



Frugal innovation in the midst of societal and operational pressures

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ABSTRACT

To respond to both global sustainability challenges and grassroots level needs in emerging markets with innovative solutions, firms need the capacity to operate under societal and operational pressures and skills to blend local knowledge with other forms of expertise. Frugal innovation considers societal and operational challenges as starting points for innovative solutions that could serve as drivers of sustainable development. Prior research, however, has done little to understand firm level requirements to set-up a frugal innovation-based business. In this article, we established a link between frugal innovation and the sustainable business model concept. More specifically, the research questions are: 1) How do societal and operational pressures together influence business activities and 2) how can these pressures be assessed analytically? We present an analytical framework that can be used in assessing frugal innovations for long-term sustainability and we demonstrate the functioning of the framework with the empirical analysis of three case firms. Our findings show that the sustainability outcomes of frugal innovations often depend more on their business models than on their technological innovativeness. We point out that positive sustainability outcomes may become possible when the societal sustainability concerns and the operational concerns become interlinked activities in specific business model elements.

1. Introduction

Economic growth is leading to increased consumption opportunities in the Global South and this increased demand for new goods is worsening global sustainability challenges, such as biodiversity loss and climate change. This development is forcing scholars and practitioners to rethink the role of businesses as societal change-makers (Agnihotri, 2015; Brandt et al., 2013). *Frugal innovation* has appeared as a way for businesses to tackle societal sustainability problems while remaining profitable at the same time (Radjou and Prabhu, 2014). Frugal innovation is defined as a novel offering that is radically more resource-efficient than current alternatives and still accessible and user-friendly especially to low-income customers (Hossain, 2018; von Janda et al., 2020). When developing frugal innovations, societal sustainability challenges and operational constraints are typically the starting point for the innovation process (Hossain, 2020; Zeschky et al., 2014). Exploring sustainability aspects from the perspective of frugality helps to understand the interlinkages between societal and operational concerns.

In practice, frugal offerings are novel products or services that help

to address long-term problems, such as poverty and inequality (Bhatti et al., 2018), and more rapidly emerging threats, such as the COVID-19 pandemic or a local natural disaster (Vesci et al., 2021). In addition to resource efficiency, frugal innovations typically bring about improved local resilience and rapid scalability (Corsini et al., 2020). Frugal innovations are often developed and used by grassroots actors (Hossain, 2016; Pansera and Sarkar, 2016) who have a low-income background, with little formal education, but with significant traditional and practical knowledge to develop innovations (Pansera and Sarkar, 2016; Wierenga, 2020). Frugal innovations are often seen as disruptive in nature (Rao, 2013; Rosca et al., 2017) and they typically diffuse between countries with similar socio-economic conditions (Hossain et al., 2016).

Empirically, it is known that frugal innovations have the potential to generate positive sustainability implications (Albert, 2019; Howell et al., 2018; Levänen et al., 2016). However, we still lack theoretical understanding about how these implications could be strengthened in a systematic manner and replicated in different localities (Ratten, 2019). Frugal innovation has also been criticised for being a technical concept which does not address the root causes of the societal problems these innovations claim to address (Pansera, 2018). In this article, we aim to

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unpack this complexity by assessing the potential of frugal innovation-based businesses in the midst of societal and operational pressures. We pose the following two research questions: 1) *How do societal and operational pressures together influence business activities* and 2) *how can these pressures be assessed analytically?*

Despite the promise for social change connected to the frugal innovation phenomenon, the idea that this type of innovating would automatically contribute to solving societal sustainability challenges seems too simplistic as the reality in and for which frugal innovations are developed, is profoundly complex. Given this contested nature of frugal innovations, their exploration should begin from a multi-dimensional perspective that simultaneously considers both societal and operational implications (Leliveld and Knorringa, 2018), which is not sufficiently addressed in the existing literature.

We approach the sustainability potential of frugal innovation-based businesses with *sustainable business model* concept. A business model is a conceptual representation of how a firm aims to conduct business in a certain operational and institutional environment (Boons and Lüdeke-Freund, 2013; Levänen et al., 2018; Zott and Amit, 2010). Research on sustainable business models – as a sub-stream of business model research – considers the societal and environmental value that firms produce for their customers and other stakeholders in addition to typically considered economic value (Evans et al., 2017; Stubbs and Cocklin, 2008). This thinking is also closely linked to discussions about shared value creation and triple bottom line as strategies to address diverse societal concerns as part of business development (Govindan et al., 2013; Keränen, 2017; Porter and Kramer, 2011).

