Sustainable Business Model for Frugal Innovation at the Grassroots Level in Emerging Markets


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Abstract

The objective of the study is to explore how frugal innovations with novel business models emerge from the grassroots level in the emerging markets and contribute for sustainable development. Based on a multiple case study approach, this study explores various elements of business model considering value proposition, value creation, and value capture. Frugal innovations create novel customer groups at the grassroots level from the underserved customers. Exploring three frugal innovation cases that emerged from the grassroots level in three different states in India, this study contributes to the literature of frugal innovation and business model in the context of emerging markets. It shows how individuals with limited education, fund, and resources with outside the box thinking bring out affordable products to serve underserved customers in emerging markets.

**Keywords**: Business model; grassroots innovation; frugal innovation; sustainability; emerging markets
Introduction

The massive economic growth in emerging markets has led to a significant scholarly interest in the innovation management practices (Bruton et al., 2015; Nair et al., 2015). Economic growth has picked up in emerging markets and stagnated in developed countries (Ramamurti, 2012). It is important to rethink how to utilize resources effectively to gain sustainable business in emerging markets. Products for resource-constraint customers in emerging markets have received significant attention from scholars and practitioners (Zeschky et al., 2014). Howell et al. (in press) argue that providing value to underserved customers in developing countries is one of the key challenges for businesses. Emerging markets consist of a large number of customers who may not afford conventional products and services. These customers are increasingly seeking products that are good enough and affordable. They mostly live in rural areas and need last mile services.

The low-end customer segment is a fastest growing market in the emerging markets. To fulfil the needs of these customers, offering affordable products is essential. Frugal innovation has emerged as a promising option to offer affordable products to low-income customers in emerging markets. Frugal innovation is defined as a good enough solution that is developed under resource constraints to fulfil the needs of underserved customers (Hossain et al., 2016). Along with products and services, developing new business model is essential. A business model explains how firms create and capture value (Foss and Saebi, 2017; Volberda and Heij, 2017). Business model takes shape through experimentation (Guo and Ahlstrom, 2016). A key approach to success in this market is to develop a business model around the frugal innovations to achieve sustainable development. Although sustainable development is a nebulous term with many different meanings it broadly means to combine growing concerns regarding various economic, social and environmental issues (Hopwood et al., 2005).

Frugal innovations differ significantly from conventional innovations in terms of products and business models (Wan et al., 2015). They are highly promising for sustainable development (Levänen et al., 2016). A growing significance of the emerging markets as breeding grounds of frugal innovation for sustainable development has received significant attention from scholars and practitioners (Rosca et al., 2017). The
theoretical development of frugal innovation as a discipline is in a nascent stage (Hossain, 2018b) even though it is a growing means to serve low-income customers (Prahalad, 2012). Integrating business model and low-income contexts, Howell et al. (in press) identified that IT support is crucial in delivering frugal innovations to low-income customers. Winterhalter et al. (2018) investigated how firms create and capture value with unique value propositions to reach customers in the remote areas. These above studies have enlightened us to understand the sustainable business model, frugal innovation and emerging market for products originated from western sources. As a whole, there is a dearth of studies on frugal innovations and their underlying business models, specifically for the frugal innovations that originate from and for the grassroots level in the emerging markets (Winterhalter et al., 2017). Hence, the objective of the study is to explore how frugal innovations with novel business models emerge from the grassroots level in the emerging markets and contribute for sustainable development.

Theoretical review

Product innovations for unserved customers in emerging markets have been identified as an opportunity to create new markets. The extant literature has limited research on how innovation capabilities can be developed for these underserved customers in emerging markets (Lim et al., 2013). Innovations are typically developed in the developed countries and transferred to emerging countries (George et al., 2012). The last decades have witnessed a tremendous growth of innovation processes under the resource-constraint environment focusing on emerging markets (Agarwal et al., 2017). Large western firms collaborate with their subsidiaries located in the local markets. It is essential to blend advanced knowledge and local knowledge to create breakthrough innovation for the emerging markets (Altmann and Engberg, 2016). Emerging multinationals raise issues such as their unique capability and how they perform in their target markets (Malik, 2017). Innovation has been considered as a key enabler for economic growth (Bhagavatula et al., 2017). Ahlstrom (2010) shows that small changes in economic growth yield large differences in income over time.

