

Frugal innovation: Conception, development, diffusion, and outcome

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ABSTRACT

Frugal innovation (FI) demonstrates a new entrepreneurial landscape where small firms with limited resources develop innovations for underserved customers in low-income countries. FIs also create new markets and contribute to sustainability. The studies so far have highlighted various frugal products introduced by large and small firms around the world. This study aims to explore the process of how individuals at the grassroots level successfully conceptualize, develop, and diffuse their FIs to achieve commercial success. It analyzes the antecedents, processes, and consequences of FI development and commercialization, and explores how FIs evolve and diffuse in emerging markets. It also seeks to identify what triggers and motivates individuals to engage in FI. The study points out the initiative that individuals take and the challenges they face, from inception to the successful commercialization of their innovations. We therefore portray an overall understanding of the antecedents, processes, and consequences for these entrepreneurs. Along with the scholars, the findings of this study will be insightful for practitioners who are interested in the frugal innovation phenomenon. It points out issues, such as the dual-business model, innovation to serve low-income customers, and diffusion patterns that managers need to understand when shaping their business strategies, for emerging markets in particular and the world in general.

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1. Introduction

Developing something from nothing through entrepreneurial bricolage is a growing phenomenon in emerging markets (Baker and Nelson, 2005). In recent years, there has been a surge in developing affordable products targeting new markets (Ravishankar and Gurca, 2015). Entrepreneurs in resource-scarce environments often develop such products (Hossain, 2017; Simula et al., 2015). As suggested by Baker and Nelson (2005), firms engage in bricolage to overcome the limitations imposed by a resource-scarce environment. In the current age of austerity, resource constraints and sustainability concerns are forcing firms to develop affordable, quality offerings.

Frugal innovation (FI) is an example means to develop such offerings. The FI concept overlaps with numerous other concepts (Agarwal et al., 2016; Hossain, 2018b), and naturally, scholars are not unified behind a single definition of FI. However, FI can be broadly defined as developing resource-scarce but quality solutions that are cheaper than the existing products (Zeschky et al., 2014). According to Hossain et al. (2016), an FI is a resource-scarce solution

that has been developed and used under financial, technological, and material or other resource constraints, yet it is good enough to meet the needs of underserved customers who would otherwise be unable to afford the existing products and services.

Developing FIs with a bricolage approach has emerged as a promising way to meet the needs of underserved customers while emerging markets provide fertile grounds for FIs (Bhatti et al., 2018). There is a growing consensus that firms need to focus not just on developing products but also on providing affordable solutions to customers while also keeping sustainability as a key element (Fernando et al., 2019). Sustainability issues—such as economic, social, and environmental concerns—are getting increasingly more important for product development (Jabbour et al., 2019a,b). The social dimensions of sustainability also need special attention from product development (Jabbour et al., 2019a,b). The acquisition of technologies and innovations that promote sustainability are also essential to the product-development process (Seles et al., 2019). Thus, a holistic approach to sustainability is essential for staying ahead of the business competition curve.

Entrepreneurial activities are changing, and many entrepreneurs emerge from the grassroots level with limited education, poor technological knowledge, and no access to knowhow

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(Hossain, 2017). They often dwell in impecunious environments and work under severe resource constraints (Sarkar, 2018; Xie et al., 2015), yet they offer frugal solutions to underserved customers and make an impact on sustainability (Levänen et al., 2016). Many individuals with a limited education and no access to expertise come up with brilliant ideas to solve local problems (Albert, 2019). They walk untrodden paths in their innovative entrepreneurial journeys and overcome a variety of new challenges. With their affordable products, they make invaluable contributions to society, especially in terms of sustainable development. They therefore contribute to meeting sustainable development goals (SDGs) by offering sustainable products and services for a healthy life, female empowerment, and child emancipation (Pisoni et al., 2018; Sarkar and Pansera, 2017).

However, we have very limited knowledge about how individuals at the grassroots level with limited resources survive and flourish with their frugal ingenuity. We also lack knowledge about how FI contributes toward sustainability. Hence, we need to understand how entrepreneurs with FIs emerge, become commercially successful, and contribute to sustainability. The objective of this study is therefore to explore the process in which individuals successfully conceptualize, develop, and diffuse their FIs to achieve continued commercial success and contribute to sustainability. This study aims to accomplish this objective by answering the following questions:

- What are the antecedents, processes, and consequences of frugal innovation development and commercialization?
- How do frugal innovations evolve and diffuse in emerging markets?
- What are the key outcomes of frugal innovations?

