

Frugal geeks: how founder knowledge boosts performance through bricolage and innovation

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Abstract

Purpose – This study explores the relationship between founder's knowledge on information and communication technology (ICT) and startup performance through frugal innovation (FI) and entrepreneurial bricolage (EB) in the product/service development strategy by using the lens of the knowledge-based view (KBV).

Design/methodology/approach – This study adopted a qualitative, multiple-case and contrasting approach. Primary data were collected through semi-structured interviews with founders of four Brazilian startups, complemented by secondary data from official documents, social media and industry report. Data analysis was conducted with a theory-driven coding scheme supported by triangulation of data sources by using Atlas.ti software.

Findings – The founder's prior knowledge on ICT influenced the product development strategy through FI and EB, resulting in different performance outcomes.

Research limitations/implications – Potential limitations include subjective biases from semi-structured interviews, such as reliance on the founders' perceptions, which may not capture the performance of their startups and thus result in incomplete secondary data.

Practical implications – The contrasting cases allowed for a deeper understanding of the relationships among founders regarding their knowledge on ICT, EB, FI and performance in the technology startup context.

Originality/value – By relating the concepts of FI with KBV based on the startup founder's knowledge on ICT, this study found that EB plays an intermediary role between them and FI, which influenced the startup performance. Moreover, this study informs founders and investors about how the founders' team composition, especially in technology startups, can boost startup performance in restricted environments.

Keywords Frugal innovation, Bricolage, Startup, Founder, Knowledge, Performance

Paper type Research article

1. Introduction

Startups in emerging markets, such as Brazil, operate in environments characterized by extreme resource scarcity and high mortality rates (D'Andrea, Santos, Costa, & Zen, 2023). Unlike their counterparts in developed economies, these ventures lack the financial, technological and managerial buffers required to survive the market turbulence (Gbadegehin *et al.*, 2022). Resource constraints and market competitiveness present a significant challenge for survival. In emerging economies, high resource scarcity leads to elevated failure rates, with few businesses achieving maturity and sustainable growth (Kaplinsky & Kraemer-Mbula, 2022). This is consistent with evidence from small and medium enterprises (SMEs), in which financial and capability constraints hinder their ability to innovate independently, forcing them to rely on external resources and thus



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weakening their performance in turbulent contexts (Abbas, Liu, Mahmood, & Mushtaq, 2024). Consequently, survival often depends on the ability to innovate frugally (Yousaf, Radulescu, Sinisi, Serbanescu, & Păunescu, 2021). Frugal innovation (FI) can be defined as the development of innovative solutions that achieve substantial reductions in maintenance cost, focusing on core properties while meeting or exceeding expected quality standards (Rossetto, Borini, Bernardes, & Frankwick, 2023).

Recent literature highlights that in such constrained ecosystems, human capital and technological capabilities are the primary engines of resilience. For instance, Shahzad, Rashid, and Abbas (2023) demonstrate that human capital development is a critical catalyst for technological innovation and sustainable growth. Similarly, Abbas, Liu, and Khushnood (2025) argue that the synergy between human cognitive skills and digital tools increasingly drives engagement toward breakthrough innovations. Furthermore, Abbas and Liu (2021) emphasized that startups in emerging economies must develop specific innovation capabilities to overcome the challenges and disadvantages associated with being new.

However, a critical challenge remains: in Brazil, for instance, only 3% of professionals possess advanced knowledge on information and communication technology (ICT) (ITU, 2020). While it is assumed that founders with technical skills are valuable resources (Hossain, Agarwal, Bhatti, & Levänen, 2022), the literature calls for more studies on specific mechanisms through which companies use ICT for FI (Khanal, Aubert, Bernard, Narasimhamurthy, & Dé, 2021; Tan, Ky, & Tan, 2016) and how they process knowledge to innovate frugally (Berndt, Gomes, & Borini, 2024).

The current literature lacks a granular understanding of how a founder's ICT knowledge triggers these mechanisms. It remains unclear whether technical expertise automatically leads to innovation or requires additional improvisational capability. This study posits that entrepreneurial bricolage (EB), which Baker and Nelson (2005) define as the practice of making combinations of available resources to solve new problems, serves as this missing link. Although existing research suggests that EB mediates knowledge constraints (Shen, 2018), the complex relationship between FI, EB and performance in technology-intensive contexts remains underexplored (Santos, Borini, & Oliveira, 2020; Chakravarty, 2022), particularly in emerging contexts (Iqbal, Piwowar-Sulej, & Kallmuenzer, 2025).

Based on the arguments presented, it is possible to assume that startup founders with ICT skills are valuable resources for promoting innovation quickly and at lower costs. These align with the principles of FI, thus generating a competitive advantage for the startup and improving its performance. With regard to the dual challenges of high mortality and talent scarcity, this study addresses the following research question: What is the relationship between founders' ICT knowledge and generation of FI via bricolage that improves performance in technology-based startups?

By addressing this inquiry, we contribute to the theory by connecting micro-level founder knowledge with firm-level performance outcomes. From a managerial perspective, this study informs founders and investors about how team composition, particularly the presence of the so-called frugal geeks, can boost survival in restriction-based environments.

2. Theoretical background

2.1 Founder knowledge and knowledge-based view

To maintain a competitive advantage, companies in emerging economies adopt a low-cost approach and seek new innovative paradigms, such as FI. Resource-restricted organizations have focused on optimizing their internal and external knowledge to develop their learning capabilities in a frugal environment to continuously provide value-added services to their clients and improve their shareholders' financial wealth (Yousaf et al., 2021).

Knowledge is considered a strategically important resource whose effective use can contribute to firm innovativeness, performance and competitive advantage (Cooper, Pereira, Vrontis, & Liu, 2023). According to Grant's (1996) knowledge-based view (KBV) of the firm, knowledge primarily resides in individuals, while the organization's central role is to integrate and apply their specialized knowledge. From this perspective, human productivity depends on knowledge and machines can be understood as embodiments of knowledge (Grant, 1996).

According to the KBV, a firm's primary role is to transform the specialized knowledge residing in individuals into goods and services (Grant, 1996; Kogut, 2000). According to Grant (1996), the emphasis on the role of the individual as the main player in the creation of knowledge and as the main repository of knowledge is essential to unveiling organizational knowledge and clarifying the role of organizations in knowledge creation and application. Consequently, KBV conceptualizes the company as a generator and incubator of knowledge as human capital (Chowdhury, Budhwar, Dey, Joel-Edgar, & Abadie, 2022).