The sustainable business model conceptualisation helps to understand how societal pressures can be integrated into the operational management of a company (Bocken et al., 2014; Lüdeke-Freund and Dembek, 2017). We present an analytical framework that can be used in assessing sustainability implications of frugal innovations, demonstrate the functioning of the framework through three case firms founded by innovator-entrepreneurs from the grassroots level and conclude that a truly sustainable frugal innovation is not only technologically sound but is also accompanied by a business model that suits the operational environment. For frugal entrepreneurs, business model development can be a more challenging task compared to the development of a product or service innovation (Michaelis et al., 2020).

The rest of the article is structured as follows. Next, we will introduce societal and operational pressures that the development of frugal innovations faces and an analytical framework for depicting such pressures. After that, we present our methodology and data. Thereafter, we demonstrate the functioning of the framework by analysing case firms. In the discussion section, we reflect on our theoretical contributions and the value of the framework. The article ends with conclusions.

2. Complex pressures toward frugal innovation

All firms struggle with operational pressures. However, due to the aim to address sustainability challenges, developers of frugal innovations must simultaneously cope with both societal and operational pressures. This notion adds complexity to the studies concerning frugal innovations because sustainability is a multidimensional, contradictory and politically sensitive objective (Escobar, 2012). The broad scope of sustainability-related activities becomes evident for example in 17 Sustainable Development Goals (SDGs) by the United Nations, which contain objectives from peace and justice to industrial development and responsible consumption. Therefore, addressing both societal and operational pressures simultaneously with business-based solutions requires continuous balancing between multiple, often conflicting aims.

Critical perspectives on the frugal innovation phenomenon typically focus on the core concepts of sustainability and development. It has been pointed out that despite their original intentions, frugal innovations may end up strengthening unequal power structures and marketing models that are socially or environmentally harmful at the local level (Pansera,

2018). Thus, while addressing some of the pressing societal problems, frugal innovations may also maintain the root causes of many such problems. We consider this criticism of frugal innovation phenomenon especially relevant in the Global South, where consumption of previously inaccessible products and services are growing rapidly (Levänen et al., 2020). The scholarly communities must acknowledge that if business models associated with frugal innovations do not proactively facilitate sustainability, they might contribute to creating additional societal problems (Bocken and Short, 2021).

2.1. Sustainability as a business target

The triple bottom line, which differentiates between social, environmental and economic impacts of a firm, can be utilized to assess the sustainability of various goods (Jouzdani and Govindan, 2021). The key challenge for businesses is to aim for positive impact in a complex operating environment (Govindan et al., 2013). In an attempt to unpack this complexity, we direct our analytical scope to the societal and operational pressures of particular frugal innovation-based business. By *societal pressures* toward frugal innovations we mean grand sustainability challenges, such as social inequality, environmental problems and economic imbalances (George et al., 2016). *Operational pressures* refer to a firm's competitive position at a market (Schendel, 1994), potential negative externalities that may cause extra costs or other risks (Libecap, 2013), and market failures which may hamper a firm's strategic activities in a specific market (Liu et al., 2015).

Integrating societal sustainability concerns and coping with operational concerns form pressure towards the business model of a firm whose business is based on a frugal innovation. These pressures may hinder the achievement of sustainability-related objectives. On the other hand, it has also been suggested that especially at the grassroots level of emerging market countries, shared value creation and business model development can often be seen as interrelated activities (Sinkovics et al., 2014). We argue that with the help of innovatively created and functional business models, frugal innovations have the potential to address the various types of societal and operational pressures at the same time (see also Angeli and Jaiswal, 2016; Khan, 2016).

2.2. Sustainable business models for frugal innovations – an analytical model

While the relationship between frugal innovations and sustainable development has been identified (Pansera and Sarkar, 2016), the literature does not sufficiently address the requirements from firms to realize the sustainability potential of frugal innovations. To address that, the sustainable business model approach describes ways in which societal and operational concerns can be managed at the level of a single firm (Bocken et al., 2014). Business models are typically built around the elements of value proposition, value creation and value capture (Oskam et al., 2020; Zott et al., 2011). *Value proposition* describes the offering and the kind of customer value the proposed solution provides (Baldassarre et al., 2017). *Value creation* describes how the operations of a firm should be organised to create value (Hossain, 2016), and *value capture* describes how revenue is generated from such activities (McWilliams and Siegel, 2001). The sustainable business model approach explains how a firm may manage its business in certain markets in a sustainable way (Foss and Saebi, 2017; Volberda and Heij, 2017). The analytical framework developed in this study (Fig. 1) establishes a link between sustainable business models and pressures arising from the operational environment of frugal innovations.