This study makes three main contributions: Firstly, it shows how grassroots entrepreneurs conceptualize, develop, and diffuse their FIs. Secondly, it shows how grassroots entrepreneurs translate their product ideas into commercial success by overcoming numerous challenges. Finally, it contributes to the FI literature from the perspectives of entrepreneurship and sustainability.

The remainder of this paper is structured as follows: The next section reviews the existing literature. Next, we describe the data type, the source of the data, and the data-analysis technique. The subsequent section then presents the findings of this study. Next, we point out the implications of this study and suggest future directions. Conclusions are then drawn in the final section.

2. Theoretical background

This study lies at the intersection of three literature streams, namely emerging markets, FI, and sustainability. FI contributes to sustainability in emerging markets, although it is also relevant in the context of developed countries. This section includes a discussion of the literature related to emerging markets, FI, and sustainability.

2.1. Emerging markets

Emerging markets are widely seen as a favorable environment for FIs (Hossain, 2017). The existing literature, however, has difficulty explaining why in some cases, FI provides a solid foundation for a business, but it does not in other cases. Multinational firms mainly focus on high-end consumers, and they tend to be not very successful at serving consumer groups who just want basic, affordable products (Ernst et al., 2015). There are ample success stories for FIs (Hossain, 2017), but there are also examples of failure for frugal products, such as the Tata Nano Car (Ray and Ray, 2009).

Firms are increasingly under pressure to develop sustainable products, so they need to identify new practices by embracing economic, social, and environmental concerns to gain a competitive edge (El-Kassar and Singh, 2019; Singh et al., 2019). Many small firms are developing products to meet the low-income customers of emerging markets, thereby contributing to sustainability (Ananthram and Chan, 2019). Even though small firms may have high environmental impacts, research in this direction remains limited (Singh et al., 2020). Emerging markets are regarded as being ripe for low-cost innovation (Thun, 2018), and they are increasingly hungry for innovations to meet local needs. Thus, delivering appropriate products and services to low-income consumers in emerging markets is a key challenge for businesses (Howell et al., 2018).

Innovation is a cornerstone for achieving a competitive advantage and a hotly debated topic in the management literature (Pérez-Luño et al., 2014). We know little about how appropriate innovations for emerging markets are developed and successfully commercialized (Ray and Ray, 2009). FI takes the shortcoming of resource constraints in emerging markets and transforms it into an advantage by embracing local market needs in new business models for affordable solutions (Mourtzis et al., 2016). It has emerged as a complementary approach for tackling global challenges (Agarwal and Brem, 2017). Firms in emerging markets persistently develop FIs to create value for customers (Krishnan and Prashantham, 2019), and these FIs are essential for some firms' survival and growth, as well as key drivers for social change (Reinhardt et al., 2018).

For Chinese firms, Zhou et al. (2005) found that a participative organizational culture and senior managers' positive attitudes toward change are useful for an innovative orientation. Information technology also plays an important role in FIs and new business models (Howell et al., 2018). Moreover, cognition, which is an individual's tendency to engage in, and enjoy, thinking, has a close association with his or her innovative behavior (Wu et al., 2014). We know from prior literature that bounded creativity positively moderates the relation between financial constraints and innovation project performance (Hoegl et al., 2008). We also know that scarce resources may promote or hinder innovation (Katila and Shane, 2005). Studies, however, do indicate that a lack of access to technology and knowhow, especially in resource-scarce environments, significantly slows down the FI-development process (Albert, 2019; Levänen et al., 2016).

2.2. Frugal innovation

Effective innovative solutions are essential for solving today's complex problems (Kantola et al., 2017), and FI is a way to accomplish this goal (Bhatti et al., 2018). Weyrauch and Herstatt (2017) suggest considering the following three criteria to define frugal innovation: substantial cost reduction, concentration on core functionalities, and optimized performance level. According to von Janda et al. (2020), frugality is a formative construct that encompasses four dimensions: basic quality, cost of consumption, simplicity, and sustainability. They argue that low cost and sustainability need to be considered together when creating frugal products. Policymakers largely ignore the consumers within sustainable innovation. To address poverty at the grassroots level, Dembek et al. (2018) argue that the market-based approach has proven challenging when serving low-income customers, whereas a sustainable business model approach has shown promising results. Frugality is also an important issue for western countries, however (Thøgersen, 2018).