Human capital can be defined as a set of literacy, formal education and previous experiences. It should also be noted that previous technological knowledge is particularly valuable for expanding expertise to identify a greater variety of opportunities (Marvel, Wolfe, & Kuratko, 2020). Prior research indicates that internal and external knowledge sources are significantly associated with FI (Dost, Pahi, Magsi, & Umrani, 2019). More recently, in a study of 260 Pakistani SMEs, Latif, Iftikhar, Ferasso, and Danish (2025) found that knowledge mobilization through absorptive capacity was positively associated with FI. KBV has been used to reveal how frugal innovators leverage resources and capabilities in restrictive environments, manage resource constraints and how the environment influences FI outcomes (Dabić, Obradović, Vlačić, Sahasranamam, & Paul, 2022).

The founders' knowledge on a technology startup is a resource that, when converted into currency, can be called intellectual capital and is necessary for generating innovations that impact its performance (Sveiby, 2001). Nevertheless, KBV assumes that knowledge yields value only through its application and not through its mere possession (Cooper *et al.*, 2023; Grant, 1996; Nonaka, 1994). This highlights a conceptual tension, as the founders' ICT knowledge may be a necessary resource for FI because its translation into frugal outcomes is neither automatic nor uniform. Dost *et al.* (2019) show that the effect of knowledge sources on FI is moderated by environmental turbulence, while the bricolage literature identifies boundary conditions (e.g. strategic orientation) that determine whether knowledge is enacted through resource recombination (Steffens, Baker, Davidsson, & Senyard, 2023).

- P1. The founder's ICT knowledge provides an enabling condition for the company to innovate with few resources (FI).

2.2 Frugal innovation and Entrepreneurial bricolage

FI is defined as innovation under resource scarcity, cost reduction and acceptable quality. This involves creating solutions (i.e. products, services, processes or business models) despite resource constraints, resulting in significantly cheaper offerings that meet the basic needs of underserved customers (Hossain, 2016, 2022). To define FI, Weyrauch and Herstatt (2016) used three main criteria: substantial cost reduction, focus on core features and optimized performance level. FI should not be confused with the cheapest product; instead, it must display accessibility, quality, ease of use and sustainability. Complementary to this, Rossetto *et al.* (2023) proposed that the overall capabilities to achieve FI are substantial cost reduction, focus on core functionalities and sustainable engagement.

Bricolage is the creative repurposing of available resources to generate FIs regardless of their original function. Lévi-Strauss (1966) introduced this concept as an analogy for mythical thinking, in which cultural fragments are recombined into new forms. In entrepreneurship, bricolage is the act of improvising by combining the resources at hand to address new

problems and opportunities (Fisher, 2012). The characteristics of bricolage, according to Baker and Nelson (2005) and Fisher (2012), can be defined as (1) improvising with what is available and (2) creating something from nothing through improvisation, combining resources for new purposes and using available resources. The operationalization of doing more with less for more people, which is the definition of FI, is especially challenging because of resource scarcity. This is why FI was developed as an alternative to the Base of the Pyramid (BoP), as proposed by Prahalad, Di Benedetto, and Nakata (2012). Thus, bricolage is a common practice in the theory of FI, as cited elsewhere (Bhatti & Ventresca, 2013; Pisoni, Michelini, & Martignoni, 2017; Rosca, Arnold, & Bendul, 2017; Winterhalter, Zeschky, Neumann, & Gassmann, 2017). Winterhalter *et al.* (2017) positioned bricolage as key to the business model for frugal entrepreneurs.

A study of Asian emerging markets found that bricolage positively affects resource-constrained innovation as well as knowledge management regarding acquisition, retrieval and exploration, showing that knowledge use also has a positive effect (Chatterjee, Chaudhuri, & Vrontis, 2021). A study of 248 entrepreneurs confirmed that heterogeneous knowledge was positively associated with EB (Zhao, Huang, Xi, & Wang, 2021). Additionally, data from a survey of 183 entrepreneurs in the United States showed that EB fully mediates the relationship between knowledge constraints and innovation (Shen, 2018). These studies revealed a relationship between knowledge, FI and bricolage.

As discussed earlier, we posit that ICT knowledge is a necessary but not sufficient condition for bricolage and FI. Accordingly, this study addresses the founders' ICT knowledge as an enabling but boundary-conditioned antecedent of FI, whose realization depends on how that knowledge is strategically employed (Grant, 1996). This interpretation is consistent with Santos *et al.* (2020), who conceptualize FI as a firm-level strategy and argue that its implementation requires firms to develop specific capabilities to operate under resource constraints. The literature shows that resource-constrained ventures do not follow a single path; that is, they alternate between bricolage and resource-seeking in order to acquire standard resources at a market price (Baker & Nelson, 2005; Reypens, Bacq, & Milanov, 2021). Whether a knowledgeable founder recombines or acquires is governed by strategic orientation and market conditions. Reypens *et al.* (2021) demonstrate that high technological sophistication or stringent regulation (e.g. healthcare) may push ventures toward resource-seeking to meet required standards, causing a minimum-cost "make-do" logic to be incompatible with the market's quality and compliance thresholds. Thus, strategic orientation operates as a boundary condition on the knowledge-bricolage link (Abid, Dowling, Ceci, & Aftab, 2023; Steffens *et al.*, 2023).

2.2.1 Boundary conditions of the knowledge-bricolage-frugal innovation link. If knowledge yields value only through application (Grant, 1996; Cooper *et al.*, 2023), then a second boundary condition beyond strategic orientation concerns the type of ICT knowledge founders hold. Hands-on development knowledge, that is the ability to write, adapt and recombine code and hardware, equips founders to enact bricolage directly because "making do with what is at hand" (Baker & Nelson, 2005) requires knowing what the resources at hand can be made to do. Governance-level ICT knowledge, which is the ability to specify, evaluate and manage technological solutions, reduces information asymmetry with suppliers and lowers transaction costs, but it does not by itself produce recombination. Both are valuable under the KBV, but only the former is a bricolage input. Taken together with the strategic orientation discussed above, this implies that the founders' ICT knowledge expands the range of feasible recombinations. However, its conversion into bricolage-based FI depends on the kind of knowledge held and on an orientation toward recombining rather than acquiring resources.