Sustainability management can be understood as a capacity to create societal value in accordance with core business activities (Kottler, 2011; Vargo and Lusch, 2004). In line with the triple bottom line (Govindan et al., 2013), sustainability management often translates into aspects in *social, environmental* and *economic* dimensions (Fig. 1). Frugal innovation-based businesses are typically conducted in an environment

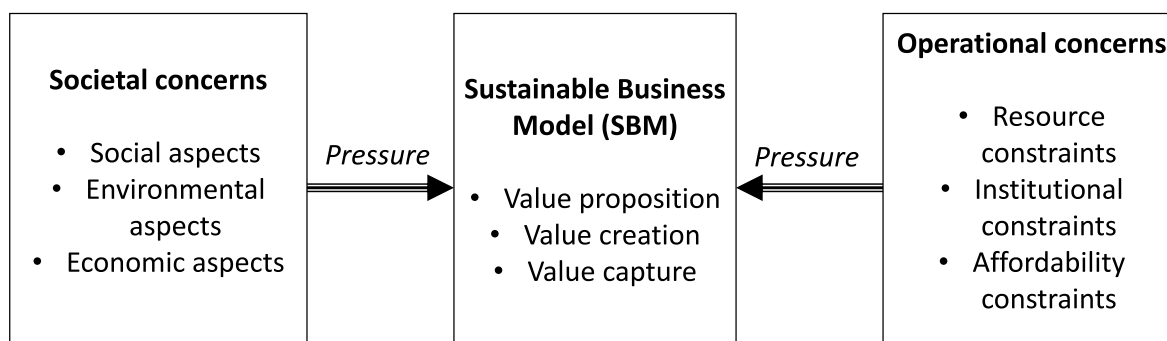


Fig. 1. The analytical framework.

characterised by operational pressures related to resource scarcity, market affordability and institutional issues (Bhatti et al., 2018). *Resource constraints* refer to the lack of critical resources, such as materials, energy and human workforce (De Massis et al., 2018; Härrri et al., 2020). *Affordability constraints* refer to social dynamics that prevent large population groups from accessing basic products and services that would improve their living standards and general wellbeing (Collier, 2007; Prahalad, 2012). *Institutional constraints* refer to socio-cultural and legal aspects that hamper operational business conduct or related innovation activities (Desa, 2012; Mair et al., 2012).

With the empirical analysis of case firms, we illustrate how the generation of positive sustainability outcomes may become possible when the integration of societal sustainability concerns and the operational concerns become interlinked activities in specific business model elements. In the following, we will first introduce the cases studied and then unpack the empirical analysis of this integration.

3. Materials and methods

In this section, we describe the empirical assessment of frugal innovation-based businesses. Studied case firms differ from each other in many ways, but also share certain similarities. The firms provided detailed information on interlinked constraints, business responses and sustainability outcomes in grassroots contexts. The core business idea of all three case firms is based on a frugal innovation and all of them operate in rural India – an epicentre of grassroots innovation (Gupta, 2016).

3.1. Case selection and data

We aimed at finding innovations that have market traction despite the challenges in their development. To identify appropriate cases, we conducted a comprehensive search on various online repositories, including a list of frugal innovation cases on the website of India’s National Innovation Foundation and public media archives. Finally, from a large number of cases, we narrowed the selection down to three relatively well-known firms. Three cases enable comparison between the cases without compromising the required depth in their analysis. The cases were selected because they can be considered frugal innovations: they have been developed in constrained environments with the aim of solving societal problems by providing affordable alternatives to customers who cannot afford conventional products or services. Table 1 provides an overview of the case firms, which we describe next.

3.2. The case firms

The first case firm, *MittiCool*, makes innovative clay products, including their flagship product, the clay fridge which costs about US \$80, keeps food and vegetables fresh for several days and does not need electricity to operate. In rural areas, the *MittiCool* fridge is also widely used to keep medical items at a specific temperature. The *MittiCool*

Table 1
Case firms.

Case	MittiCool	Ksheera Enterprise	Jayashree Industries
Established	2005	2003	2006
Ownership	Private	Private	Private
Headquarters	Gujarat, India	Karnataka, India	Tamil Nadu, India
Product	Clay fridge and other cooking tools	Low cost milking machine	Sanitary pad making machine
Units produced	50,000 (fridge)	10,000 (milking machine)	1,300 (sanitary pad making machine)
Product price (US\$)	80–100	150–315	2000–3500
Revenue per year	US\$ 30 000–70 000	US\$ 30 000–70 000	US\$ 50 000–100 000
Number of employees (approximate)	30	25	5
Machine life (years)	5	5–10	20

fridge can be considered a frugal innovation because it provides a low-cost alternative for the people who may not have access to electricity or cannot afford a conventional fridge. The firm was formally established in 2005, and it has about 30 employees.

The second case firm, *Ksheera Enterprise* (hereafter *Ksheera*), makes low-cost milking machines. These milking machines, branded as *Milk-master* and *Imilker*, can milk up to 2 L per minute, meaning up to 10 cows in an hour. *Ksheera* has three versions of their milking machine: a hand-operated model, a single-phase AC motor driven model and a 12-V battery-operated model. The prices of these machines range from US \$250 to US\$650. These milking machines can be considered frugal innovations because they offer affordable alternatives to cattle farmers who are milking their cows manually. The firm was established in 2003, and it has about 25 employees.

