Journal of Cleaner Production 406 (2023) 137050

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

Frugal innovation as a source of sustainable entrepreneurship to tackle social and environmental challenges

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ARTICLE INFO

Handling Editor: Cecilia Maria Villas Bôas de Almeida

Keywords:
Sustainable entrepreneurship
Frugal innovation
Sustainability
Developing countries

ABSTRACT

Sustainable entrepreneurs have increasingly faced challenges in achieving triple-bottom-line objectives. The study portrays frugal innovation as a source to foster sustainable entrepreneurship to move the debate beyond discussing the challenges of sustainable entrepreneurship. As such, we investigate how sustainable entrepreneurship with frugal innovation can tackle social and environmental challenges in the context of a developing country. An inductive approach with multiple case-method is used in this study. The results show that entrepreneurship based on frugal innovation leads to several social outcomes, such as female empowerment, improved quality of life, and access to affordable healthcare for low-income customers as well as environmental outcomes, such as sustainable products and production techniques. Furthermore, sustainable entrepreneurship creates new markets in developing countries and promotes inclusive growth. Our research reveals that sustainable entrepreneurship if based on frugal innovation, serves dual purposes. It enables businesses to make a profit and contribute to solving societal problems simultaneously. Juxtaposing with frugal innovation, we expand the field of sustainable entrepreneurship by shifting the debate from barriers to potential sources and enablers. Based on the findings, we provide implications and future research directions.

1. Introduction

Sustainable entrepreneurship as a way to solve inequality and environmental degradation is gaining growing recognition from scholars, practitioners, and policymakers (Mendes et al., 2022; Muñoz and Cohen, 2018; Urbaniec et al., 2022). It has been considered a key subdomain of a solution to social and environmental problems (Argade et al., 2021a,b; Stubbs, 2017). It refers to the discovery, creation, and exploitation of entrepreneurial opportunities that contribute to sustainability with triple-bottom-line objectives, i.e., economic, social, and environmental wellbeing (Hockerts and Wüstenhagen, 2010; Shepherd and Patzelt, 2011). Research on sustainable entrepreneurship thus far emphasizes the conceptual distinction from traditional entrepreneurship (Muñoz and Cohen, 2018), the promise of triple-bottom-line objectives (Cohen and Winn, 2007), and additional barriers to sustainable businesses (Hoogendoorn et al., 2019; Shahid and Reynaud, 2022). Scholars are interested in identifying risks, constraints, and obstacles in nurturing sustainable entrepreneurship.

Responding to the debate on the challenges associated with sustainable entrepreneurship (Hoogendoorn et al., 2019; Shahid and Reynaud, 2022), we aim to reveal its potential enablers. Prior research suggests that sustainable entrepreneurship has to create social and environmental benefits along with the traditional aspect of economic rents (Cohen and Winn, 2007; Muñoz and Cohen, 2018), as such a number of challenges are linked with it including access to funding, information asymmetries, lack of customer awareness and governmental support (Hoogendoorn et al., 2019; Thelken and de Jong, 2020). In addition, these challenges are even more adverse in developing countries, where discovering and exploiting sustainable business opportunities is much more strenuous (Argade et al., 2021a,b). Therefore, to present a way forward in stimulating sustainable entrepreneurship, we contend frugal innovation (FI) as a source to achieve sustainable business outcomes. Particularly in a resource-scarce context, where limited resources otherwise make it challenging to pursue such business opportunities.