P2. The founders' ICT knowledge expands their repertoire of bricolage possibilities, but its enactment depends on the venture's strategic orientation.

EB contributes to FI generation. Iqbal, Ahmad, and Halim (2021) pointed out that EB enables FI in resource-constrained environments. Empirical evidence shows that varying levels of

bricolage explain innovation under resource constraints in startups (Senyard, Baker, Steffens, & Davidsson, 2014).

FI and EB are strongly correlated. EB enables the adaptation of available resources, whereas FI aims to provide simple, affordable and value-added services to BoP consumers (Iqbal *et al.*, 2021). Thus, FI can be viewed as a result of bricolage strategies (Gurca & Ravishankar, 2016).

P3. Increased bricolage capacity allows for a greater ability to innovate frugally.

2.3 Startup performance

The results of a startup can be measured in several ways. The literature points to studies dealing with performance measures (Rompho, 2018), survival (Soto-Simeone, Sirén, & Antretter, 2020) and success (Santisteban & Mauricio, 2017) of startups or new ventures. A possible approach to evaluating startup performance is through the founders’ perceptions of competitors. This alternative is useful when comparing objective indicators. This is the case in the study conducted by Wiklund and Shepherd (2003), who included financial and non-financial measures and which was later adopted in a quantitative study (Wiklund & Shepherd, 2011).

2.4 Conceptual framework

The conceptual framework (Figure 1) illustrates how problems with startup trigger an innovative problem-solving process, which fundamentally depends on the founder’s internal ICT knowledge. This knowledge shapes how the founder interprets challenges, evaluates available ICT resources and navigates constraints on time, finance, human capital and infrastructure. Empirical evidence shows that firms with stronger learning and knowledge integration capabilities are significantly better at generating innovative responses to such constraints, as these capabilities enhance experimentation, dialog and opportunity recognition (Berndt, Gomes, Borini, & Bernardes, 2023). Therefore, ICT knowledge enables bricolage and creative recombination of existing tools and components, which becomes essential under severe constraints.

Together, ICT knowledge, resource constraints and bricolage capabilities interact dynamically. In this sense, ICT knowledge informs what can be reused or adapted, constraints define the boundaries of feasible action and available resources provide the raw material for experimentation. Through this interaction, founders develop frugal innovative solutions that emphasize affordability, focused functionality and efficient resource use. This dynamic aligns with evidence that FI boosts startup performance by reducing costs, accelerating implementation and enhancing the venture’s ability to operate effectively under limitations (Berndt *et al.*, 2024).

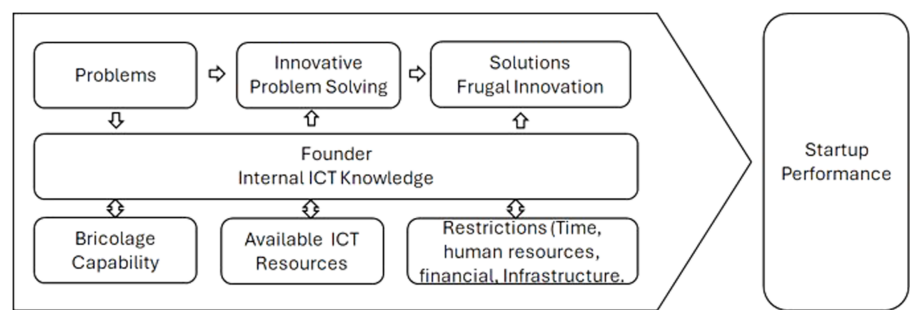


Figure 1. Conceptual framework. Source(s): Authors’ own work

Innovative problem solving arises when founders apply their internal ICT knowledge through a frugal mindset by deliberately seeking solutions that minimize costs while preserving essential functionality. This technical grounding enables them to break down problems, understand system limitations and identify which digital tools, components or architecture can be simplified, adapted or reused. Empirical evidence indicates that knowledge-oriented capabilities play a central role in how firms interpret challenges and mobilize solutions under resource constraints. For example, in the textile industry, organizational learning capability has been shown to significantly strengthen the firms' ability to generate FI outcomes by enhancing experimentation, external interaction and opportunity recognition (Berndt *et al.*, 2023).

When combined with bricolage capabilities, the founders can creatively recombine existing ICT resources, such as repurposing legacy hardware, customizing open-source software and integrating low-cost digital platforms, to meet specific needs under tight resource constraints. Through this interaction, internal ICT knowledge guides which elements can be modified or substituted, frugal mindset establishes the criteria for what is "good enough," and bricolage transforms available materials into workable solutions. Together, these mechanisms generate frugal innovations that are affordable, efficient and well-aligned with the realities of resource-limited startup environments.

ICT founders' knowledge is central to the startup performance in technology-intensive environments, which depicts their critical role in generating innovative frugal solutions. This knowledge shapes how the founder interprets challenges, evaluates available ICT resources and navigates constraints on time, finance, human capital and infrastructure. The ability to select appropriate technologies enhances productivity, reduces operational costs and enhances performance. However, the incorporation of specialized ICT assets often introduces complexity. Founders with strong ICT knowledge are better equipped to make strategic technological decisions, whereas those possessing bricolage capabilities can creatively recombine existing resources to develop low-cost, innovative solutions. This adaptability depends on ICT expertise to manage technological complexity and minimize reliance on costly specialized resources.

From a theoretical standpoint, the founders' ICT knowledge, understood as a strategic resource in terms of KBV, broadens the range of possible resource combinations in line with the effectuation-based perspective. This capacity for resource recombination supports the practical application of FI principles, namely cost reduction, focused functionality and sustainable co-creation. Together, these mechanisms enhance startup performance, particularly in contexts defined by severe constraints. This micro-level logic is consistent with empirical evidence that firms with stronger learning and knowledge capabilities are more likely to generate FI outcomes and achieve superior operational performance. Berndt *et al.* (2023) demonstrated that organizational learning capability, conceptually aligned with the founder's ICT knowledge in early-stage startups, significantly enhances FI, which in turn improves performance. Their findings reinforce the argument that knowledge-driven recombination, cost-conscious design and resource-efficient experimentation are foundational mechanisms that link frugality to improved results.