Several studies provide primary insights on serving underserved customers with frugal innovations. Frugal innovations need novel business models. Business model research has grown significantly in last 15 years (Lüdeke-Freund and Dembek, 2017).
Sustainable business model is a recent topic in the business model literature (Bocken et al., 2014; Lüdeke-Freund and Dembek, 2017; Prabhu and Jain, 2015). Frugal innovation plays a significant role in inclusive innovation. However, recent years have witnessed a rise of the number of innovations from the emerging markets, many of which are called “frugal innovation” (Petrick & Juntiwasarakij, 2011). India is at the front of the frugal innovation phenomenon (Hossain, 2016; Krishnan and Prashantham, 2018). Citizen participation as a co-producer in the frugal innovation process for small, local entrepreneurs to develop products to meet the expected needs of the customers is essential (Annala et al., 2018). A key challenge for the frugal innovation phenomenon is to develop different, new offerings with limited resources (Pisoni et al., 2018).

Inclusive innovation has become increasingly important for social and political empowerment rooted at the grassroots level (Pansera and Owen, 2018). A challenge to explore in emerging market is that local researchers who possess deep contextual knowledge have limited experience and incentive to pursue academic research (Nkomo, 2015). On the other hand, researchers from western countries face difficulty to understand the emerging market contexts and collect data (Barnard et al., 2017). Emerging markets are becoming a new frontier for multinationals, which threat local enterprise to grow (Mutlu et al., 2015). Therefore, understanding business model in the emerging market context for the frugal innovation is an interesting research avenue.

It is an urgent need to develop deep understanding on socio-political and economic context and how business models enable local entrepreneurs to compete with established multinationals in the emerging markets (Luo and Child, 2015). Massa et al. (2017) found that business models consist of three interpretations of their meanings and functions: business models as attributes of real firms, cognitive/linguistic schema, and formal conceptual representations of how business functions. Some enterprises compete without the benefits of resource, core technology, or market power. This phenomenon is viewed from a composition-based view which emphasizes how ordinary firms with limited resources generate tremendous results (Luo and Child, 2015). Hence, the importance of indigenous research to understand the specific knowledge of local phenomena and to generate theoretical knowledge across national boundaries is noticeable (van de Ven and Jing, 2012). Leung et al. (2009) defined indigenous research as a broad sense to embrace context-sensitive approaches to a unique local
phenomenon. Frugal innovations embrace context-sensitive approaches to serve low-income customers.

**Method**

*Research setting:* Multiple case study method with abductive research approach has been applied in this study (Dubois and Gadde, 2002). The abductive research approach is effective for theory development. Case study is a suitable method to get in-depth insights on limitedly explored or underexplored phenomena (Yin, 2017). However, multiple case study approach has been criticized for providing a mere description (Dubois and Gadde, 2002). Yet, case study is a widely used research method in the qualitative studies.

*Case selection:* Three cases of frugal innovation that emerge from the grassroots level have been considered in this study. Frugal innovation at the grassroots level is an emerging literature (Hossain, 2016). Frugal innovation phenomenon is being explored from several literature streams including social entrepreneurship, the bottom of the pyramid, and sustainable development. We selected three cases that are similar in terms of their origin and struggle. All three cases are from India. These are MittiCool, Ksheera Enterprise, and Jayashree Industries. MittiCool enterprise is located in Gujarat state, India. It has a range of clay-made products including a flagship product Mitticool-clay refrigerator. Ksheera Enterprise is located in Karnataka, India. It sells low-cost milking machine. Jayashree Industries is located in Tamil Nadu, India, which produces sanitary napkin machine. An overview of the three cases is illustrated in Table 1.
Table 1: Overview of the three frugal innovation cases