The third case firm, *Jayashree Industries* (hereafter *Jayashree*), sells low-cost sanitary napkin-making machines and the raw materials for making the napkins to individuals, NGOs and co-operative societies who can then produce and sell affordable sanitary pads to women in their localities. With this solution, *Jayashree* responds to the significant societal problem that over 88% of the 355 million menstruating women in India use unhygienic clothes, ash and husk to take care of menstruation. There are two models of the machine: a manually operated model (US \$2000) and a semi-automated model (US\$3500). *Jayashree*’s machines can be considered frugal innovations because they enable over 22,000 women to earn a livelihood and provide access to sanitary pads to more than a million women in India. Each sanitary pad entrepreneur has her own brand name for her sanitary pads, and there are at least 900 brand names. The firm was established in 2006, and it has five employees.

3.3. Data and analysis

We collected data on the business model development of the case firms from their genesis to the present time. Data for this study consists of thematic interviews, field observations and documentary materials. We conducted eight semi-structured interviews with the inventors of the products and managers of the three firms. All interviews took place face-to-face at the firm premises. Additionally, we had several face-to-face discussions with Professor Anil Gupta of the Indian Institute of Management in Ahmedabad. He is the founder or co-founder of organizations which had supported these firms in their early stages. These interviews served as background information and provided contextual understanding for us. To get in-field knowledge and to understand how the studied firms operate, we also visited the production facilities of the three firms. These visits provided us opportunities to observe the employees' work and the overall business environment. During the visits, all three firms demonstrated and explained the mechanisms of their machines and the functioning of their production processes.

As the firms are thoroughly discussed in the literature and public media, we were able to collect a large amount of archival data from online sources. We thus developed a comprehensive database of articles, reports, video clips and firm websites, which we saved in a temporary folder. Through archival data, field visits and on-site observation we were able to construct a comprehensive picture of the selected case firms.

The analysis followed the principles of abductive reasoning (Dubois and Gadde, 2002; Mantere and Ketokivi, 2013). Here the analytical process starts from the literature and the data, and the analysis is guided by the literature as opposed to a traditional grounded process where the data drives the analytical process. For example, as the literature has clearly indicated the business model items, it felt natural to follow these items in the analytical process. During the analysis we frequently revisited the literature and modified the analytical model as the data was informing and providing us with new insights.

4. Findings

In this section, we share the findings of the empirical analysis of the case firms, focusing on the key business model elements: value

proposition, value creation and value capture. The analysis highlights the diversity in the influences of constraints and societal issues addressed by the case firms. The analysis also shows the dilemmas entrepreneurs face when developing their business models and illuminates the complexity of the frugal innovation operational space. Findings are summarised in Fig. 2.

4.1. Notions on the value proposition

The main value proposition of all three firms is a unique low-price product or means of production with minimal features but with 'good enough' quality. With this value proposition, firms respond to the needs of poor people who live in rural areas and lack access to products or services that would improve their general living standards and well-being (point 1 in Fig. 2). This value proposition is closely connected to the potential to address health-related problems (point 2). Mitticool, for example, provides access to fridges for people who otherwise could not afford one, Ksheera provides more time for small-scale cattle farmers to focus on things other than the repetitive milking of their cows, and accessible sanitary pads made by Jayashree's machines improve women's menstrual hygiene.

Affordability that does not compromise the quality of the products is the cornerstone of this value proposition, and the strong commitment of the entrepreneurs to this is reflected in the words of the inventor of Jayashree: 'Do not tell me low-cost. It is customized at affordable cost. [...] If you sell something low, cheap, free, it will lead bad consequence. Nowhere in the world we should make men into low dignity or embarrassment by comparing low, cheap or free.' In a way, all other aspects of the firms' business models, including potential sustainability implications, are dependent on the price of the end-product or means of production. For example, the inventor of Mitticool explained their success, saying that 'these products marketed under the MittiCool banner are not only eco-friendly, sustainable and effective, but also very cheap.'