FI plays a pivotal role in improving business performance by helping entrepreneurs minimize resource dependency and secure first-mover advantages (Zahra, 2021). Its emphasis on cost-effective and affordable value innovation drives performance by lowering expenses through tailored features and delivering new functionalities at reduced cost (Cai, Ying, Liu, & Wu, 2019). Berndt *et al.* (2023) found that FI strongly and positively influences operational performance, particularly by improving process efficiency, reducing costs and enhancing responsiveness. These findings align with the expectation that frugal solutions developed through ICT-driven bricolage and problem-solving ability yield measurable performance advantages in resource-constrained environments. Additionally, bricolage capabilities allow firms in emerging markets to overcome critical technological resource limitations (Cai *et al.*, 2019). Supporting this view, Dost, Nikbin, and Qureshi (2022) provide empirical evidence

from emerging market firms, showing that FI has a significantly positive influence on both financial and environmental outcomes. Furthermore, FI is inherently tied to broader economic performance, enabling firms to meet strategic objectives, implement business strategies effectively and improve their relative performance (Iqbal *et al.*, 2021).

- P4. When associated with the founders' knowledge and their bricolage capability, FI provides better performance to the startup.

3. Methodological procedures

A multiple-contrast case study methodology was adopted, which provides better variance along the relevant dimensions (Seawright & Gerring, 2008). Each case was carefully selected so that individual case studies predicted contrasting results, but which, for predictable reasons, involved a theoretical replication (Eisenhardt, 1989; Yin, 2018). The extreme variation cases allow us to obtain information about the significance of the variation in case circumstances regarding processes and outcomes (Flyvbjerg, 2006).

3.1 Case selection

Case selection followed a two-stage process. In the first stage, a set of eligibility criteria were applied as follows: a startup had to be formally registered and active, have a defined product, be engaged in an incubation program, have received investment or grants and offer a product incorporating ICT components.

The second stage used theoretical sampling to provide a contrasting set of cases along two dimensions: the founders' level of ICT knowledge (i.e. high or low) and the mode of ICT resource use (i.e. in-house or outsourced). These dimensions were chosen to examine how different combinations of founders' knowledge and development strategy shape startup performance through EB and FI. The design draws on established case-study guidance: Yin (2018) notes that selecting cases for theoretical replication is essential for identifying patterns and generalizations in qualitative studies, while Eisenhardt (1989) argues that deliberately varying the selection criteria strengthens a study's capacity to build robust theory. Flyvbjerg (2006) further emphasizes that well-conducted case studies yield an in-depth, well-founded understanding of complex phenomena even with a small number of units of analysis, while Patton (2002) observes that a contrasting approach such as the one used here is well-suited to capturing the nuances of multidimensional phenomena. To examine the effect of founders' ICT knowledge and development strategy (in-house versus outsourced) on startup performance, potential cases were identified through startup databases, incubators, accelerators and ecosystem networks, with preliminary inquiries to confirm data availability and willingness to participate.

Based on these criteria, four distinct cases were identified to capture these variations (Table 1). *Case 1*: Agritech represents startups whose founders have high ICT knowledge and use in-house ICT resources; *Case 2*: Healthtech includes startups with high ICT knowledge but relies on outsourced ICT resources; *Case 3*: Proptech comprises startups whose founders have low ICT knowledge and use in-house ICT resources; and *Case 4*: Traveltech comprises startups with founders having low ICT knowledge and relying on outsourced ICT resources. This choice ensured a balanced comparison across the different configurations of ICT knowledge and resource utilization strategies. We justified the sample size based on the principle of information power (Malterud, Siersma, & Guassora, 2016), which emphasizes the richness of pertinent data over comprehensive coverage. In this study, the four cases offered substantial information power owing to the focus of the study and the specific characteristics of the participants. By concentrating on founders who possess distinctive historical and strategic insights, we achieved sufficient depth to thoroughly investigate how technical knowledge influences innovation strategies, without requiring a larger sample.

Table 1. Selected cases

Case	Industry	Business model	Interviewed	Founders	Team	Foundation date	CTO
Case 1	Agritech	B2B	Founder and CEO	1) Electrical engineer 2) Telecommunication engineer	6	2013	Founder
Case 2	Healthtech	B2B2C	Founder and CEO	1) Production engineer 2) Electrical engineer 3) Electrical engineer and master's in system engineering	9	2020	Founder
Case 3	Proptech	B2B2C	Founder and CEO	1) Architect 2) Architect	15	2017	Partner
Case 4	Traveltech	C2C	Founder and CEO	1) Production engineer and PhD in production engineering 2) Advertising and 3) Administration	3	2020	Absent

Note(s): CEO (Chief Executive Officer) and CTO (Chief Technology Officer)

Source(s): Interviews and secondary data (authors)

3.2 Data collection

Primary data were collected through semi-structured interviews with startup founders to ensure flexibility within a structured inquiry (Yin, 2018). The interviews were recorded, transcribed and analyzed. To enhance the reliability and validity of the findings, we implemented a member-checking procedure in which the participants reviewed preliminary interpretations to ensure factual accuracy and consistency (Pozzebon, 2018). Secondary data were used to enhance the construct validity through multiple sources (Yin, 2018; Ridder, 2017), including company documents, social media and industry reports. All the data were compiled into a research database for cross-referencing and reliability.

3.3 Data analysis

To ensure rigor and validity, we applied content analysis (Bardin, 2013) by using a theory-driven coding schema (Table 2). Triangulation of multiple data sources strengthens credibility and reliability as core themes aligned with theoretical constructs could be identified (Denzin & Lincoln, 2017; Yin, 2018), thus ensuring methodological coherence. Atlas.ti software facilitated structured analysis and enhanced transparency and reproducibility.

In addition to the qualitative coding process, we incorporated a complementary quantitative step to classify each case across the theoretical dimensions of our framework. After each interview, the founders completed a structured survey covering four key dimensions, namely ICT knowledge (two items; Yu & Wang, 2021), EB (nine items; Davidsson, Baker, & Senyard, 2017; Santos *et al.*, 2020), FI (ten items; Rossetto *et al.*, 2023; Santos *et al.*, 2020) and startup performance (five items; Wiklund and Shepherd, 2003, 2011). The full wording of the survey items and their response scales is presented in Appendix A. The comparative subjective evaluation of performance proposed by Wiklund and Shepherd (2003, 2011) is particularly appropriate for early-stage and resource-constrained startups, where standardized objective performance indicators are rarely available or comparable. All instruments used 5-point Likert-type scales to generate standardized indicators for each construct.

