This theme focuses on localised, community-based innovations emerging from informal economies and underserved populations.

5 Discussion

The findings of this study reflect a notable transformation in the scholarly discourse surrounding innovation within start-up ecosystems under resource constraints. What emerges is a clear progression from isolated conceptual treatments of frugal, inclusive, and reverse innovation toward a more integrated, interdisciplinary, and applied research orientation. This evolution mirrors the increasing urgency to address global socio-economic and environmental challenges through scalable and accessible innovation pathways.

Initially, co-citation analysis revealed a solid foundation of seminal theories, particularly institutional voids (Mair and Marti, 2009) and resource-based perspectives (George, 2005), which continue to anchor the field. These clusters highlight the formative role of concepts such as bricolage, slack resources, and grassroots entrepreneurship. However, the bibliometric coupling and keyword co-occurrence analyses revealed a diversification of themes-ranging from frugal and inclusive innovation to digital entrepreneurship, BoP strategies, and post-pandemic adaptation-signifying a shift toward practice-oriented, contextualised, and geographically specific studies. This transition is further evidenced by the geographic spread of influential institutions, where a noticeable rise of Global South actors-such as the University of Pretoria, IIM Ahmedabad, and LUMS, suggests a decentralisation of academic authority in this space. These findings reflect a growing recognition of context-driven innovation in emerging markets, where constraints catalyse rather than inhibit entrepreneurial problem-solving.

The co-citation clusters offer backward-facing insight into the theoretical roots of the field, whereas the keyword co-occurrence and thematic maps reflect forward-facing, emergent directions. For instance, themes like frugal innovation in emerging markets and inclusive entrepreneurship in Sub-Saharan Africa represent increasingly localised responses to global issues. Similarly, the emergence of themes like digital tools and social capital in grassroots innovation shows a fusion of traditional practices with modern capabilities. The observed discrepancy between publication growth and citation frequency (notably post-2018) suggests that while scholarly attention is increasing, many recent contributions have yet to reach full academic impact-a lag that aligns with typical citation cycles but also indicates a rich reservoir of evolving research yet to be fully acknowledged.

5.1 Implications for scholars

This study points to significant implications for academic researchers. The broad thematic diversity-spanning innovation strategy, digital entrepreneurship, grassroots models, and inclusive frameworks-highlights an increasingly interdisciplinary field that benefits from cross-sectoral engagement. The publication of high-impact articles in journals across management, development studies, sustainability, and entrepreneurship suggest fertile ground for multi-perspective integration. However, the dominance of Western institutions in early influential works and their limited engagement with local realities in the Global South suggests a need for context-sensitive scholarship. It is also found that the relatively weak linkage between co-citation clusters and recent bibliographic clusters implies a gap in theoretical continuity. While new research has pivoted toward real-time global challenges such as COVID-19, climate adaptation, and digital inequality, it has not always been firmly anchored in existing conceptual frameworks. This presents an opportunity for scholars to bridge legacy theories with current applied innovations, producing research that is both theoretically robust and practically relevant.

The use of bibliometric tools like VOSviewer and Bibliometrix not only allows for mapping of trends but also highlights underexplored intersections, such as the relationship between frugal innovation and digital transformation, or inclusive innovation and gendered entrepreneurship. These areas remain underrepresented and offer promising avenues for future inquiry. Ultimately, scholars are encouraged to move beyond disciplinary silos and embrace a pluralistic, systems-thinking approach to innovation under constraints.

5.2 Implications for practitioners and ecosystem stakeholders

For practitioners, especially entrepreneurs, policy-makers, and innovation ecosystem enablers, the study underscores the strategic importance of constraint-driven innovation as a viable pathway to competitive advantage. As shown by the thematic clusters and institutional contributions, scarcity can foster agility, creativity, and resilience, particularly in resource-constrained start-up environments. Managers and ecosystem builders should view frugal and inclusive innovation not as cost-cutting mechanisms but as long-term value creation strategies, especially for underserved markets. The rise of reverse innovation also signals a paradigm shift-where innovations originating in the Global South can influence global markets, challenging traditional hierarchies of knowledge transfer. This creates opportunities for cross-border collaboration, local-global scaling strategies, and South–South knowledge exchanges.