It is widely accepted that innovation diffuses from the developed to the developing countries, from high-income customers to

the low-income ones (Rogers, 2010). FIs, in contrast, diffuse in the opposite direction. Hossain et al. (2016) argue that the diffusion of FIs mainly shows four patterns. They label them as local, proximity, distance, and global diffusion. In general, FIs diffuse from low-income customers to high-income ones, from developing countries to developed ones. However, before reaching the more developed countries, they diffuse through neighboring or distant countries with similar socioeconomic settings. When an innovation is successfully used in developing countries and then trickles up to developed countries, it is called reverse innovation (Rosca et al., 2017). Diffusion is defined as the process through which an innovation spreads over time through markets (Ray and Ray, 2009), and it depends on several factors. Both individual and cultural factors are important for an innovation's diffusion. We know that advertising plays an important role in diffusing new products. Our extensive search and review of the extant literature reveal that studies into the diffusion of FIs and similar innovations in the context of developing countries are largely absent.

Rogers (2010) argues that the diffusion of innovation comprises four elements, namely innovation, communication channels, time, and the social system. Innovation takes time to diffuse from one industry to another (Bass, 1969), while individuals, groups, and authorities may take a diffusion decision (Rogers, 2010). Diffusion can take two forms: evolutionary and transformative (Edwards and Tempel, 2010). In evolutionary diffusion, firms embrace useful practices and implement them in their existing strategies, while transformative diffusion happens when firms encounter practices that are radically novel for their businesses. Developing a theoretical model of the diffusion process is challenging due to the involvement of numerous variables.

Overall, affordable products for emerging markets are clearly increasingly important for businesses and society. The extant literature presents limited knowledge about affordable products and associated business models for emerging markets. We need to understand the antecedents, consequences, and processes of FI activities. Furthermore, how FIs diffuse is an interesting and timely topic to study.

2.3. Sustainability

Sustainability is a nebulous term, and scholars perceive it in many ways. However, we follow the scholars who postulate that sustainability is defined through the following interconnected pillars: economic, social, and environmental (Hossain, 2020). According to the U.S. National Environmental Policy Act of 1969 (NEPA), the objective of sustainability is to create and maintain conditions that allow fulfillment of the economic, social, environmental, and other requirements of present and future generations (Caldwell et al., 1998). The concept of sustainability is complex. It is still contested and debated.

Sustainability refers to business success not just in financial terms but also in social and environmental terms (Yong et al., 2020). Innovation is also increasingly penetrating the sustainability lexicon (Pansera and Owen, 2018). Inigo and Albareda (2016) found five ontological sustainable innovation components: collaborative, holistic, instrumental, operational, and organizational. Along with economic aspects, technological and environmental aspects trigger sustainable solutions (Kim et al., 2019). Due to the considerable sustainability mandate for businesses, many higher education institutions are also integrating sustainability issues into their curriculum (Khan and Henderson, 2020).

Innovations that encompass sustainability dimensions have proven to be significant intangible resources for firms to achieve a lasting competitive edge (Fernando et al., 2019). However, studies into organizational sustainability and the sustainable use of

resources are mainly conducted at the level of large firms, while small firms remain largely unexplored (Singh et al., 2020). Appropriate attitudes, behaviors, and decision-making processes are essential to launch and manage sustainable products (Yong et al., 2020). Recognizing the ethical aspects of innovation is a prerequisite for social and environmental sustainability (Stahl et al., 2019), while increasing evidence is emerging to support FI as a catalyst for sustainable development (Albert, 2019; Levänen et al., 2016).

In summary, the importance of measuring innovation and service through the lens of sustainability is growing, and there is a significant connection between FI and sustainability in emerging markets. Understanding FI and its contribution to sustainability in emerging markets is therefore crucial, and this study attempts to help meet this need.

3. Research method

This study applies a multiple-case approach, which is useful for the generalizability of inferences (Eisenhardt and Graebner, 2007). Numerous attempts have been made to improve theorizing in case studies (Corley and Gioia, 2011; Suddaby, 2014; Whetten, 1989), and this method is widely used in qualitative studies. The case variation allows for replication and theory extension (Yin, 1994). A multiple-case study approach involves low risk for its findings, because it is idiosyncratic and observes findings based on common attributes. Nevertheless, the case study approach has been criticized as it provides a mere description of cases (Shepherd and Sutcliffe, 2011). Despite such criticisms, the case study approach continues to be widely used in academic research (Eisenhardt and Graebner, 2007; Siggelkow, 2007).

3.1. Case selection

To accomplish the objective of the study and answer the research questions, we used purposive sampling. We started collecting various FI cases from around the world. From a list of 94 cases, we selected those cases that received significant media coverage. These cases originated in Bangladesh, Canada, India, the UK, and the USA, with their target customers being at the grassroots level in emerging markets. India is considered an epicenter for FI (Prabhu and Jain, 2015). Table 1 gives an overview of the cases used in this study. A set of diverse cases enables a cross-case analysis. We collected and compiled a comprehensive list of secondary documents for the cases, with sources including media articles, reports, video clips, documentaries, and the websites of studied cases. These documents enabled us to understand the cases and their journey from inception to commercialization.