To operationalize the intensity of each construct, we defined explicit classification criteria derived through triangulation of the quantitative and qualitative data, following a three-step procedure detailed in Appendix B (Tables B1 and B2).

Table 2. Summary of categories

Construct	Definition	Categories	Subcategories	References
Knowledge	Prior technological knowledge is particularly valuable for expanding the pool of knowledge to identify a wider variety of opportunities (Marvel <i>et al.</i> , 2020)	Education Experience	Graduation and post-graduation ICT work experience	Marvel <i>et al.</i> (2016)
Bricolage	Making combinations of available resources applied to new problems and opportunities (Baker & Nelson, 2005)	<i>Improvise</i> with what is available <i>Create something from nothing</i> through improvisation, combining features in new purposes and using available resources	Reuse Improvise	Baker and Nelson (2005), Fisher (2012)
Frugal innovation	Products, services, technologies and business models that are financially accessible, ecologically responsible and continue to provide technological excellence (Herstatt & Tiwari, 2020)	Cost reduction Focus on main functionalities Sustainable co-creation	good and cheap products/services Resource optimization in the operational process Central functionality Ease of use Durability Social Environmental Local partnership	Tiwari and Herstatt (2012), Weyrauch and Herstatt (2016), Rossetto <i>et al.</i> (2023) Weyrauch and Herstatt (2016), Rossetto <i>et al.</i> (2023) Herstatt and Tiwari (2020), Rossetto <i>et al.</i> (2023)
Startup performance		Relative performance	Sales increasing Customer satisfaction Product/Service quality Product/Service innovation Process innovation	Wiklund and Shepherd (2003), Wiklund and Shepherd (2011)
Source(s): Authors' own work				

First, a quantitative assessment was conducted wherein founders completed a self-assessment survey using 5-point Likert scales (1 = strongly disagree to 5 = strongly agree). For bricolage and FI, mean scores were preliminarily classified as high (above 4.0), low (below 3.0) and medium (intermediate values). Performance, on the other hand, was scored according to its original comparative assignment on the competitor-referenced scale (i.e. ranging from much lower to much higher) as follows: “much higher” indicates that founders consistently rated their venture above competitors across the performance items, which was corroborated by interview evidence, whereas “medium” (score = 3) indicates performance perceived as on par with competitors. As for the operationalization of ICT knowledge specifically, this study used objective criteria to categorize it as high or low based on human capital literature (Marvel, Davis, & Sproul, 2016). High ICT knowledge was defined at the founding-team level as at least one founder possessing formal academic

education in Engineering, Computer Science, Information Systems or equivalent (undergraduate level or higher) combined with extensive professional experience (more than ten years) in ICT development or management. Low ICT knowledge was defined as the absence of both formal technical education and ICT work experience among the founders. Within the high category, we further distinguished the nature of the knowledge as development (i.e. direct involvement in building technological solutions, Cases 1 and 3 after Chief Technology Officer (CTO) entry) or governance (i.e. specification and management of technological solutions, Case 2), a distinction emerging from the coded transcripts and proved theoretically consequential for the bricolage analysis.

Second, these scores were qualitatively validated by cross-verification against the coded interview transcripts. For instance, a high classification for bricolage required not only a high survey score, but also specific narrative evidence of resource recombination, such as repurposing of mobile hardware (Case 1). Finally, a divergence resolution was applied to address these discrepancies. In Case 2, for example, although ICT knowledge was rated as high, the bricolage classification was adjusted to low values because the qualitative evidence explicitly indicated a strategic preference for outsourcing (i.e. “buy, not build”) over improvisation, thus superseding the theoretical potential for bricolage. This triangulated procedure provided a rigorous, empirically grounded basis for the categorizations presented in Table 3, ensuring methodological transparency regarding the definitions of intensity levels.

4. Results

4.1 Case 1: Agritech

Agritech, founded in 2013, uses computer vision for B2B counting systems in agribusiness. The solution does not require complex installation, which enables easy product sorting. Established by two engineers with over 15 years of technology experience, the startup leveraged expertise in ARM-based software development to innovate by adapting mobile phones as a hardware platform.

Bricolage was key to the startup’s technology development, with the founders increasing their knowledge of Advanced RISC Machine (ARM) architecture to create a market for frugal solution. As F1 noted, “this feature significantly reduced chipset costs, leading us to adapt our product to this hardware, while using more powerful machines would have been easier with the existing solutions. So, our differential ended up being to do this on the ARM architecture top, which today is our differential, and we ended up taking one step forward, aiming at the low cost without a doubt.” Bricolage enables cost-effective innovation by leveraging ARM platforms from Android mobile phones, as exclusive hardware is too costly. The founders used

Table 3. Summary of the case study outcomes

	Case 1 Agritech	Case 2 Healthtech	Case 3 Proptech	Case 4 Traveltech
ICT knowledge	Founder (development)	Founder (governance)	Partner (development)	Absent
Bricolage	High	Low	High	Low
Frugal innovation – cost reduction	High	High	High	Low
Frugal innovation – focus	High	High	High	Low
Frugal innovation – sustainable co-creation	High	High	High	Low
Performance	Much higher	Medium	Much higher	Medium
Source(s): Authors’ own work				

their expertise to modify their phones for the final product, allowing flexibility in meeting custom demands. This approach has led to two new products: showcasing adaptability and resourcefulness. As F1 stated, “reuse the technology by making small adjustments to serve completely different markets”.

Evidence showed that FI contributed to the startup’s success by reducing costs, allowing access to niche markets and smaller clients overlooked by expensive solutions. F1 emphasized a focus on high-quality, affordable products to maintain a healthy cash flow: “A software that will generate the maintenance that makes it impossible for you in the medium-long term. So, without a doubt, we think about this a lot when we think about both current and new products in our company.” With regard to cost reduction in the operational process, “all our projects left the drawing board already with this in mindset”. Moreover, the founder highlighted the need for cost-efficient resource use to sustain profits and cover initial investments. Owing to challenges in hiring senior developers, the founder took on the role of Chief Executive Officer (CEO) and delegated sales to new employees.

FI also demonstrated that they are doing the basics to generate the value the client seeks and then thinking about features that generate secondary values “Basic first, then the features that add value.” F1 highlights the quick deployment without needing a technician and software ergonomics tailored for agribusiness clients and designed as “a solution most simply and practically possible, with few screens and interactions.” In addition, the startup addresses electronic waste by partnering with local companies for proper disposal, reflecting the FI’s focus on sustainable co-creation.