<table>
<thead>
<tr>
<th>Case</th>
<th>MittiCool</th>
<th>Ksheera Enterprise</th>
<th>Jayashree Industries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Establishment</td>
<td>2005</td>
<td>2003</td>
<td>2006</td>
</tr>
<tr>
<td>Ownership</td>
<td>Private</td>
<td>Private</td>
<td>Private</td>
</tr>
<tr>
<td>Headquarter</td>
<td>Gujarat, India</td>
<td>Karnataka, India</td>
<td>Tamil Nadu, India</td>
</tr>
<tr>
<td>Product</td>
<td>Clay fridge and other cookeries</td>
<td>Low cost milking machine</td>
<td>Sanitary pad making machine</td>
</tr>
<tr>
<td>Unit Produced</td>
<td>50000 (fridge)</td>
<td>10000 (milking machine)</td>
<td>1300 sanitary pad making machine</td>
</tr>
<tr>
<td>Product price (US$)</td>
<td>80-100</td>
<td>150 - 315</td>
<td>2000- 3500</td>
</tr>
<tr>
<td>Revenue per year (million)</td>
<td>US$0.03-0.07</td>
<td>US$0.03-0.07</td>
<td>US$ 0.05-0.10</td>
</tr>
<tr>
<td>Number of employees (about)</td>
<td>30</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>20</td>
<td>35</td>
<td>A set of machines</td>
</tr>
<tr>
<td>Machine life (year)</td>
<td>5</td>
<td>5 -10</td>
<td>20</td>
</tr>
<tr>
<td>Interviews</td>
<td>· Inventor and owner</td>
<td>· Inventor and owner</td>
<td>· Inventor and owner</td>
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<td>· Head of sales and</td>
<td>· Head of sales and marketing</td>
<td>· A sanitary pad entrepreneur</td>
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Data collection: Data were collected from sources including interviews, secondary data, and observations. Multi data sources are useful for triangulation (Yin, 2017). Data collection methods include interviews with the inventors of the products and managers of the three companies. Interviews were face to face and taken place at the company premises in three states of India - Gujarat, Karnataka, and Tamil Nadu. Moreover, there was a long face-to-face discussion with Professor Anil Gupta of Indian Institute of Management, Ahmedabad who supported these frugal innovations in the early stage. We also developed a comprehensive database of secondary sources, such as media articles, reports, video clips, and enterprise websites.

All three factory premises were visited to get in-field knowledge and to know how these enterprises operate. The interviews were open structured. The interviews were conducted mainly to understand the current situation of their enterprises and future
plans. Their previous achievements are well-documented in the secondary sources. We explored secondary sources extensively before developing interview questionnaires. Due to long interviews, we partially recorded and transcribed the interview texts and extracted the main insights from the not transcribed parts of the interviews. Field visits provided us opportunities to observe the office, factories, employees, and business environment. The observations were noted down in a field notebook during the visits and also reflected on them immediately after each field visit and transferred them into digital format. Extensive photographs of various machines, tools, and process were taken to remember in the later stages. The visits were very long in the case of MittiCool and Ksheera enterprise. A researcher spent a whole day on each of the enterprise premise and around two hours at the Jayashree Industries site. During the visit, all three entrepreneurs demonstrated and explained the mechanism of machines and production process. There are many videos on each enterprise as interviews, Tedex event, and documentary. These three inventions were awarded by the National Innovation Foundation (NIF), India. NIF is a national body that recognize innovation especially that emerge from the grassroots level.

Data analysis: The abduction logic is applied in the study. The data analysis was a process of iterative manner going back and forth between theories, data, and phenomenon. The iterative process expanded our understanding of theory building. We have not developed propositions for future tests. Rather, our focus was on exploring the phenomenon. The data documents were compiled together in a temporary folder. All documents were uploaded on the Atlas.ti which is an effective software program for qualitative data analysis. The coding activities were started based on initially predetermined codes considering various elements of a business model. As the coding process progressed, we added new codes. The analytical process was iterative. We developed refine inference of novel theoretical perspective from the data. We also used open coding the transcripts and marking codes to describe the contents. Open coding means reading the transcripts and identifying codes. The main codes covered three elements of the business model: value proposition, value creation, and value capture from 31 initial codes. The credibility of the study relies on triangulation – using various data sources such as interviews, observations, and archival secondary data.
Case description

MittiCool: Mansukhbhai Prajapati from Gujarat state, India invented the clay refrigerator in 2005. Mansukhbhai was born in a traditional pottery family. He was used to helping his parents in family pottery businesses. Mansukhbhai is a school dropout and unsuccessfully worked as a pottery helper, tea seller, and helper in a tile manufacturing factory. His family lost everything because of Machhu Dam break down and moved to a nearby town in 1979. He had to drop from school out after an unsuccessful attempt to pass class 10. To support the family, his started working in a local tile manufacturing factory as a teenager. He got an eye injury and left the job. In 1984, he started a tea stall by a highway, which he had to close in six months because of sarcastic remarks from his acquaintances. One of his uncles visited his tea stall to find a person who can work in a tile manufacturing factory. He joined there in 1985 and worked for three years. Seeing the tile manufacturing mechanism, he thought that he could manufacture several hundred of pans per day whereas a potter generally can make about 100 items per day. Therefore, he can sell pottery items at a cheaper price.