An extensive exploration of secondary data was useful for developing the first case descriptions according to the sequence of events and performing a primary analysis of the enterprises. After analyzing the secondary data, we contacted the selected enterprises by email and telephone to arrange interviews and visit their sites, which included factories, offices, and markets associated with the innovations.

When considering the entrepreneurs, we kept in mind that they had already long struggled but persisted with their ventures. The founders of three enterprises are from Western countries. Three founders are Western-educated, while another was highly educated locally. Another six grassroots founders had just an elementary educational qualification. Boond, Bright, Grameen Shakti, Nuru Energy, and Selco are five cases who provide energy to people who would otherwise lack access to it. Embrace and mOm, meanwhile, produce infant incubators that are used to save the lives of underprivileged premature infants in remote locations. Jayashree Industries makes machines for making sanitary pads and

Table 1
Summary of cases and informants.

Case	Founder origin	Informant (#)	Informant profile	Founded in	Employee (#)	Main market	Description of the enterprises
Mitticool clay fridge	India	2	-Inventor and CEO -Manager, sales	2005	50	India	Mitticool produces clay cookerries including its flagship product MittiCool fridge
Sanitary pad making machine	India	2	-Inventor and CEO -Entrepreneur	2004	10	India	Jayashree Industries produces and sells sanitary pad making machines mainly across India
Milking machine	India	3	-Inventor and CEO -Manager, sales -Manager, HRM	2011	30	India	Ksheera Enterprise produces and sells milking machine mainly across India
Cotton stripping machine	India	1	-Inventor's presentation and discussion in a session of 15 summers school participants	2000	5	India	Chetak Industries produces and sells cotton stripping machine mainly across India
Bamboo splint making machine	India	1	-Inventor -Inventor's presentation and discussion in a session of 15 summers school participants	2007	10	India	Bonobo innovative products ltd. produces and sells Bamboo splint making machine to make Agarbatti (Incense) stick.
Cotton wick making machine	India	2	-Two inventors' presentation and discussion in a session of 15 summers school participants	2013	5	India	Dipvijay Industries produces and sells cotton wick making machine mainly across India
mOm	UK	1	-Inventor	2014	5	Emerging markets	mOm is an inexpensive, electronically controlled, inflatable infant incubator designed and built to decrease the number of infant deaths.
Embrace	USA	2	-Manager, USA -Manager, India	2008	30	Emerging markets	Embrace provides low-cost incubators to prevent neonatal deaths in rural areas in emerging markets
Nuru energy	Canada	1	-Country Manager, India	2008	20	Africa and India	Nuru Energy provides Nuru Lights and other USB-charged devices, such as mobile phones, are all charged directly from its plug-and-play recharge station, consisting of the POWERCycle pedal generator, the Nuru Solar Panel and the

Table 1 (continued)

Case	Founder origin	Informant (#)	Informant profile	Founded in	Employee (#)	Main market	Description of the enterprises
Selco	India	1	-Manager, India	1995	50	India	Nuru Octopus Charger. Selco provides sustainable energy solutions and services to under-served households and businesses in India.
Grameen Shakti	BD	1	-Manager, Bangladesh	1996	11,000	Bangladesh	Grameen Shakti provides sustainable energy solutions and services to under-served households and businesses in Bangladesh.
Bright green energy foundation	BD	1	-CEO	2010	1500	Bangladesh	Bright Green provides pollution free renewable energy to the underprivileged rural people of Bangladesh through innovative monthly installment based financing model.
Boond	India	3	-CEO -CFO -Site Engineer	2010	50	India	Boond provide solutions in alternative energy technology and works across 11 states in India. Our major focus is providing appropriate and customized solar solutions across the spectrum of communities, sectors and geographies.
Anil Gupta	India	1	Prof. Gupta supports thousands of grassroots innovators through four organizations: GIAN, NIF, HBN and SRISTI				
Total		22					

sells them to female entrepreneurs who in turn manufacture and sell sanitary pads for low-income females who cannot afford the sanitary pads from multinational firms. Mitticool manufactures clay cookware, as well as its flagship Mitticool clay fridge. Next, there is the case of a milking machine that serves small-hold farmers who would otherwise milk their cows by hand because they cannot afford the expensive conventional milking machines. There is also a cotton-stripping machine that mechanically strips rain-fed cotton from cotton shells, a process traditionally performed manually by local female workers in states like Gujarat. Similarly, a cotton wick-making machine automates a task traditionally performed by female workers manually. Next, a machine for making bamboo splints produces bamboo sticks for the Agarbatti (incense stick) industry. Traditionally, rural communities use a knife to manually cut bamboo strips and sticks.