F1 stated that startups excelled in sales, quality and innovation, showing that employing bricolage and FI enhances their performance. Plans are underway to expand internationally with two key clients and enter the Chinese market. Despite being an innovative lead, the founder fears a decline in competitiveness without adequate investment in global sales growth.

4.2 Case 2: Healthtech

Founded in 2020, Healthtech is a company using wearables and cloud platform for early health risk detection in a B2B model. Led by three engineers with over 15 years of experience, it follows a “buy, not build” strategy, focusing on ICT expertise in project governance. Although outsourcing was essential for diverse expertise, F2 noted the potential benefits of more insourcing.

Case 2 presents low evidence of bricolage practice, as F2 stated, “we should do more of this in the development of products and services to find viable solutions to new challenges by using our existing resources, because in fact whenever something new or a new situation appears, we tend to seek new resources to try to solve this”. The startup relies exclusively on human resources to analyze and learn new requirements and market regulations when addressing new problems or opportunities.

With regard to frugality, startups have substantial cost-reduction characteristics, focus on main functionalities and sustainable co-creation in the product and service development strategy. F2 stated that startups always seek to formulate cheap and affordable products by seeking to have “a very efficient operational process at more optimized costs”. The founders’ prior ICT knowledge and experience help support decisions and strategic planning to manage organizational and human resources, thus achieving operational efficiency. This evidence points to the characteristics of substantial cost reduction in FI.

F2 believes that the startup’s focus resides in its core functionality. Moreover, he considers the product/service ease of use an “Achilles’ heel” of technology adoption, such as the startups, “because it may seem intuitive and useful but, if it is not simple, the customer will not use it”. Given the rapid obsolescence of hardware, the startup focuses on ensuring durability through services.

The startup contributes to environmental sustainability by adding efficiency to health data use, thus reducing displacement and eliminating repetitive examinations. Additionally, as

hardware is delivered on a loan-for-use basis, environmental sustainability in the operational process is achieved through responsible disposal.

According to F2, Case 2's performance matches that of its competitors, except for product quality, as its scientific foundation provides superior results. Positive customer feedback has highlighted the maturity of the solutions used, with innovation being focused on reducing process and operational costs for better efficiency.

4.3 Case 3: Proptech

Founded in 2017 by two architects without ICT experience, this Proptech company aims to democratize decoration by reducing project time and costs. After four years, an ICT supplier joined as CTO. Despite the lack of ICT expertise, this startup differentiates itself by leveraging technology, founder knowledge and resource bricolage to automate project creation by using basic software, questionnaires and database. According to F3, the goal has always been to deliver high-quality, affordable decoration projects and to optimize technology to reduce costs and execution time. "So today our idea is to increase the number of projects without having to increase the team," the founder said.

F3 views the startup's performance as superior to its competitors, except for comparable sales growth, noting that there is a need for more effective marketing. Product quality and customer satisfaction, measured by the Net Promoter Score, are considered significantly better. With regard to product innovation, the founder reported that innovation lies in "technology in relation to competitors, being by far something we have that they do not." Process innovation is seen as superior to competitors because of the startup's technology-based business model, which enables disruptive solutions to reach both local and national markets.

4.4 Case 4: Traveltech

Traveltech was founded in 2020 by an advertiser, an administrator and a PhD in production engineering. The solution aims to connect adventure experience providers to the final customers in a B2B2C model. The Case 4's value proposition relies on mobile solutions such as a procurement platform. The founders outsourced development as they lack ICT knowledge, which F4 found "traumatic due to delays, poor service, and high costs," thus negatively impacting their startup's performance.

Startups struggle to solve problems and address new issues by relying on bricolage with the founders' knowledge and external resources. This promotes careful evaluation rather than quick actions as there is a struggle to integrate resources for diverse challenges, with credit often having the opposite effect.

Case 4 minimally applies frugality to its product and service development by cutting costs and prioritizing local suppliers within budget limits over costlier options from developed regions. However, due to technical issues related to the founders' lack of ICT knowledge, resource optimization has been deprioritized. According to F4, partnerships with local service providers are essential to the B2B2C model.

According to F4, the startup's performance is "comparable to that of competitors" in terms of sales and product quality, although customer satisfaction has not yet been evaluated and innovation is considered superior. Both the startup and its competitors face ICT-related challenges. Despite this, F4 sees innovation in applying technology to adventure tourism. Although the COVID-19 pandemic impacted tourism, Case 4 was unaffected as its solution was not widely functional.

5. Discussion

The four selected cases show an interaction between ICT knowledge, FI, EB and startup performance. The founders' ICT knowledge, guided by product development strategies, is

summarized in [Table 3](#). In Case 1, the founder's knowledge accelerated the development of the minimum viable product, prototyping and pivoting. ICT knowledge facilitates the orchestration of existing resources, in addition to solving related problems. The founder's ICT knowledge is an enabling input ([Niroumand, Shahin, Naghsh, & Peikari, 2020](#)), which helps recognize opportunities and new uses for the technologies available and accessible to startups in a resource-restricted environment. High EB and FI were found to result in much higher perceived performance.

While Case 1 demonstrates how ICT knowledge can directly amplify bricolage and FI, Case 2 reveals a contrasting dynamic, in which strong ICT knowledge does not necessarily translate into bricolage practices. Although the founder does not act directly in the development in Case 2, his expertise is essential for more efficient choices and correct answers. In this case, EB was not evidenced as an action element, but still had a high FI, resulting in performance (medium) comparable to that of competitors. In Case 2, we see a clear absence of bricolage, despite the founders having a strong knowledge of ICT. This highlights the tension between technical skills and ability to improvise. We found that Case 2 explicitly adopts a strategic governance model based on outsourcing and acquisition of resources instead of recombining internal ones. This mindset is the opposite of that required for bricolage. Bricolage depends on the principle of "making do with what is at hand" ([Baker & Nelson, 2005](#)), whereas Case 2's founders adopt a logic based on resource expansion rather than on resource recombination. Therefore, bricolage does not emerge because the strategic posture relies on a non-bricolage design. Even though the founders have the potential to creatively combine resources as suggested by bricolage theory ([Baker & Nelson, 2005](#)), their strategic focus leans toward a "buy, not build" mentality. Notably, the ICT knowledge present in Case 2 was of the governance type as the founders specified, evaluated and managed the outsourced development process, whereas in Cases 1 and 3, it was hands-on development knowledge applied directly to recombination. In this sense, absence of bricolage in Case 2 reflects both boundary conditions simultaneously: knowledge type and resource-acquisition orientation. Therefore, this case illustrates that although having ICT knowledge is important, it is not sufficient to foster bricolage. Factors such as organizational strategy, institutional constraints and founders' professional attitudes can hinder its implementation, creating a gap between what they are capable of and how they operate.