In 1988, he quit the job and borrowed US$500 from a money lender to start his own business. He bought a piece of land, built his factory there and bought necessary machinery. He could make 700 earthen pans a day. With numerous attempts, he managed to produce quality pans. He was used to selling his pottery items in different villages. In 1995, a businessman was looking for someone who could supply 500 clay water filters to deliver them to Nairobi, Kenya. He approached Mansukhbhai who successfully delivered the filters. Among others, in 2001, he was producing clay water reservoirs which were featured in a local newspaper with the caption “the broken fridge of the poor” which inspired him to develop clay fridges. After five years of experiment, from 2005 he started manufacturing clay fridge made of main materials sand and sawdust. He launched a company called MittiCool based on its flagship Mitticool1 fridge which is typically 18.5 inches x13 inches x 11 inches in size and weighs 20 kg. with a single door. The fridge does not require any electricity so no recurring cost.

1 The MittiCool is used for the enterprise and the Mitticool for the clay fridge which is the flagship product of the enterprise.
He borrowed money initially from a money lender, then from local banks, and funding twice from National Innovation Foundation. He borrowed US$10000 from a local Jivan Commercial Cooperative bank at an 18% interest. More recently, however, Gujarat state started a special scheme to disburse loan at less than 1% interest rate for ventures like MittiCool. MittiCool enterprise has benefited significantly from this loan scheme. The fridge keeps foods and vegetables fresh for several days. The Mitticool fridge is used not only to preserve food items but also to keep medicines and medical items in a particular temperature in rural areas. It is an alternative for the rural people who may not have access to electricity and cannot afford a conventional fridge. The current price of a Mitticool is about US$80. The fridge has two chambers. The top chamber stores water and the bottom chamber stores food. Water drips from the top chamber down the side walls of the bottom chamber and evaporates; thereby, remove heat through this process. There is a built-in tap in the top chamber to dispense drinking water.

**Ksheera Enterprise:** Ksheera enterprise is located in Karnataka state, India. The enterprise was started based on the low-cost milking machine invented by Raghava Gowda who was a schoolteacher and farmer. The enterprise established in 2003 to produce milking machine with several mechanisms and brand names MILKMASTER and IMILKER. Traditionally, farmers in India milk their cows manually with hands. Raghava had a cow that needed to milk every day. Milking was neglected as there was no available person to milk the cow. Consequently, the cow got udder infection. On the other hand, Gowda experienced strained nerve from manual milking.

Gowda’s milking machines are useful for farmers who have several cows to milk. From the local idea of the gutter spray pump, he started to invent a hygienic low-cost milking machine considering the electricity scarcity of different regions. Due to time constraints, paying for a substitute teacher, he took a year-long sabbatical leave from his school to fully concentrate on developing a milking machine. After four years of trial and error, he developed a functional milking machine with different power options, which can milk 1.5-2.0 litres per minute. The machine can milk up to 10 cows per hour, one animal at a time. The invention was awarded national award for grassroots innovations from the president of India. Currently, the factory of Ksheera Enterprise has a capacity of making 250 machines per month and employs 25 full-time technicians. The enterprise has three
types of milking machine: hand operated milking machine, single phase AC motor driven milking machine, and 12-volt battery operated milking machine.

Jayashree Industries: Arunachalam Muruganantham from Tamil Nadu, India invented a low-cost sanitary pad making machine with a simple mechanism. Over 88% of 355 million menstruating women in India use unsanitized cloth, ash, and husk to take care of the menstruations. Due to premature demise of his father, Arunachalam dropped out from the school and started working as a day labourer, helper in a repairing shop of farming equipment, machine operator, insurance agent, and yarn-selling agent.

His entrepreneurial journey started after his marriage in 1988. He witnessed his wife carrying a dirty rag to take care of her menstruation. Consequently, he for the first time learned how women take care of menstruation in a highly unhygienic way. To surprise his wife, he bought a sanitary pack and found that it is very expensive even though raw materials used in it are not expensive. He developed sanitary napkins using local materials and approached his wife and sisters to test his napkins. They were embarrassed and reluctantly participated in his experiment. Next, he approached some female medical students and managed to find 20 medical students to participate in his experiment. However, he did not receive proper support from the medical students. Eventually, he then decided to use his napkins himself. He was walking and cycling wearing a football tube filled with animal blood, under his underwear, to understand the menstruation process. Seeing his activities, his wife and then his mother left him, which is rare in the Indian context. Meanwhile, people of his locality considered him insane.