According to Hossain et al. (2016, p.113), FI is a resource-scarce

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https://doi.org/10.1016/j.jclepro.2023.137050
Received 19 September 2022; Received in revised form 25 March 2023; Accepted 31 March 2023
Available online 5 April 2023

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. FI has emerged as a solution to social challenges (Hossain et al., 2021), and many aspects of FI link to sustainability (Albert, 2019). FI's offering of sustainability overlaps with the qualities of sustainable entrepreneurship. However, to the best of our knowledge, there is no scholarly attempt to theorize the link between these two concepts. Exploring sustainable entrepreneurship with FI to tackle social and environmental challenges is a timely and valuable research area. Hence, *this study explores how entrepreneurship based on FI contributes to sustainable development by solving economic, social, and environmental challenges in a developing country*. Based on six cases of Pakistani start-ups and using interviews, observation, and secondary data, we attempt to understand how sustainable entrepreneurship with FI contributes to solving socio-ecological challenges. As a result, we bring together two apparently separate theoretical disciplines – sustainable entrepreneurship and frugal innovation – and offer a more integrative framework for achieving sustainable development in developing countries. Our study makes three key contributions to the literature.

First, considering the additional challenges associated with sustainable entrepreneurship (Hoogendoorn et al., 2019; Shahid, 2022), we theorize frugal innovations as a source to achieve sustainable outcomes. Sustainable entrepreneurship enables entrepreneurs to gain profit and improve social and environmental conditions simultaneously (Belz and Binder, 2017). Meanwhile, FI has become apparent as an affordable solution for cleaner production processes and quality products that serve underserved customers (Albert, 2022; Dabić et al., 2022). As such, we explain that frugal innovation is a reliable solution in resource-scarce environments that subsequently contributes to sustainable development. This shifts the debate from discussing the challenges of sustainable entrepreneurship towards potential solutions for promoting sustainable entrepreneurship. We argue and explain that sustainable entrepreneurship if based on FI has enabled people from all social groups to afford a healthy lifestyle and improve the overall quality of life in the developing world. Such entrepreneurship contributes to female empowerment and creates social value in the communities (Barrachina-Fernández et al., 2021). In addition, it plays a crucial role in promoting sustainable lifestyles while also focusing on the environment-friendly production of goods and services. Eventually, entrepreneurship based on FI has enhanced the prospects of inclusive growth through opportunity creation and development.

Second, we explain what enables frugal innovation from the entrepreneur's perspective. We divulge those entrepreneurs' personal characteristics, networks, and inspirations contribute to identifying and exploiting frugal innovations with socio-environmental benefits that result in sustainable business practices. We emphasize the importance of entrepreneurs' personal factors that motivates them to pursue FI-based sustainable entrepreneurial opportunities. *Finally*, as the current body of literature on sustainable entrepreneurship is dominated mainly by research in the context of developed countries (Argade et al., 2021a,b), the case of Pakistan not only brings in the perspective of a resource-constrained setting but also explains how sustainable entrepreneurship with frugal solutions can serve low segments of society. Prior research indicates that resources and culture are key factors affecting entrepreneurs' intention to create social and environmental value (Brieger and De Clercq, 2018). Therefore, context is another pivotal factor in considering entrepreneurs' propensity to solve social challenges (Urbano et al., 2019). We present the case of a developing country where despite resource constraints; FI has emerged as a cost-effective way to foster sustainable entrepreneurial opportunities.

2. Theoretical background

2.1. Sustainable entrepreneurship

Every day the world is besieged by grand challenges impacting people's political, economic, and social wellbeing, such as climate change, environmental degradation, food insecurity, famine, rising poverty and homelessness, deforestation, and depletion of clean drinking water, to name a few. Despite technological, economic, and social progress, these grand challenges remain stubbornly persistent and are becoming even more evident with time (George et al., 2016). Can entrepreneurship help solve these grand challenges? Traditionally, entrepreneurship has been studied as a mechanism to stimulate economic development (Kirzner, 1973; Sarango-Lalangui et al., 2018) and create financial value (Schumpeter, 1934). However, increasing awareness of global social and environmental challenges has caused many academics to reconceptualize the notion of entrepreneurship from merely being a wealth-generating activity to an endeavor that must also incorporate elements of social and environmental goodness in its mission (Anand et al., 2021; Gast et al., 2017; Schaltegger and Wagner, 2011). This reconceptualization of entrepreneurship in the academic discourse is referred to as sustainable entrepreneurship – an increasingly important sub-field of entrepreneurship research. According to Shepherd and Patzelt (2011, p.142), sustainable entrepreneurship is defined as an activity *"focused on the preservation of nature, life* support*, and community in the pursuit of perceived opportunities to bring into existence future products, processes, and services for gain, where the gain is broadly construed to include economic and non-economic gains to individuals, the economy, and society"*.