This pattern supports the conditional form of [Proposition 2](#): Case 2 achieved high FI through disciplined product architecture, outsourcing and cost-efficient governance rather than through bricolage. However, its perceived performance was only comparable to that of competitors (medium). This result suggests that FI without bricolage does not allow for the same performance observed among the frugal geeks in Cases 1 and 3, who recombine resources internally. Therefore, superior performance appears to depend on the interaction between ICT knowledge and bricolage rather than on ICT knowledge alone.

As for Case 3, its growth suffered due to difficulties and lack of ICT skills in the early stages. However, the inclusion of a partner with high knowledge accelerated the processes and boosted performance, with the startup presenting high EB and FI scores in subsequent years as such knowledge was available and convenient to use ([Dost et al., 2019](#)). The lack of EB and ICT knowledge in Case 4 resulted in technological development barriers. Difficulties in specifying and negotiating with outsourced developers impacted the capability to innovate, resulting in low EB and low FI scores and consequently in medium performance comparable to that of competitors.

Cases 1 and 3, whose founders and partners have ICT knowledge, showed that although they initially planned to build a simple and easy-to-use product in the product and service development strategy ([Hossain, 2018](#); [Weyrauch & Herstatt, 2016](#)), they were also able to meet the customers' needs with quality and durability, even with additional functionalities in mind. In addition, their statements in the interviews suggest that they have concerns about social and environmental requirements ([Sarkar & Mateus, 2022](#)), including the disposal of

technological equipment. According to the founders of these companies, hiring local suppliers is a stand-out strategy (Pisoni *et al.*, 2017).

For Cases 1 and 4, the relevance of ICT knowledge was presented in opposite ways. While F1 presented ICT knowledge as an antecedent to FI, which is key to competitive advantage, F4 pointed out that the absence of a CTO has affected the outsourcing process of application development, which was inefficient for the startup. The gap in ICT knowledge between founders and partners has an impact on the startup performance and can be explained by agency theory as information asymmetry (Eisenhardt, 1989), which results in additional transaction costs (Coase, 1937) for the startup. The startup strategy's use of ICT knowledge appears to differentiate Cases 1 and 3, contributing to better results and serving as an antecedent to EB and FI. On the other hand, the outsourcing strategy used in Cases 2 and 4 made it difficult to create EB and frugality in product development innovation strategies.

The analysis of these four contrasting cases allows for a systematic evaluation of the propositions advanced in this study. Drawing on the logic of theoretical replication, the evidence confirms all four propositions, although with nuances reflecting differentiated configurations of ICT knowledge, bricolage capacity and FI across the startups examined.

The first proposition states that founders' ICT knowledge enhances their ability to innovate with limited resources. These cases provide strong support for this proposition, as shown in Table 4. The Agritech and Healthtech cases exhibited high levels of FI, which was directly associated with the founders' technical backgrounds. Their ICT knowledge enabled strategic decisions regarding system architecture, reuse of existing technological components, cost-efficient development practices and simplified product configurations aligned with frugal principles. Similarly, in the Proptech case, FI was strengthened after the incorporation of an ICT-trained CTO, demonstrating the catalytic effect of internal technical expertise on frugal capabilities. In contrast, the Traveltech case, whose founders lacked ICT knowledge, showed a limited ability to develop frugal solutions and remained dependent on external providers. This comparative pattern indicates that FI flourishes when founders possess ICT knowledge and is inhibited when such expertise is absent.

The founder's ICT knowledge enables companies to innovate with limited resources (FI), thus supporting our first proposition. All cases analyzed demonstrated direct or indirect evidence of previous knowledge on the capacity to innovate with limited resources in a scarce environment (Weyrauch & Herstatt, 2016).

The second proposition argues that ICT knowledge expands the founder's repertoire of bricolage. This relationship was also confirmed, although the cases revealed that ICT knowledge is a necessary but insufficient condition for bricolage behavior. In the cases of Agritech and Proptech, technical knowledge facilitated the creative recombination of existing digital components, adaptation of low-cost hardware and rapid experimentation – all hallmarks of bricolage. Interestingly, Healthtech offers an important nuance: although the

Table 4. Summary of ICT knowledge and FI strength

Case	ICT knowledge	FI strength	Empirical evidence
Case 1 – Agritech	High	High	ARM-based reuse and low-cost hardware adaptation enabled by ICT expertise
Case 2 – Healthtech	High	High	Lean processes and cost-efficient product design informed by technical literacy
Case 3 – Proptech	Initially low; later high	High	FI was strengthened after the entry of an ICT-skilled CTO
Case 4 – Traveltech	Low	Low	Lack of technical expertise inhibited frugal innovation

Source(s): Authors' own work

founders possessed ICT knowledge, they preferred to acquire new resources rather than recombine existing ones. Still, they recognized that bricolage was feasible, reinforcing the idea that ICT knowledge expands the possibilities for bricolage, even if it does not ensure its practice. Meanwhile, Traveltech demonstrated minimal bricolage capacity as founders were unable to adapt or integrate technological components independently as they lacked ICT expertise. Table 5 presents the evidence of the relationship between ICT knowledge and bricolage levels in each case.

Founders’ ICT knowledge supports the exploration of new possibilities and resources for FI, thus reinforcing our second proposition. All startups relied on ICT resources for their innovations by identifying or combining appropriate resources, thus contributing to low-cost, high-value FIs.

The third proposition claims that greater bricolage capacity increases FI. This proposition was confirmed in all cases, as shown in Table 6. Both Agritech and Proptech startups demonstrated that high bricolage capacity is closely associated with strong FI outcomes, which is an important qualification. These firms leveraged improvisation and resource recombination to achieve substantial cost reduction, functional simplification and rapid prototyping. Conversely, Traveltech demonstrated limited frugal innovations due to its minimal bricolage. Healthtech represents an exception as, despite its low level of bricolage, it achieved high levels of FI through architectural discipline and cost-efficient governance. Therefore, while bricolage remains a powerful pathway to frugality, it is not the only one as FI may also emerge through managerial choices that emphasize operational streamlining.