Often, people living in rural areas in emerging market countries do not have access to electricity due to its high cost or unavailability (point 7). Even if basic amenities of this kind were available, a great share of people could not afford using them due to their high and recurring costs. MittiCool and Ksheera respond to the lack of electricity with value propositions involving products that do not require electricity. In a

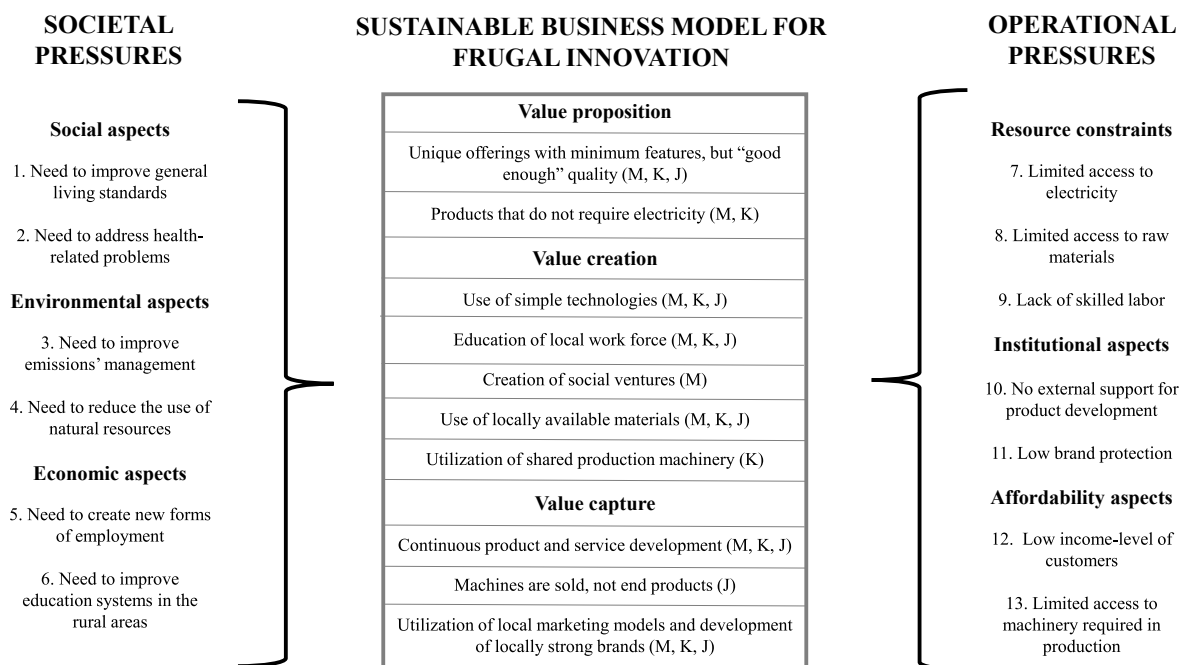


Fig. 2. Summary of findings (M = Mitticool, K=Ksheera, J = Jayashree).

MittiCool fridge, food stays cool through the circulation of water between two chambers through dripping and evaporation, which removes heat. The MittiCool inventor explained the importance of low recurring costs as follows: *'A good majority of Indians cannot buy a fridge as it is expensive. Besides this, electricity bills and maintenance costs are also high. MittiCool [fridge][...] has no maintenance costs.'*

Selling products that do not require electricity is connected to positive social and environmental implications. Avoiding the use of electricity makes it possible to improve emissions' management by avoiding emissions from energy production (point 3). In the studied contexts, as is the case for many rural areas in emerging market countries, energy is produced at least partly with kerosene or diesel generators that not only cause large amounts of CO₂ emissions but also particle pollution, which weakens the local air quality significantly. Decreasing the need for small-scale energy generators can thus have a major impact on air quality, which is again connected to numerous health benefits (point 2).

4.2. Notions on value creation

An important aspect of value creation in all three case firms is that they use simple technologies and locally available machinery and materials. Using simple technologies enables these firms to respond to resource-based constraints related to a lack of expertise in the high-end technology use (point 9) and affordability constraints related to limited access to costly production machinery (point 13). Using simple technologies often means that the machines are easy for local technicians to repair and maintain. This strategy has positive economic effects because it provides work opportunities (point 5) and increases the profitability of frugal innovation-based businesses through a locally efficient production model.

The firms also provide employment opportunities in areas where employment opportunities are scarce. This method of value creation responds to the lack of jobs, which is a significant institutional constraint, especially in rural areas. New forms of employment (point 5) mean new ways to earn income, which has both social and economic effects at the household and wider societal levels. For example, MittiCool has 30 employees working in its factory, and it has inspired about 1000 families towards similar production. Altogether, they send items to over a million users. Additionally, many people work indirectly for MittiCool as salespeople or suppliers.