He could not identify the raw materials that are used by multinationals. With the support of a local professor, he managed to receive samples of raw materials (wood fibres) that are used by multinationals. He found that wood fibres are not expensive, but the cost of the manufacturing machine is the main reason for the high cost of sanitary napkins of multinationals. After four and a half years of trial and error, he managed to develop a sanitary pad making machine in 2004. Currently, there are two models of the machine - a manually operated (US$2000) and semi-automated model (US$3500). Arunachalam points out that his machines enable 22000 women to earn a livelihood and more than a million use sanitary pads made with his Machine.
Analysis and results

Business model typically has three key components: value proposition, value creation, and value capture (Zott et al., 2011). Value proposition refers to a business statement that a company puts forward to convince customers to buy its products. Value creation identifies different values and their interrelation while value capture determines how value is monetized (Hossain, 2016). A framework of sustainable business model for frugal innovation is depicted in Table 1. The value propositions of the three enterprises are slightly different as they target different customers. However, their ways of value creation and value capture are broadly same.

1.1 Value proposition

The main value propositions of the all three enterprises are an affordable product, a new product for a niche market, local employment, and sustainable development. Furthermore, clay fridge does not need electricity and milking machine has an option to operate without electricity. The enterprises focus on fulfilling the needs of the people who live in rural areas. Often, people who live in rural areas in developing countries have no access to electricity and healthcare. Even if basic amenities are available they cannot afford them due to their limited income. Mitticool is a clay fridge which works without electricity. It gives low-income people to afford a fridge and there is no recurring cost for electricity.

Ksheera enterprise’ milking machine has several options. Its manually-operated machine is suitable for customers who may not have the budget to buy the other versions. A machine can be shared by several families in rural areas that lead to lower price per family. A milking machine takes several minutes to milk a cow. Therefore, a machine can be used many times by many people. A machine can be used to milk a large number of cows. Therefore, real price per customer for a milking machine is minuscule.

Jayashree Industries sells sanitary making machine along with raw materials to individuals, NGOs, societies who make and sell sanitary pads to their localities. There is no single brand for sanitary pads. Each sanitary pad entrepreneur has its own brand name for her sanitary pads and there are at least 900 brand names. Low price product
in a niche market has provided these enterprises an opportunity to offer unique value propositions.

All three enterprises have significant role in local employment. For example, MittiCool has 30 employees working in its factory. It pays locally high salary to its employees, as Mansukhbhai pointed out: “Yes I pay a high salary to my employees because skilled people are difficult to find and I want them to feel at home here”. He also points out that his work has inspired about 1000 families who send items to over a million users. Making profit is not his main objective. He wants his employees and community to benefit from this company. Moreover, many people are indirectly working for the MittiCool in various ways such as a salesperson and supplier. Similarly, Ksheera enterprise has 25 employees who are mostly the former students of the inventor or studied in the school where the inventor was teaching in. Additionally, many people are indirectly working for the milking machine. Even though Jayashree industries has few employees of its own it has generated several thousand employees with 1300 machines, each machine creates several (mainly) female employees. Thus, the sanitary pad machines provide employment to thousands of rural women.

A key element of the value proposition of all three enterprises is sustainable development. Enterprises serve underserved customers and employ different types of employees. They largely employ female employees. Jayashree industries’ sanitary pads exclusively empower underprivileged women. Currently, people are shifting towards natural and organic products. Hence, clay fridge and similar products are getting attention even from some high-income customers. According to the head of sale and marketing of MittiCool, their products develop green societies in the rural areas, thereby contribute to reduce carbon footprint. MittiCool enterprise runs an organization called “Prajapati Hastakala Vikas Trust” to recognize poor students who score 70% or more in class one to class 12. The organization also pays the school fees and accommodation costs of poor students. Interestingly, students do not know about this as they are told by the schools that their fees are exempted so that students do not feel indebted to MittiCool. Ksheera enterprise enables farmers to milk their animals in a hygienic way. Jayashree industries is empowering women as entrepreneurs and sanitary pad users.
Figure 1. A framework of sustainable business models for frugal innovation