These 13 enterprises serve many underprivileged customers. For

example, Embrace has served over 300,000 babies in 22 countries, while Jayashree Industries have sold 1300 machines for making sanitary pads to businesses employing over 5000 females in total. Hence, these cases are appropriate for exploring the nascent phenomenon of frugal entrepreneurship.

3.2. Data

The selected enterprises are at the growth stage of their ventures. In total, we conducted interviews with 22 informants, including entrepreneurs, managers, and a patron, namely Prof. Anil Gupta, who leads four organizations in India to support grassroots innovations. These four organizations are the Grassroots Innovations Augmentation Network (GIAN), the Society for Research and Initiatives for Sustainable Technologies and Institutions (SRISTI), the Honey Bee Network (HBN), and the National

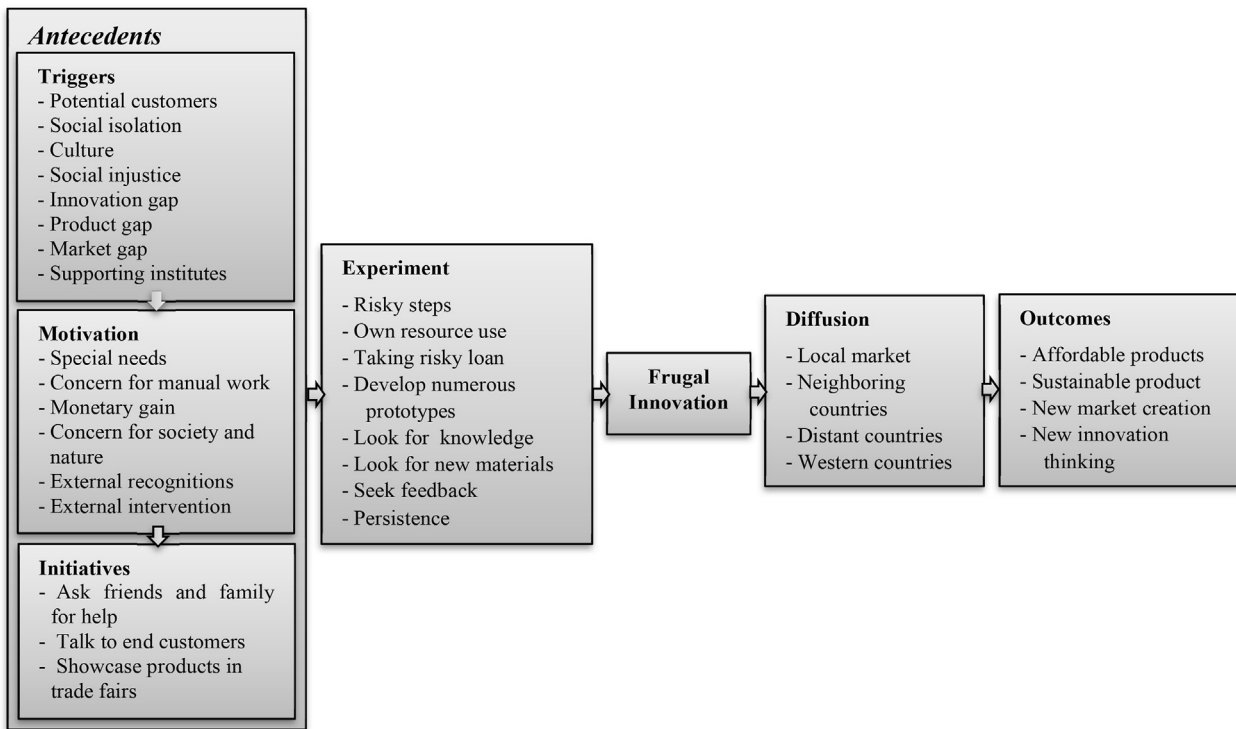


Fig. 1. Antecedents, diffusion, and outcomes of the frugal innovation process.

Innovation Foundation (NIF). These organizations have supported thousands of individuals in the informal sector in their FI endeavors at the grassroots level.