In a similar manner, Ksheera has 25 employees, who are mostly former students of the inventor who served as a teacher in the local school. The human resource manager of Ksheera explained the challenges and related business activities concerning local employment as follows: *'Previously youngsters were going to cities for work. Now, many of them are happy to stay here in this locality, as there is an opportunity for them to work in our company.'* As in the case of MittiCool, many people also indirectly work for Ksheera. Jayashree, on the other hand, has few employees of its own, but the firm has created thousands of jobs with over 1300 sold machines. Each machine creates several jobs, mainly for women. The inventor of the company stated that these *'women in rural areas [would not] otherwise [...] have any source of income.'*

One form of value creation as a response to institutional constraints of the education system operates through philanthropy. In emerging markets, many families face difficulties in sending their children to school because of high school fees. MittiCool addresses these difficulties by paying the school fees and accommodation costs of poor students. The director of sales and marketing explained this activity as follows: *'We support students by providing their tuition fees and the students do not know who provides their tuition fees because they are told that they offered scholarship by the school.'* Because students do not know about this, they do not feel indebted to MittiCool. This kind of social initiative has positive effects on the whole community through an improved education system (point 6).

All three firms respond to the resource constraint of expensive or otherwise inaccessible materials (point 10) by utilizing locally available

cheaper materials. MittiCool uses local clay and husks in production, Ksheera uses locally available steel and plastic, and Jayashree uses diverse local materials, such as recycled iron. Furthermore, Jayashree encourages its clients to use local materials as the raw material for final products to replace the wood fibres that need to be exported from other countries such as the USA, Canada and Australia. The utilisation of local materials in production has positive environmental effects because it reduces the use of natural resources and enables the avoidance of emissions from the transportation of materials (point 3).

All three firms also optimise their costs throughout the innovation and production processes to fulfil the needs of low-income customers. Ksheera has created a value creation model that responds to affordability constraints preventing people in rural areas from accessing costly production machinery (point 13) by providing a machine that can be shared by several families. This model leads to increased availability of these machines among poor families with a lower price per family. This activity has positive economic implications because it serves as an efficient production model for local production.

4.3. Notions on value capture

All three firms respond to the diverse constraints in the operational environment with their value capture models. In emerging markets, there is typically no institutional support available for product development processes, which are carried out in individual firms (point 10). The case firms respond to this so that, alongside the actual production process, the owners continuously develop their offerings. Consequently, there are no separate product development and production phases, and thus everything is done at the same time. Typically, this requires a capacity for patient development work, as MittiCool's inventor explained: *'I started making them [the skilllets] and after me one and then two and then a lot of them also started making them. I started working on the fridge and stopped the production of the skilllet. As I was doing the research for five years the business remained closed and the kiln also failed twice and that resulted in problems of sustenance of the family and the debt on my head increased to 19 lakhs.'*

When successful, close commitment to product and value creation models improves the profitability of the business in the long run. Jayashree, for example, responded to the lack of institutional support for product development by changing the focus from end-products to the means of production, which was a critically important invention from the perspective of the efficiency of the business model. This decision took place when the inventor realised that wood fibres used in sanitary napkins were not expensive – expensive manufacturing machinery was the main reason for the high cost of sanitary napkins made by multinational firms.

Difficulties in accessing formal marketing channels is a big challenge for many firms operating at the grassroots level in emerging market countries. The director of sales and marketing of MittiCool explained this constraint as follows: *'It is difficult to develop formal marketing channels and we are still unsuccessful to collaborate with companies who have [formal] distribution channels.'* All three case firms have responded to this by boosting their sales through efficient utilisation of local informal marketing. Word of mouth is the main catalyst to disseminate information about their products. In many situations, it has turned out to be an efficient marketing model at the local level.

Another significant problem in emerging markets is low brand protection (point 11). The inventor of Jayashree explained this as follows: *'My machines are being copied frequently, but I do not care. I have uploaded all information on my company website. It is true [that] I lose market for this reason.'* In this kind of situation, not caring can be an appropriate strategy for long-time survival of the company because fighting against copying could require too much resources from a small-scale firm. Entrepreneurs also respond creatively to copying, as the factory manager of Ksheera described: *'Our machines are copied using low quality materials. Here is a copied machine that we bought from the market and [we] kept [it]*

here to show the customers so that customers can perceive our product quality.' However, the main response strategy to low brand protection of all case firms was development of brands that are locally well known. We found evidence of situations where strong local branding brings strategic benefits to small firms that compete over market position in difficult operational environments.

Above we have highlighted the capacities of the studied companies to integrate societal sustainability concerns into their operational activities while they cope with constraints arising from the operational environment. It is important to note that these firms also face several challenges related to continuous development of their offerings and related business models. For example, because the firms operate in remote rural areas, it is difficult to ensure the durability of the products in all situations, and logistics seem to be a constant problem. Minimisation of the environmental impacts of production and the end products is also a challenge.

5. Discussion

The aim of this article was to understand 1) *How do societal and operational pressures together influence business activities* and 2) *how can these pressures be assessed analytically?* Operating in a constrained environment is a complex endeavour where the activities of firms may have unintended consequences. Adhering to sustainability goals in such environments adds to the complexity. Hence, answering to the research questions requires an in-depth discussion on the organizational aspects of frugal innovation with focus on affordability questions and the possibilities of grassroots actors to develop innovative offerings with limited resources (Annala et al., 2018; Pisoni et al., 2018).