Scholars increasingly perceive entrepreneurship and sustainable development as two interconnected phenomena. As a result, entrepreneurs are seen to make efforts to reduce the negative impacts of their activities on the environment and society (Markman et al., 2019; Muñoz et al., 2018). Many terminologies have been used to discuss the sustainability discourse in entrepreneurship. Such as "ecopreneurship" (Dixon and Clifford, 2007; Isaak, 2002), "sustainable development entrepreneurship" (Muñoz and Cohen, 2018), "sustainable entrepreneurs" (Choi and Gray, 2008; Tilley and Young, 2009), "environmental entrepreneurship" (Linnanen, 2005), "green entrepreneurship" (Schaltegger, 2002) being employed interchangeably to connote sustainable entrepreneurship. Most commonly, sustainable entrepreneurship has been linked with the concepts of ecopreneurship and social entrepreneurship for their focus on preserving the natural environment and creating social value, respectively. Sustainable entrepreneurship, however, is a distinctive concept that combines economic, social, and environmental value creation with its focus on the wellbeing of future generations (Terán-Yépez and Marín-Carrillo, 2020; Belz and Binder, 2017). Therefore, many scholars view an entrepreneurial activity as sustainable when it combines holistic economic, social, and environmental goals to pursue business opportunities (Schlange, 2009; Tilley and Young, 2009). Sustainable entrepreneurship, in its essence, is a pursuit of the triple bottom line (Muñoz et al., 2018; Nicolopoulou, 2014). While the achievement of the triple bottom line is an integral objective of sustainable entrepreneurship, it must also involve an active discovery, creation, and exploitation of new opportunities on the part of the agents (i.e., sustainable entrepreneurs) to distinguish itself from sustainable development and become entrepreneurial (Shepherd and Patzelt, 2011).

Over the last decade or so, various streams of inquiry have emerged within the mainstream literature of entrepreneurship vis-à-vis the theoretical development of sustainable entrepreneurship. The earliest of these streams focused on the conceptualization of sustainable entrepreneurship, within which we see a group of scholars trying to develop different constructs of sustainable entrepreneurship while others focus on distinguishing it from other forms of entrepreneurship (Schaefer et al., 2015; Schaltegger and Wagner, 2011). Another strand of research

has rather focused on understanding the agent themselves, i.e., the sustainable entrepreneurs, providing several conceptualizations around what motivates entrepreneurs to pursue sustainability goals (Nhemachena and Murimbika, 2018) and the capabilities they need to materialize such goals (Brieger and De Clercq, 2018).

Many scholars have focused on understanding the process of sustainable entrepreneurship, i.e., how new sustainable ventures are created and their particular contribution to sustainable development goals (Belz and Binder, 2017). The main emphasis of scholars within this process stream is 'opportunity exploitation' process in the field of sustainable entrepreneurship and how 'sustainable innovation' and its associated activities emerge within firms (Bapoo et al., 2022; Schaltegger and Wagner, 2011). As the field develops, recent studies try to offer more holistic overviews of the phenomenon, ranging from studies exploring the framework of 'sustainable business models' (Lüdeke-Freund, 2020; Davies and Chambers, 2018), the role of digital technologies in achieving socio-ecological value (Gregori and Holzmann, 2020) and the formulation of sustainable entrepreneurship strategies (Rantala et al., 2019). There is also growing literature on the challenges and barriers of sustainable entrepreneurship spreading from lack of institutional support, access to funding, perceived risk, customer awareness, and information asymmetries (Hoogendoorn et al., 2019; Shahid, 2022). Lastly, most of the evidence and conceptualizations of sustainable entrepreneurship thus far are situated in the context of developed countries (Terán-Yépez and Marín-Carrillo, 2020), with a very scant understanding of this phenomenon in the context of developing countries.