Some of the informants were interviewed several times in different formal and informal settings. The interview length varied from around 20 min to 8 h. For example, an interview with Mitticool's inventor and marketing manager ran from 09:00 to 17:00. The discussions with Prof. Anil Gupta, meanwhile, took place many times in different settings over a weeklong period during a summer school, specifically at his office, at his home, and while walking with him at night around his home at the Indian Institute of Management in Ahmedabad. Another inventor was interviewed at his office, at his residence, and while accompanying him on a 40-min journey from his home to Coimbatore International Airport. With another informant, the interviews took place at the headquarters, during a car journey from the headquarters to its site, at the site itself, and a hotel. The interviewer also shared a hotel room with an interviewee during a field visit to India. The researcher's field trip to Bangladesh and India from Europe allowed him to observe the enterprises in a real-life setting. Most interviews were conducted face to face, with two interviews being conducted over Skype. The data also included comprehensive field observations. Once the interviews were completed, the researcher returned from his three-week field visit and all interview and secondary data were compiled. The 10 recorded interviews were transcribed, some fully but others only partially because it was not possible to transcribe them fully because the interviews took place in informal settings where it was practically impossible to accurately record them. We used several data sources to enable triangulation, thus combining different kinds of data from various sources, to ensure the quality of the empirical findings (Jick, 1979).

3.3. Data analysis

The interview texts and other documents were analyzed using Atlas.ti, which is a prominent software package for qualitative data analysis, data management, coding, and retrieval. We started coding inductively based on concepts and themes expressed in the documents. We used an inductive, in-depth, and field-based approach that is suitable for developing new theories and elaborating on under-explored ones (Eisenhardt, 1989). In the beginning, we focused on issues that have been frequently discussed in the literature for frugal enterprise and related fields. A large number of codes emerged from the initial coding for the granular and descriptive nature. The codes lacked conceptual boundaries between them, however, we consolidated and refined the codes. Any codes where it was unclear how they related to the research objective were provisionally set aside, helping to reduce the codes to a reasonable number. All transcripts were iteratively revisited to ensure that all the major aspects had been captured and understood. We revisited the literature for the research topic, going back and forth between the data and literature, and created new codes in a recurring cycle (Gioia et al., 2013). We also examined descriptive codes that hinted at broader themes. This continuous iteration between the literature and the data led to aggregate codes. The findings are discussed in the next section.

4. Findings

4.1. Antecedents

The antecedents of FI are numerous. We analyzed the antecedents in three groups, namely triggers, motivations, and initiatives (Fig. 1). A set of issues triggers FI. The potential customers for a

new type of product encourage individuals to pursue FI. Some people are socially isolated due to their caste, color, ethnicity, religion, etc. Consequently, they tend to find solutions to meet their personal and social needs. Cultural aspects are significant in FIs, and many FIs arise out of a prevalent injustice in society. In addition, the prior experience of an individual in a particular industry plays an important role in FI. We found that entrepreneurs possess skills in multiple domains, and they apply these skills holistically to find solutions for problems. The knowledge and experience gained from various trades therefore enable entrepreneurs to develop affordable products. This helps to find gaps in terms of innovation, products, and market. The availability of supporting institutions is also crucial for nurturing FIs. Fig. 1 shows the overall antecedents, diffusion, and outcomes of the frugal innovation process. Here, the antecedents are categorized into three subcategories: triggers, motivations, and initiatives. Antecedents lead to experiments with various frugal innovations. Once minimally viable products or services are ready, they start diffusing through the markets. After this, we can understand the outcomes of frugal innovation.

The motivations for FI can be both intrinsic and extrinsic. The intrinsic motivations for FI include personal dissatisfaction with the existing way of doing things, concern for nature, a curiosity for everyday affairs, and concern for the greater good of society. The extrinsic motivations, meanwhile, include customers' needs, a concern for the plight of manual workers, interventions from institutes/organizations, monetary and non-monetary recognition, and inspiration from other ideas.

Entrepreneurs take the necessary initiatives once they are motivated to pursue an FI journey. Such initiatives are initially taken based mainly on internal factors. Entrepreneurs expend their own limited resources, time, and efforts to develop an FI. After some time, they then try to seek support from external sources. Technical support is essential for entrepreneurs if their knowledge of advanced technologies is limited. Furthermore, they need financial support to meet their own sustenance needs and purchase the necessary materials for their ideas. They often initially receive technical support from close friends and social networks, with support from state and market actors coming at a later stage. Entrepreneurs often seek help from their friends and family, engage with customers to get feedback from them, and showcase their products at different exhibitions and trade fairs. Feedback and support from various sources allow entrepreneurs to understand the commercial potential of their ideas.

4.2. Experiments

Entrepreneurs begin experimenting with their ideas once they sense their potential, and such experiments involve many tough decisions for entrepreneurs. A key trait of an entrepreneur is the tenacity for turning an idea into a viable product. They take risky steps like installing new equipment for production or applying existing technologies for new purposes. Even though entrepreneurs may have difficulty meeting their own everyday needs, they use their own financial and other resources for FI development. When they exhaust their own resources, they attempt with difficulty to borrow from informal lenders, often at a high interest rate. Entrepreneurs often sell off their own properties environment or the absence of technical knowledge for trivial issues. However, they use different materials in new ways based on their intuition, and they seek knowledge from external sources, although usually only from within a limited geographical area.