Based on our analysis of the case firms, we emphasize two aspects related to the frugal innovation phenomenon. Firstly, it is critically important to understand that frugal innovations operate in a complex and contested operational space, in which organizations need to continuously balance between societal and operational pressures. Secondly, the sustainability outcomes of frugal innovations seem to depend more on their business models than on their technological innovativeness. All the studied firms make use of relatively simple technologies and locally available resources, but still their business models allow significant positive implications to emerge from their business activities.

We have explained how the studied firms were able to serve previously underserved customers with affordable and technically simple offerings. Frugal innovations are developed in line with the thinking of the triple bottom line approach, as the economic, social and environmental aspects are highly embedded in them. Hence, frugal innovations play also an important role towards the SDGs. Next, we will discuss more generally the potential of frugal innovations to serve as drivers of sustainable development. We will outline the prospects of frugal innovation-based businesses, managerial implications, and the limitations of this study.

5.1. The potential of frugal innovation to drive sustainable development

Frugal innovation can be seen as part of the wider emergence of 'social' and 'inclusive' businesses that have been argued to play a significant role in the social and political empowerment of people and in mitigating the sustainability challenges in emerging markets (Bocken et al., 2016; Halme et al., 2012). Frugal innovation can be seen as a one way to operationalize shared value creation and triple bottom line strategies in which business approaches are expected to have not only local but also global implications in social, environmental and economic dimensions (Govindan et al., 2013; Govindarajan and Ramamurti, 2011; Pansera and Sarkar, 2016). Levänen and Lindeman (2016) have also argued that frugal innovation approach can help when considering the different forms of sustainable development locally.

This study has focused on frugal innovations emerging from the grassroots level which are promising for their potential contribution

towards meeting the SDGs (Pansera and Sarkar, 2016). At the same time, it has become clear that the causal links between business activities and exact sustainability outcomes are not yet well understood nor tested in the current literature (Hart et al., 2016). The statement that frugal innovation inherently contributes to sustainable development has proven too straightforward (Howell et al., 2018; Levänen et al., 2016), and, therefore, the potential of frugal innovations to serve as drivers of sustainable development justifiably remains under debate (Pansera, 2018).

Emerging economies often lack the necessary institutions, suitable infrastructure and well-functioning markets to support innovation activities pursuing societal development (Bhatti et al., 2018; Hoskisson et al., 2013). Diverse operational constraints and the overall complexity of the operational environment may reduce firms' willingness to operate in the in the midst of societal and operational pressures. To really do that, our study demonstrate that firms need to have strong intentions to pursue positive sustainability outcomes and the ability to respond creatively to myriad of operational constraints. Creativity is important because typically there are very little reference cases present in similar circumstances from which entrepreneurs could learn.

In addition to internal passion to pursue positive sustainability outcomes, local entrepreneurs need to have the capacity to incorporate sustainability-related activities into the business model elements, which can be a challenging task. The sustainability effects of business may appear at both local and wider societal levels, which makes their anticipation difficult. This can negatively affect an entrepreneur's motivation to pursue sustainability-related activities in the first place. Our empirical exploration further illuminates the complexity of these issues. By exploring frugal innovations developed in the grassroots context through a sustainable business model approach, we see that different elements of a business model hold the potential to respond to different constraints and to produce diverse implications. For example, firms whose value proposition does not rely on access to electricity can respond at the same time to affordability constraints present in the personal lives of customers and institutional constraints present in the operational environment.

Importantly, entrepreneurs need to decide whether to try to influence the root causes of the visible constraints of their businesses, or merely try to cope with the constraints that directly influence their everyday business conduct. The root causes of the constraints typically have to do with macro-level socio-economic problems, which makes them complex by nature. Addressing of the root causes of macro-problems systemically is a daunting task for any firm. Still, it is important to note that, at least in certain situations, firms may have an opportunity to influence root causes at the scale of their operations and thus at least reduce the root causes' negative effects on the business environment at the local level. At the same time, it needs to be understood that without carefully crafted business models that emphasize sustainability-related aspects, frugal innovations can have unintended consequences and even create new problems.

With this study, we contribute to the ongoing debate on the contributions frugal innovation make to sustainable development (Pansera and Sarkar, 2016). Based on our findings, we argue that frugal innovations can only address sustainable development if the entrepreneurs proactively consider both the operational constraints and the effects on sustainability at the same time. Commitment to business model development together with in-depth understanding of local challenges provide a promising starting point for sustainability-oriented local firms in emerging markets. Continuous business model development serves reaching the right target groups and helps to better understand their needs and concerns.