In addition, the emergence of digital technologies in the thematic maps reflects the growing role of platforms, AI, and mobile infrastructure in supporting scalable innovation. Start-ups are advised to integrate lean innovation methodologies with digital tools and local knowledge systems, promoting inclusivity while remaining adaptive to global disruptions, such as pandemics or climate-related shocks. From a policy standpoint, insights from this study advocate for targeted support for innovation under constraint, including infrastructure for digital inclusion, funding mechanisms for grassroots entrepreneurship, and policies fostering collaborative innovation ecosystems. Ultimately, these strategies not only empower entrepreneurs but contribute to broader goals of sustainable development and economic equity.

6 Conclusions

This study reveals a significant transformation in how innovation is understood and practiced within start-up ecosystems operating under resource constraints. The field has shifted from conceptually isolated frameworks-such as frugal, inclusive, and reverse innovation-to more integrated, applied, and context-sensitive approaches that reflect real-world complexities. Early scholarship focused on foundational theories like institutional voids and bricolage; however, contemporary research emphasises inclusive entrepreneurship, sustainability, and grassroots innovation, particularly in emerging markets. The increasing presence of digital tools, post-pandemic adaptations, and localised responses underscores the interdisciplinary expansion of the field. A marked rise in publications since 2015 reflects this transition, aligning with global challenges such as inequality, climate change, and systemic shocks like COVID-19.

Despite this growth, a gap remains in the convergence of theoretical depth and empirical application. The fragmented landscape of journals-spanning development studies, innovation management, and entrepreneurship-indicates a vibrant but still maturing domain. The findings underscore both opportunities and challenges: for scholars, the chance to unify diverse constructs under cohesive theoretical models; for practitioners, the imperative to turn constraints into innovation opportunities that foster resilience and social impact.

This study has general limitations, including reliance on selected databases, language restrictions, keyword sensitivity, and potential subjectivity in interpreting bibliometric and thematic analyses. The reliance on Scopus and Web of Science may have omitted relevant literature from alternative sources or non-English publications. The specificity of keywords used may also have excluded interdisciplinary works not explicitly labelled under frugal or inclusive innovation. Furthermore, interpretation of clusters in bibliometric analyses-while systematically conducted-remains partially subjective and may reflect biases in thematic coding. These limitations, however, offer direction for future research. First, there is a growing need to explore how national policies, entrepreneurial ecosystems, and corporate strategies can align to advance frugal and inclusive innovation agendas. Such efforts require more granular, case-based studies that explore institutional incentives and regulatory mechanisms that support innovation in resource-limited settings. Secondly, the lessons of the COVID-19 pandemic highlight the urgency of embedding resilience into start-up innovation strategies. Future studies could investigate how start-ups can proactively anticipate disruptions and adapt using constraint-based models of innovation.

Geographical specificity also emerged as a critical factor. Localised studies that account for cultural, economic, and institutional differences can provide more contextually grounded insights. In particular, the Global South offers fertile ground for further research that authentically captures indigenous innovation practices. Moreover, the diversity of themes across clusters underscores the importance of interdisciplinary collaboration. Bridging innovation studies with fields like development economics, digital transformation, and public policy can enrich the understanding of how start-ups drive inclusive, sustainable change.

Finally, this study calls for continuous innovation and adaptive strategic thinking in the face of a rapidly shifting global environment. Future scholars should examine how start-ups can embed sustainability and inclusivity into the core of their business models, not only to thrive in challenging environments but also to actively shape more equitable

and resilient economies. By advancing this research agenda, we can unlock the transformative potential of innovation under constraints, paving the way toward a more inclusive and sustainable entrepreneurial future.

Declarations

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