Entrepreneurs’ bricolage behavior allows for a greater ability to innovate frugally (Chatterjee *et al.*, 2021), which supports our third proposition. The capacity to explore existing resources by creative and innovative ways in order to use the resources available to create something contributed to boosting the FI level of the startups (Sarkar & Mateus, 2022).

Table 5. Summary of ICT knowledge and bricolage level

Case	ICT knowledge	Bricolage level	Empirical evidence
Case 1 – Agritech	High	High	Creative recombination of ARM systems and mobile hardware
Case 2 – Healthtech	High	Low	ICT knowledge present, but bricolage not practiced, though acknowledged as viable
Case 3 – Proptech	High (after CTO)	High	ICT expertise stimulated experimentation and recombination
Case 4 – Traveltech	Low	Low	Absence of ICT knowledge inhibited bricolage
Source(s): Authors’ own work			

Table 6. Summary of the levels of bricolage and FI

Case	Bricolage level	FI level	Empirical evidence
Case 1 – Agritech	High	High	Resource recombination enabled cost reduction and rapid prototyping
Case 3 – Proptech	High	High	Reuse of digital components supported frugal outcomes
Case 2 – Healthtech	Low	High	FI was achieved through governance rather than bricolage
Case 4 – Traveltech	Low	Low	Absence of bricolage corresponded to limited FI
Source(s): Authors’ own work			

The fourth proposition posits that the combination of ICT knowledge, bricolage capacity and FI leads to superior startup performance. The comparative evidence strongly supports this proposition. As the cases of Agritech and Proptech demonstrated high levels of ICT knowledge, bricolage and FI, they reported the strongest performance. Their technical expertise enabled the effective governance of technological choices, bricolage facilitated the adaptation of available resources and FI produced cost-efficient solutions that strengthened their competitiveness. In contrast, Healthtech demonstrated only moderate performance owing to its limited bricolage capacity despite achieving FI. Traveltech, with its low levels of ICT knowledge and bricolage, also showed moderate rather than superior performance. These results indicate that FI alone is insufficient to ensure high performance and that the synergistic interaction between ICT knowledge and bricolage is essential.

Finally, Table 7 presents the combined effects of ICT knowledge, bricolage behavior and FI as key drivers of superior performance, thus supporting Proposition 4. ICT knowledge is essential not only for enabling bricolage, but also for expanding the range of feasible resource combinations that underpin FI in constrained environments.

6. Conclusions

This study investigated how a founder's knowledge on ICT influences the startup performance in resource-constrained emerging markets. Specifically, we sought to understand the mediating roles of EB and FI in this process by using the KBV as a theoretical lens.

The findings reveal that ICT knowledge is a fundamental enabler of FI but does not guarantee it. The contrasting-case analysis demonstrates that superior startup performance is achieved only when ICT knowledge is paired with a bricolage mindset, that is willingness to actively recombine and repurpose existing resources. Founders who possessed technical knowledge but opted for outsourcing (i.e. governance model) achieved valid innovations but failed to reach the superior performance levels of the frugal geeks who built solutions in-house by using improvised resources.

This study contributes to academia in three ways. First, it extends the KBV approach to the context of FI, demonstrating that founder-level knowledge is the micro-foundation of firm-level frugality. Second, it refines the bricolage theory. Contrary to the assumption that knowledge automatically breeds improvisation, we showed that strategic orientation acts as a boundary condition: highly knowledgeable founders may deliberately choose *not* to bricolage, thus impacting the frugality of the outcome. Third, it problematizes the construct of ICT knowledge itself. The cases reveal that formal education and professional experience capture the possession of knowledge, but not its mode of application as development-type knowledge enabled recombination, whereas governance-type knowledge enabled efficient acquisition. This suggests that KBV studies of innovation under constraint should treat knowledge type rather than knowledge level as a theoretically relevant dimension, thus opening an agenda on how differently acquired and differently applied ICT knowledge shapes frugal outcomes.

Table 7. ICT knowledge, bricolage, FI and performance relationship

Case	ICT knowledge	Bricolage	FI	Performance
Case 1 – Agritech	High	High	High	Much higher
Case 3 – Proptech	High	High	High	Much higher
Case 2 – Healthtech	High	Low	High	Medium
Case 4 – Traveltech	Low	Low	Low	Medium

Source(s): Authors' own work

6.1 Managerial implications

For practitioners, this study offers a clear directive: internalizing technical skills. Founders relying on outsourcing (Case 4) struggled with the costs and agility. We suggest that non-technical founders in emerging markets should prioritize bringing a CTO on board (as seen in Case 3), not just for coding but to enable the resourcefulness required to survive. For investors, the presence of a frugal geek as a founder who can hack solutions from limited resources should be viewed as a key predictor of resilience and performance.

6.2 Study limitations

The primary limitation of this study is its reliance on founders' self-reported perceptions of performance, which may be subject to cognitive biases. Additionally, although the four contrasting cases provide information power for the proposed framework, the findings are contextually bound to the Brazilian ecosystem and may not be statistically generalizable to all emerging markets. Moreover, although the cases contrast by design in sector, ICT knowledge and bricolage levels, they remain contextually homogeneous: all four ventures were drawn from a single national ecosystem, share exposure to the same institutional environment and operate under similar resource-scarcity conditions. This restricted contextual diversity means that the patterns observed may reflect configurations particular to the Brazilian startup environment rather than generalizable regularities. Consistent with the logic of theory building from cases (Eisenhardt, 1989; Yin, 2018), we therefore treat our propositions as analytically rather than statistically generalizable, that is candidates for testing in more diverse sectoral, institutional and geographic settings.

6.3 Suggestions for future studies

Future research should validate this framework quantitatively across a larger sample of startups to measure the statistical strength of the knowledge-bricolage correlation. Additionally, considering the rapid evolution of digital tools, scholars should explore how hybrid intelligence (Abbas *et al.*, 2025) and AI-driven platforms might substitute founder ICT knowledge in future low-code environments. Finally, we suggest broadening the scope of the KBV approach by investigating whether this frugal geek phenomenon persists in developed economies, where resource scarcity is less acute, but efficiency remains critical.

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Supplementary material

The supplementary material for this article can be found online.

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