When developing or assessing diverse aspects of frugal innovations, it is important to keep in mind that successfully responding to operational constraints does not necessarily make a business model sustainable. Social, environmental and economic concerns must be brought into the core of business to really facilitate positive sustainability

outcomes. Our analysis illustrates how these types of emphases can be put into practice in business activities of single firms so that business ventures improve the general wellbeing of people in a sustainable manner.

5.2. Future prospects of businesses based on frugal innovations

The frugal innovation approach embraces context sensitivity, which enables solutions to emerge from the grassroots level (Nair et al., 2015). The case firms in this study operate in the low-income context and have developed innovations for people who live in similar circumstances as the entrepreneur-innovators. However, when larger firms pursue frugal innovation, new questions arise. For example, it might be a challenge for larger firms and multinationals to gain a deep-enough understanding of the actual needs of people living with constrained budgets in different emerging market countries (Hyvärinen et al., 2020). Similarly, it requires extra effort to provide positive sustainability implications at the wider societal level as compared to the local level. Despite these challenges, we argue that sustainability-oriented frugal innovations could serve as interesting targets for larger firms.

To develop frugal innovations at the grassroots level, entrepreneurs need numerous kinds of support, which are not easily available in emerging markets (Hossain et al., 2021). Based on our analysis, we highlight three issues related to supporting functions. First, finding external funding for innovation development is typically very important, yet also very challenging in emerging market countries. Second, even though frugal innovations are likely to be patented, they might be copied, and in these situations, local firms typically cannot take legal action due to their limited resources in property rights' management. Third, a lack of basic infrastructure, such as decent transportation and information systems, may prevent frugal innovations from scaling up from the grassroots level. To respond to these types of challenges, policy actors at different levels of governance play an important role.

5.3. Managerial implications

The analytical model accompanied with the empirical analysis of the three cases form the foundation for managerial implications. Firstly, the items surfaced through the empirical analysis can serve as indicators for entrepreneurs, small firms and multinational companies. Second, our analysis shows that when pursuing positive sustainability outcomes in emerging markets, developing and maintaining a mindset and culture, which allows for trial and error and a do-it-yourself attitude to flourish, is essential. Further, entrepreneurs at the grassroots level have in-depth knowledge about their customers and the emerging markets more generally. It is important that this local knowledge is utilized in a wise and responsible manner when innovating happens in a partnership with other organizations. In these kinds of operational environments, geographical location and political, social and reputational capital are especially crucial for firms to access resources and gain legitimacy for their businesses. Lastly, it is also important to note that frugal innovations typically aim to solve problems that other businesses ignore. This requires entrepreneurs to have the capacity for market creation, along with passion toward business development. Rapidly emerging threats, such as the COVID-19 pandemic, underline the need to pursue sustainability with frugal perspectives.

5.4. Limitations and future research

This study has several limitations, which provide opportunities for future research. First, the developed framework is based on both the literature and the analysis of three case firms. However, exploring a larger number of cases and/or going even deeper in the empirical analysis with single case studies could provide additional insight on the sustainability outcomes of frugal innovations and their potential to address constraints of the operational environment. Second, all three

case firms we studied operate in India. Understanding the dynamics of frugal innovation from other institutional and geographical environments may add significant value to frugal innovation research, keeping in mind that frugal innovation is a recent entry into academic literature. Third, some frugal innovations are trickling up from the grassroots level of emerging markets into developed countries. How frugal innovations can successfully capture value and generate positive sustainability outcomes in developed countries, and what are the associated challenges provide important areas for future research.

6. Conclusions

Even though the number of studies on innovation for emerging markets is growing steadily, the extant literature provides only limited information about the actual links between sustainable development and innovations. Frugal innovation aims to reduce the technological complexity of products and services to deliver sustainable value for customers, especially in emerging markets. Discussion on frugal innovation is particularly relevant in resource-constrained environments because it emphasises the affordability and creative development of new and different offerings with limited resources.

In this article, we have emphasized the importance of sustainable business models associated with frugal innovations for achieving sustainable development. We have argued that frugal innovations provide bottom-up, local approaches to grand sustainability challenges, and they have the potential to boost local empowerment and general wellbeing. Frugal products and services may create completely new markets, and their contribution to sustainable development might become more positive than that of conventional offerings. At the same time, we have shown the significant uncertainties underlying frugal innovation discussion that need to be considered in analytical approaches. An important limiting factor of the growth of frugal innovation-based businesses as well as the theoretical understanding of the potential of frugal innovation is that the business model concept remains underdeveloped in this context. There is a dearth of information on how business models can be co-developed with the actual offering and how they can be integrated with frugal innovations. In many cases, business models not only define firms' chances of survival but also underscore their societal significance.

CRedit authorship contribution statement

Jarkko Levänen: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing, Visualization.
Mokter Hossain: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing.
Marleen Wierenga: Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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