Despite the aforementioned theoretical developments, sustainable entrepreneurship as a field of research, as asserted by Muñoz et al. (2018), is in its nascency with many challenges and opportunities. There is still a need to analyze sustainable entrepreneurial behaviors, processes, and effects (Muñoz and Dimov, 2015), especially in the face of ever-changing circumstances and grand challenges. Particularly, there is a need to go beyond discussing the objectives of sustainable entrepreneurship, crafting a difference among several ways of practicing entrepreneurship and the additional challenges associated with fostering sustainable entrepreneurship. Therefore, there is a need for "cross-pollination of research" (Anand et al., 2021, p.15) between sustainable entrepreneurship and other related subject areas to advance the field by delving into potential sources of sustainable opportunities. For example, innovation and social entrepreneurship literature have the potential to inform sustainable entrepreneurship with regard to developing a more profound and broader understanding of its processes and outcomes. As of now, our ability to understand the dynamics of a sustainable venture vis-a-vis innovation is limited (Hockerts et al., 2018).

Finally, there is also a need to engage more closely with the 'outcomes' of sustainable entrepreneurship activity. Sustainable ventures are distinct in their pursuit of a net positive impact on individuals, societies, and the wider ecological system. Their pursuit of a triple bottom line that makes it difficult for researchers to capture and evaluate the outcomes of sustainable entrepreneurship in an objective manner (Anand et al., 2021). There is a heightened need for studies that "can explore how the solutions developed and promoted by sustainable ventures contribute directly to improving the wellbeing of social groups and changing the behavior of markets, competitors and industries" (Muñoz et al., 2018, p.328), an objective that warrants cross-fertilization of sustainable entrepreneurship literature with the theoretical discourse of innovation.

2.2. Frugal innovation

A newly emerged concept called frugal innovation has caught great attention, particularly in management research (Fischer et al., 2020; Hossain, 2020; Zeschky et al., 2017). It refers to developing affordable solutions with limited resources for producing goods and services (Hossain et al., 2016). The uniqueness of FI lies in its being an innovative solution that provides low-cost yet quality products to meet the needs of low-income customers living in a resource-constrained environment (Zeschky et al., 2011). Generally, FI spans the healthcare, transport, energy, housing, education, and manufacturing sectors, enabling entrepreneurs to develop unconventional yet affordable business solutions. The innovative aspect of FI involves simplification (Lim et al., 2021) to deliver fundamental needs with minimum resource consumption, targeting the low-end customers of society (Hossain, 2018) while also considering their wellbeing (Hossain et al., 2016). Over the years, FI has been conceptualized differently in several areas. Some academics have a product-centric perspective (Winterhalter et al., 2017), others like to conceptualize it as a process (Knizkov and Arlinghaus, 2020), while some also define it as a type of business strategy or as a blend of unique techniques, goods, and services (Bound and Thornton, 2012). When it comes to novel product architecture (Rao, 2013; Lim and Fujimoto, 2019) or opening a new market (Zeschky et al., 2011), FIs can occasionally even be "disruptive" for established mainstream solutions (Rao, 2013). Even though there are different ways to approach FI, there is a broader consensus on its ability to provide quality and cost-effective solutions to meet the needs of under-served communities in resource-constrained settings.