4.3. Diffusion

Once entrepreneurs develop products that are ready for

commercialization, the key challenge is how to diffuse a product into the target market. The diffusion patterns of frugal products differ from those of mainstream products. Frugal products are first introduced at the grassroots level and then later to other markets. They can be readily commercialized in local markets because they are specifically developed to meet local needs. Once successful at a local level, these products can diffuse to other geographically close markets. With friendly business relations, some frugal products may diffuse to neighboring countries through trade. However, many entrepreneurs use online marketplaces and set up dealerships abroad to sell their products to the international market. Some frugal products may even be suitable for trickling up to western countries, and this is called reverse innovation (Govindarajan and Ramamurti, 2011).

4.4. Outcomes

FIs have significant and different types of outcomes that conventional products may not have. These products are affordable, sustainable, and resource-efficient, and they create a new market for new customers with a new type of product. They are also affordable to some customers who cannot afford the equivalent conventional products. For example, the clay fridge does not consume electricity because its cooling system is based on a natural process, so it contributes to sustainability and creates a new market for refrigerators where electricity is unavailable. In other examples, the milking machine, cotton-stripping machine, and bamboo-splint-making machine all relieve the drudgery of female manual workers, thus contributing to female empowerment. Above all, FIs employ new ways of thinking to solve problems through profitable ventures. Many similar products are emerging in various locations, which means that successful frugal products are in turn inspiring many new forms of innovation thinking. We find that FIs are robust, easy to use, and environmentally friendly, as well as strongly associated with sustainability concerns. Not surprisingly, readily available local and used materials are frequently employed as raw materials for FIs, often in novel ways. Overall, FIs have many significant social implications, including female empowerment, relieving the drudgery of manual work, and creating business opportunities for marginalized people. Thus, frugal products have many outcomes that help achieve sustainable-development goals (Hák et al., 2016).

5. Discussion

This section is structured in three subsections: First, we explain the theoretical implications of this study. Secondly, we point out its practical implications. Finally, the limitations and suggested avenues for future research are presented. Our analysis reveals a pattern for the FI process, and this study makes three main contributions: It provides a robust and documented empirical examination of the antecedents of frugal entrepreneurship. We also reveal new patterns of diffusion for innovation (Hossain et al., 2016) that go against the conventional forms of diffusion (Rogers, 2010). In addition, it points out the outcomes of FI, namely more affordable, environmentally friendly products that create new markets by using new innovations to meet social needs (Hossain, 2018b).

5.1. Theoretical contributions

The antecedents of FI-based entrepreneurship stem from a range of issues. Entrepreneurs have both internal and external motivations for pursuing FI, but they achieve the best outcomes when the internal and external motivations match appropriately for meeting the goal. Most entrepreneurs possess skills in multiple

domains, and this is a great advantage for innovating with limited external support. This is not common in typical entrepreneurs, especially those in western countries (Begley and Tan, 2001). Hence, understanding the agility of individual entrepreneurs warrants further exploration from new theoretical perspectives.

Most frugal innovators approach their endeavors very differently than conventional innovators would, especially those with a western mindset. They experiment in various ways to solve particular local problems, mainly because of a lack of access to relevant knowledge. Many frugal innovators are highly tenacious despite their deprived conditions and scarce resources (Hossain, 2018a). New or revised theories are therefore needed to understand frugal innovators.

This paper shows how the diffusion of frugal innovations is different from that of conventional innovations. It flows from low-income markets to high-income markets (in terms of customers and countries). Hence, it goes against the diffusion theory proposed by Rogers (2010). Since innovation is increasingly originating from emerging markets, our contribution to diffusion theory may be useful for advancing our knowledge in that direction. Frugal innovation has been proven to be an important concept for development, but understanding the role of FI in developed countries is essential for furthering our holistic knowledge, because this has yet to be explored in the academic literature (Hossain, 2018b).

The outcomes suggest that frugal innovation contributes to sustainability, so this study supports previous work indicating the importance of frugal innovation for sustainability (Khan, 2016; Levänen et al., 2016; Rosca et al., 2017). However, this finding is still at the anecdotal stage. There are many ways to explore FI further in order to understand it to a fuller extent and relate it to the extant literature on innovation.