Value creation

All three enterprises have unique business models with “out of the box thinking”. Inventors were far away from modern science and technologies. They created value by using local employees, local raw materials, simple technologies, and local supply chain. They optimized costs in their innovation process to fulfill the needs of resource-constraint customers. Production cost is minimized throughout the production process. The innovation method of the three enterprises enables the firms to meet cost criteria on the one hand and to satisfy low-income customers, the other. Locally available low-cost people are an advantage for all three enterprises to produce their products at a low cost. Mitticool fridge is made largely of locally available clay which is very cheap. Mitticool works on a simple principle. Water evaporates through the walls to keep the food items cool and fresh. MittiCool has received significant support from Gujarat state as shared by the Mansukhbhai: “if we want to go Delhi to attend a trade fair, our carrying cost and hotel cost were born by the state unless we made enough money.”

The inventors identified the needs in a very unconventional way. The initial aim of the MittiCool inventor was to gain efficiency by producing more products in less time,
compared to the widely used methods of that time. Mitticool inventor expressed, “we worked from 4:00 am to 22:00 pm. Now, the same work takes only one hour.” He got the idea of production efficiency from another industry - roof tiles manufacturing industry. The inventor of the low-cost milking machine got his idea from the gutter spray pump. Both inventors have applied mechanisms that are available in other industries. The inventor of the sanitary pad making machine has not got any idea from other sectors. He invented his machine without getting any significant knowledge from external sources. Arunachalam has reduced the costs of sanitary pad significantly as he claimed: “In four years I invented an easy-to-use device which could produce pads at a third of the cost of the commercially produced ones”.

All three inventors thought to invent based on their small means and considering target customers and the unique circumstances in the emerging markets. Personal experience of the inventors and the proximity to the target customers are invaluable. Physical proximity and deep engagement are extremely important for frugal innovation (Jha et al., 2016). The Mitticool fridge is expected to last five years as the cooling power decreases over time. The clay used for the fridge is baked at 1200 ºC to make it strong. It takes 10 days to make a fridge. The milking machines last 5-10 years. The sanitary pad making machine is claimed to last 20 years. The maintenance cost for the products of all three enterprises is very little.

Inventors had to struggle for long period of time for value creation. Initially, Mansukhbhai was producing clay pans made of clay heated to a certain temperature. He experimented not only with different materials and proportions of materials but also with different heating temperatures to find the optimum combination of materials and temperature. Moreover, he was selling his products in local markets and had frequent communications with his customers. Consequently, he was getting instant customer feedback. Furthermore, local institutes extended their support to test and educate him regarding material properties. Raghava took one-year sabbatical leave from his school to fully focus on his milking machine invention project. A challenge for him was to understand the materials that are appropriate for milking machine. Arunachalam tested different materials just to find raw materials that are suitable for sanitary pads. He went through various trial and errors. His machines are made of locally available materials,
but the raw materials that are required to make sanitary pads are imported from countries such as Australia, Canada, and USA.

A key element of value creation of these cases is simple technologies. Blending commonly known properties with novel ideas has enabled them to solve problems that are crucial for the low-income customers in rural areas. Because of simple mechanisms, all three inventions are easy to operate for the target customers who are reluctant to embrace high-tech machine as most of them have limited formal education. The enterprises use local materials and local suppliers for backward and forward delivery. The inventors have brought low-cost products that are affordable to low-income customers who are not considered valuable customers by multinationals.

Value capture

All inventors used unique value capturing approach. They capture value by selling unique products to the customers and reducing production and delivery cost. The enterprises consider extreme cost reductions in acquiring raw materials, manufacturing, and sales. However, they have difficulty to reduce cost in product delivery. Low-cost, local materials are the main source of cost reduction. Another source of cost reduction is local low-cost employees. All three products have minimum features but good-enough for the target customers. The products of the three enterprises were developed without applying any cutting-edge technology. Thus, the products are developed based on extreme cost reduction. The enterprises have an edge from grassroots cost advantages in emerging markets. Products were developed by the owners of the enterprises with local institutional supports. The enterprises do not use any formal marketing channel. Word of mouth is the main catalyst to disseminate information about their products. The inventions were recognized at the national level and covered extensively in local and international media including documentary and Bollywood movie.