2.3. Frugal innovation and developing countries

FI is regarded as an imperative and cost-effective solution in developing countries due to insufficient resources and a large number of low-end customers (Hossain et al., 2016). On the one hand, developing country dynamics imply mass production, rapid growth, and high profitability (Shah, 2012). On the other hand, it also emphasizes the scarcity of resources and an increase in middle-to-low-class customers who are still looking for affordable solutions (Agnihotri, 2015; Iyer et al., 2006). FI maximizes the 'value' output for low-income background people by adopting "financial, human and material frugality" (Rao, 2013, p.133), leading to sustainable development and an empowered lifestyle for the poor. FI is highly regarded in developing countries such as entrepreneurship built on FI has been found to solve various societal and environmental challenges, such as access to primary healthcare (Agarwal et al., 2020), women empowerment (Hossain, 2021), access to clean energy (Bas, 2020), provision of affordable housing (Dressler and Bucher, 2018), and so on. It is also closely associated with the notion of inclusivity, under which markets can engage and benefit individuals who are traditionally excluded or even exploited by prevailing market systems, such as the poor, women, and other marginalized groups (Drori et al., 2018; Mair et al., 2012). Entrepreneurs practising FI combine and align principles of business strategy with those that involve social value creation (Agarwal et al., 2021) by addressing social problems like poverty, health care, and clean water. They ensure that their business models create value for the customers ignored by conventional firms (Hossain, 2018; Chliova and Ringov, 2017). It implies that FI fosters economic activities in developing countries and contributes to social and environmental well-being. However, the link between FI and sustainable entrepreneurship remains missing in the literature, the gap that this paper precisely aims to fill.

2.4. Frugal innovation: a pathway to sustainable entrepreneurship

Recent research supports that sustainability is a well-proven outcome of frugal innovation (Hossain, 2020). Scholars hold the view that frugal products are affordable for the base of the pyramid customers without compromising socio-ecological and economic sustainability (Levänen et al., 2016). FI drives social equity (Basu et al., 2013) and encourages saving resources to lower the carbon footprint (Brem and Wolfram, 2014; Rosca et al., 2017). FI and social sustainability are thus intertwined as it enables mainly poor communities to solve various problems pertaining to health, education, and energy to uplift their

living standard (Khan, 2016). The importance of measuring innovation through the lens of sustainability is growing, and there is a close connection between FI and sustainability in developing countries (Hossain, 2020).

Therefore, we argue FI should be seen as a pathway to sustainable entrepreneurship due to its ability to solve social, environmental, and economic problems faced by low-income populations residing in resource-constrained settings for three main reasons. First, given that research reveals several additional barriers to sustainable entrepreneurship, such as access to resources and perceived lower profitability (Hoogendoorn et al., 2019; Shahid, 2022), FI in developing countries enables to provide cost-effective solutions (Levänen et al., 2016) that ultimately lower their production cost and results in better economic rents. Second, due to rapid growth in developing countries, there is a significant threat of scarcity of resources (Iyer et al., 2006; Shah, 2012). However, FI may serve as a route to build goods and services with limited means, consequently facilitating the preservation of recourses. Finally, one may argue that since middle-to-low-end customers are abundant in developing countries, FI provides them with offerings that not only fulfil their needs at an affordable cost but also have socio-economic benefits in terms of efficient use of resources and social inclusion. Understanding FI and its contribution to sustainable entrepreneurship is therefore crucial. Using a qualitative lens, we look at how entrepreneurship based on FI contributes to sustainable development in developing countries, which helps advance the field of sustainable entrepreneurship by shifting the debate from barriers to potential sources and enablers of this phenomenon.

3. Methods

3.1. Research setting

With over 231 million people, Pakistan is one of the most densely populated countries in the world. The annual growth rate of 1.8% creates a unique set of economic, social, and developmental challenges for this rapidly multiplying population (World Bank Data.Pakistan, 2021). On the flip side of this steadily rising curve, the youth dividend in the country has allowed it to achieve high levels of economic growth over the last ten years, yet the most marginalized factions of society continue to be excluded from it. Compared to other developing countries in Southeast Asia, Pakistan has a much larger chunk of the population living below the poverty line. As per recent data from the multidimensional poverty index (MPI) that monitors deprivations in 10 indicators spanning health, education, and standard of living, the average percentage of poverty for South Asian countries is 20.5 percent (UNDP, OPHI, 2022). By comparison, 38.3 percent of the Pakistani population is multi-dimensionally poor, while an additional 12.9 percent has been classified as vulnerable to it. Furthermore, Pakistan appears as one of the two South Asian countries that house the world's poorest of the poor (the other being Afghanistan), who are deprived in all 10 MPI indicators with a deprivation score of 100 percent. The country also score poorly on the climate safety dimension of sustainable development. Pakistan has been hard hit by natural disasters stemming from climate change resulting in large-scale destruction of property, food insecurity, water scarcity, and healthcare issues (Hussain et al., 2019).