5.2. Practical implications

This study has a number of practical implications: FIs developed at, and for, grassroots-level customers show how small and large firms can develop products to serve low-income customers in emerging markets. It reveals that FI can be characterized as a form of breakthrough innovation for emerging markets. However, the magnitude of influence that FIs have is still at an embryonic stage, so it is hard to establish the extent of breakthrough for FIs. Traditionally, multinational firms develop products for emerging economies by stripping down non-essential features for an existing model, or they may substitute costly, high-quality materials with inexpensive, more readily available alternatives. In contrast, FIs show brand new ways to serve low-income customers in emerging markets by developing affordable products with desirable characteristics, such as adequate quality, ease of use, and reparability. FIs are also largely developed to meet personal, social, and community needs that have yet to be recognized by conventional firms.

There are numerous antecedents for FI. Most entrepreneurs who emerge at the grassroots level possess skills in multiple domains, so encouraging more innovation at the grassroots level requires providing education and training to people in such domains. FI emancipates people from social isolation, breaks down cultural barriers, and addresses social injustice. It fills gaps in terms of innovation, products, and markets. However, the lack of supporting institutions brings challenges for FI, so the establishment of more supporting institutions is essential for better FI outcomes.

Numerous factors contribute toward developing a FI for low-income customers. Grassroots entrepreneurs identify special needs, recognize the drudgery involved in some manual work, perceive social and natural problems, and identify unhygienic or unsafe working conditions. Along with other factors, thanks to their proximity to end customers, FI-based entrepreneurs take unique

steps to pursue their ideas, such as seeking help from friends and family, engaging closely with customers, and continuously soliciting feedback from different people. Frugal entrepreneurs take very risky steps and use resources differently, especially local and used materials. They need significant time to develop prototypes due to the lack of access to supporting agencies.

The existing diffusion of innovation theory needs to be revisited for FIs, because the diffusion of FIs (Hossain et al., 2016) differs from that of conventional innovations (Rogers, 2010). Managers therefore need to consider the diffusion patterns of FIs along with their development. In addition, for multinational firms to embrace FI wholeheartedly, they need dual-business models (Kuo, 2017; Markides and Charitou, 2004; Winterhalter et al., 2016), namely ones that combine costly and frugal products as part of a holistic strategy to accommodate FIs alongside their conventional counterparts. The outcomes of FI are diverse and significant for sustainable development. FI creates new markets with a different form of innovative thinking. Thus, practitioners may wish to consider the above issues while devising a strategy related to FI.

5.3. Limitations and suggestions for future research

This study has several limitations: For example, we selected cases that had been widely covered in various media, so we could obtain rich data for this study. This represents a weakness in that relatively few cases are considered. Indeed, considering a larger number of cases from different sectors might give a more holistic picture about FI. Another limitation concerns how we did not interview customers due to logistics and resource constraints. Exploring the perspectives of customers for cases may reveal richer insights into how frugal products affect their lives.

This study suggests multiple future research avenues based on the antecedents and outcomes of the innovation process, as shown in Fig. 1. To enhance our understanding, a quantitative study to verify the construct we proposed here could be interesting and valuable to consider in future. Another promising research direction could be to compare successful cases with unsuccessful ones with an eye to understanding why some entrepreneurs fail with frugal products while others flourish. Most entrepreneurs have skills in multiple domains because of their work experience in different organizations and industries. It would be interesting to identify the role of such skills in the development of FIs. This study also does not consider notions such as bricolage, improvisation, and effectuation. Many of the cases we studied here are social enterprises, so exploring FI-based entrepreneurs from a social entrepreneurship perspective may enrich and broaden our understanding of the overall entrepreneurship field.

As studies on prototyping are mainly focused on resource-rich contexts, FI allows for exploring prototyping in a resource-scarce context. Like most of the prior studies, this study considered FI in the context of developing countries, but studying the potential of FI in the context of developed countries may provide new insights into this phenomenon. Integrated approaches to policy-making for FI are also essential (Lim and Fujimoto, 2019). What is more, understanding frugal entrepreneurship in the context of developed and developing countries from a public policy perspective could help mitigate the resource constraints for innovation.

6. Conclusion

This study explores the FI phenomenon and shows how small firms with ingenious mindsets develop products to solve societal problems. It synthesizes the antecedents of FI in categories, namely triggers, motivations, and initiatives. We discuss the experiments that entrepreneurs conduct to develop FIs, which diffuse differently

to conventional innovations. Indeed, the diffusion of FIs is an interesting new phenomenon. The outcomes of FIs show how these innovations create new products, businesses, customers, markets, and so on, as well as contribute to sustainability. Overall, this study shows new ways of thinking for innovating sustainably in emerging markets.

Declaration of interests

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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