The brand is a key for all three enterprises. MittiCool is trying its best to sell its products using its own brand. It gets frequent inquiries from people and organizations who want to market Mitticool fridge with a different name. The Mitticool fridge is copied by a wide range of people and they sell their products at a price lower than the Mitticool fridge
price. MittiCool tries its best to keep its brand value. Sometimes they bend to take MittiCool logo out due to strategic reasons. For example, MittiCool sells products removing its brand name and giving 'made in India' stamp to an organization in Dubai which is the main export destination of the fridge. Moreover, it is willing to sacrifice its brand name and manufacture with the brand of the distributors. "First try will be MittiCool and if that does not work then I will also go with their brand", said by the head of the sales and marketing. MittiCool recently started investing in marketing on social media platforms and business to business portals to keep the brand name listed at the top of google searching as it realizes that many customers are interested to buy MittiCool products but they are not aware of the products.

Some conglomerates want to acquire MittiCool and others offer to joint venture, but MittiCool does not want to lose its brand name. Similarly, Jayashree and Ksheera were approached by large firms to acquire or partner but both of these enterprises have declined fearing that they may lose their brand names and they may be mistreated. MittiCool has distribution network across India. Dealers, sub-dealers, and retailers are selling MittiCool products in their respective territories. MittiCool tried to franchise but it did not work due to reluctance from the potential organizations. For MittiCool, it is not difficult to open franchise stores but maintaining them is challenging. However, just recently MittiCool has four franchise outlets in four large cities in India. Furthermore, it is trying to engage people (especially females) who can spend around US$300 and some hours in a week along with their household works. They will sell small size, fast moving products that can be easily couriered. Ksheera enterprise gets selling advantage from milk associations who subsidize farmers to purchase milking machine. MittiCool gets support from well-off people such as diabetes patients, teachers, professors, Ayurvedic doctors as well as schools and universities who advocate products like Mitticool fridge. Ironically, even though the Mitticool fridge is meant for the poor people, the outcome is opposite. According to Mansukhbhai, only 20% of about 50000 fridges are bought by poor people.

An emerging phenomenon that is highly related to frugal innovation is reverse innovation (Govindarajan and Ramamurti, 2011). When an innovation is first seen, developed or used in the developing countries and then trickle-up in developed countries that is called reverse innovation (Simula et al., 2015). Reverse innovation
shows a new way to serve customers in the developed countries. All three frugal innovations are also reverse innovation. MittiCool has exported its products to other countries including some high-income countries, such as Singapore, United Arab Emirates, and African countries. It has high demand in Gulf countries. MittiCool has received orders from 41 countries across the world. Even though Jayashree Industries is getting inquiries from neighbouring countries it is reluctant to export sanitary pad making machine at this moment. Arunachalam is aware that his machine is copied and modified by local people in countries such as Kenya, Ghana, Nigeria, and Zimbabwe. However, he plans to market his products in 106 countries and create one million jobs. Arunachalam's sanitary pad making machine is installed in Jordan for Syrian refugees. Ksheera Enterprise exports to neighbouring and distant countries including Sweden, Kenya, New Zealand, and Mexico.

The enterprises do not bother much about copying as India is a huge country and covering the whole country is difficult for them. Arunachalam goes on to say: “I put all the detail upfront on the public domain to copy. I do not worry about copying because the mission I have is to make awareness.” Intellectual property rights (IPRs) are weakly implemented in the emerging markets specifically for the frugal innovations at the grassroots level. Frugal innovations are widely copied by unscrupulous individuals and organizations. IPRs fail to protect frugal innovations that are originated from the grassroots level and frugal enterprises also least bothered about their IPRs even though they have patented their products (Hossain, 2018a). Mansukhbhai expressed: “patent for my product is not important; I have got the patent for complacent”. He feels happy when he sees the use of copied products for the mass people. Arunachalam expressed his anguish over the state supports as he pointed out: “I went to Harvard and one girl asked me in what way you are helping the Indian government. I told them both Monmahan (prime minister) and Sonia (Congress party chief) are allowing me to continue. Allowing is everything.” Even as Muruganantham was gaining worldwide recognition, he felt let down when the Government of India announced a scheme to supply free and “highly subsidized” sanitary napkins to the poor women but did not involve him. Despite many hurdles, all three enterprises have become successful in niche market with their sustainable business models.
Implications