Despite its plethora of developmental challenges, Pakistan has experienced an escalation in total entrepreneurial activity between 2017 and 2022, with a record number of new startups. In 2021, despite the COVID-19 pandemic, Pakistan hit an all-time high of $350 million in investments raised by local start-ups, more than five times the $65 million raised in the previous year (Invest2innovate, 2021). However, the link between the country's much-needed sustainable development and the targeted innovations created by this rising entrepreneurial activity is missing since most of these businesses are geared towards economic wealth creation. The start-up culture is primarily fixated on creating Silicon Valley clones of technology-enabled businesses in commerce, FinTech, or logistics, with much lesser attention being paid to sustainable business ideas that have the potential of creating greater on-ground impact in the country. Although entrepreneurship has shown proven success in achieving sustainable development through its activities (Rantala et al., 2019; Dawo et al., 2022), tackling the additional challenges posed by a developing country like Pakistan is no easy feat. The weak institutional environment and widespread poverty require nascent businesses to devise ingenious ways to chart their course toward sustainable development. This study, therefore, attempts to examine how some pioneering local start-ups have utilized frugal innovations not only to create economically profitable businesses but also to deliver socio-environmental value through their activities despite the challenging and resource-scarce environment in which they operate.

3.2. Research design

Given the limited insights on frugal innovation in relation to sustainable development, particularly in an developing country context, this study adopts a qualitative research design using an abductive approach with multiple case study method, as suggested by Eisenhardt (1989). The choice of this method is based on its effectiveness for theory development or extension (Yin, 2014). The case study method is also extensively recognized for exploring underexplored and dynamic concepts (Agarwal et al., 2021). The methodology choice also helps overcome specificity-based weaknesses and enhances the validity and generalizability of the study findings. It also helps us analyze the variations and commonalities between the cases arising out of shared culture, infrastructure, and policies. Based on this replication logic of multiple cases, authors were able to advance the theory regarding sustainable entrepreneurship targeted through frugal innovation in a developing country. Prior studies have utilized a similar methodology to study frugal innovation in developing countries (e.g., Chakravarty, 2022; Goodman et al., 2017)

3.3. Case selection

Table 1 delineates the basic characteristics of all the cases, including the year established, start-up motives, current and future products, as well as the social, environmental, and economic outcomes of their solutions. Frugal innovations from these firms were identified through purposeful sampling (Patton, 1990) to create a diverse set representing multiple sectors. Despite belonging to different industries, the common threads between the cases lay in origin and effort. All selected cases catered to low-income customers and were founded within the last five years. Furthermore, the primary business idea was to solve a latent and critical customer need through some proprietary innovation that resulted in sustainable development for the targeted underprivileged customer segment.

Appendix A provides a brief description of each case. A key part of the study included understanding systemic conditions through desk research and interactions with other local actors. In order to carry out preliminary selection, two of the co-authors engaged in desk research and network interaction in the local ecosystem to come up with thirteen innovative start-ups that were creating sustainable developmental solutions through the provision of necessities like affordable housing, clean drinking water, primary healthcare and mode of transportation. Six of the initially sampled start-ups were then shortlisted for this study. The shortlisting criteria included the ability of these enterprises to (1) serve underprivileged customer segments, (2) create socio-environmental value, (3) build proprietary technology, and (4) offer an affordable solution to address a critical customer need.

3.4. Data collection

Unstructured interviews, field observations, and extensive archival research were used to gather data for this study. Table 2 outlines the

Table 1
Case summaries and sustainability outcomes.