This study shows how novel business models of frugal innovations serve unserved customers in emerging markets and play a pivotal role in sustainable development. It illustrates how enterprises from the grassroots level develop value propositions, create value, and capture value. The enterprises provide low-cost products to low-income customers. These products are very simple to use. Their value propositions include affordable and sustainable products for a niche market to uplift the underserved customers and job creation at the local level. Where necessary, the enterprises also provide training to the customers. Frugal innovation creates new niches including new customers, new market segment, and a new way to sustainable development. Emerging markets consist of different institutional and market environment. Therefore, innovations for the emerging markets need to be tailored with new business models to reduce cost. Knowledge from the grassroots level for the business model is essential to meet the local needs. Frugal innovation lacks adequate government support which is essential. State support is a key for the frugal innovation. Arunachalam would have a massive sale growth if his machine gets included in Indian government’s recently declared scheme to provide free and highly subsidized sanitary napkins to low-income females.

All three enterprises were perseverance to develop frugal innovation. It took four to five years of experiment to develop their products. Only a few people may have commitment to spend so many years to develop products. To develop frugal innovations at the grassroots level, individuals need long-term dedication and need simple technological support which is not easily available in the emerging markets. Getting funding for the grassroots inventors is challenging. Building necessary institutes and environment for financial and technological support is important. Due to local rootedness and lack of proper transportation system, many frugal innovations fail to scale up. Even though frugal innovations are patented they are copied by unscrupulous people. The enterprises cannot take any legal action due to weak IPRs management in the emerging markets.
Enterprises gained funding from friends and family, private money lenders, and banks. Due to lack of knowledge and support from experts they were not aware of alternative sources of funding, such as crowdfunding and venture capital. There are some micro venture capitalists in India, but access to those sources for the grassroots enterprises is challenging (Sonne, 2012). Western start-ups have access to hi-tech science and technologies, innovation hub, and venture capital, which are not available for the cases we explored. Sustainability is becoming increasingly important for business and society. Frugal innovations are effective means to achieve sustainable development. Frugal innovations create a new type of employees, create new customer segment, empower local people, boost local empowerment and create niche markets. Frugal innovations at the grassroots level are a bottom-up approach which is effective for the sustainable development.

Frugal innovations are based on business models with multidimensional value propositions. Frugal innovations create a new type of materials used, new types of employees, and new types of market. Thus, their contribution to sustainable development is more effective than conventional products. This study has several implications for practitioners. It demonstrates how to solve social problems with a novel business model to meet societal needs affordably.

Developing frugal mind-set, culture, attitude by scholars, managers, and policymakers are essential for sustainable development. The frugal inventors at the grassroots level have in-depth knowledge about the low-income customers and the emerging markets. Value propositions at a very low cost by keeping low-income customers as the key focus lead to frugal innovation. In a situation of dire need, low-cost solutions for the customers who do not have access to the existing solution are a precious value proposition. Frugal innovations originated from the grassroots level do not compete with the existing products as they solve problems where mainstream products ignore. Success comes after long struggle and enterprises need to overcome barriers that are significantly different from other western start-ups. Frugal innovations bring underprivileged people into the mainstream of the society.
Future research

Frugal innovation at the grassroots level for the sustainable development is a recent entry in the academic literature. Sustainable business model, frugal innovation and emerging markets, all three are emerging concepts in the academic literature. We have limited understanding of sustainable business model in its dynamic situation. How frugal innovations evolve from its inception to its mature stage is interesting and valuable to explore. Some frugal innovations are tickling up into developed countries. How frugal innovation at the grassroots level can successfully capture value in the developed countries and what are the associated challenges for that purpose are important to study in the future. Business models differ between developed and developing countries as well as between frugal innovation and mainstream innovation. These differences are limitedly explored in the extant literature. Decision making steps of the case inventors are very different from other entrepreneurs. The physiological aspects of the frugal entrepreneurs would be valuable to explore. Developing product distribution channel is challenging for the frugal innovations. Exploring issues related to products distribution can be very insightful. Financial mechanisms are unorganized for the frugal innovations. Understanding how to establish financial mechanisms to support frugal innovations is essential. To develop frugal innovation, individuals embrace effectuation perspective in place of causation. The effectual entrepreneur starts small and the endeavor grows bigger through expanding her network of relationships in iterative cycles. Studies on IPRs at the grassroots level in the developing countries are limited in the literature. Frugal innovation is a recently emerged phenomenon as such there are numerous avenues for future research.
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