Cases	Year established	Products	Start-up motivation	Frugality characteristics	Social outcomes	Environmental outcomes	Economic outcomes
Byonyks	2017	- Bloodless home-based dialysis machine *Products under: development:* -Different models of the dialysis machine -Complimentary mobile application	-Refusal of western companies to distribute their portable dialysis machines in the low-income market of Pakistan -Personal desire of the founder to serve the underprivileged	-Costs about 1/10th of the price of imported equivalents. -Very lean physical infrastructure. -Considerable reliance on favors from individuals and voluntary groups in the US and UK.	-Dialysis machine for people suffering from kidney disease	-App designed to promote online dialysis consultation	−100% in-house designing of both mechanical and electronic components leading to the creation of new markets -Export opportunities explored in Kenya
Daisy	2016	-Eco-friendly and health-friendly sanitary napkins *Products under development:* -A range of sanitary napkins with different specifications	-Menstrual taboo and lack of female hygiene in Pakistan –Personal environmental consciousness of the founder	-Use of local raw materials. -Very low manufacturing cost due to low mechanization. -Low fixed cost due to outsourced manufacturing. -No profit charged on products sold through NGOs.	-Sanitary napkins and hygiene camps for females living in underprivileged areas to educate them on menstrual health.	-Use of cotton (organic raw material) instead of synthetic raw materials -Biodegradable menstrual pads -Environmentally friendly and carcinogen-free manufacturing process	-Local production and manufacturing team employed from the outskirts of the city, leading to self-employment opportunities for people in remote areas
Ez-Shifa	2018	-Technology-enabled kiosk for medical consultation [Apna Doctor] for the remote areas of Pakistan. *-Products under development*: -Kiosks with integrated power bank, ultrasound, and ECG machine	-Founders' self-realization of poor primary healthcare facilities in remote areas of Pakistan	-Costs 1/4th of the fee charged by a private hospital doctor. -Simple to set up, easy to use, and limited training required to operate the kiosk. -Use of local raw material. −100% in-house development of software. -Use of franchising model for product distribution	-Technology-enabled kiosk for medical consultation [Apna Doctor] in the remote areas -Costs 1/4th of the fee charged by a private hospital doctor.	- Paperless and online medical consultation	- Use of local raw material. −100% in-house development of software. - Internationalization of local business due to partnerships with doctors in the USA and UK. -An advanced version of the kiosk is under development for the South African and Middle Eastern markets
Jolta Electric	2021	Electric motorbikes: -Jolta E-bike JE 70D -Jolta E-bike JE-70D (SE) -JE-Scooty JE-Cycle *Products under development:* -Jolta Electric Care	-Personal environmental consciousness of the founder -Tesla's success in the global market	-Costs ½ of the price of imported Chinese equivalents -Significantly improved mileage (80Kms in PKR20) which means the lower operating cost -Low manufacturing cost due to conventional product design	-Electric motorbikes to promote an affordable mode of transportation for low-income segments -Affordable and independent mode of transportation for females	- Eco-friendly and noiseless alternative to conventional motorbikes	-Strategic use of the existing networks of vendors and dealers in the motorbike industry of Pakistan –100% in-house designing, manufacturing, and assembling of the kit leading to the creation of business opportunities for local small and micro businesses
Modulus Tech	2016	Prefabricated sustainable and affordable housing: -Community houses -B2B office structures *Products under development:* -Backyard housing -Eco tourist pods	-The Syrian global crisis that resulted in homelessness of displaced people	-Construction cost is 1/3rd of the comparable products due to intermesh technology -Less usage of structural material as compared to imported equivalents -More energy-efficient houses -Low packaging and shipping costs due to the	-Prefabricated and affordable housing solutions for the displaced and homeless people -Female ownership of the houses	-Patented intermesh technology for prefabricated houses - More energy-efficient designs and low carbon footprint -Solar-powered housing solutions - Optimization of product design and time in the manufacturing process	-Partnership with non-financial institutes for the provision of a mortgage to low-income customers -Product export to some African countries and exploring the US market

(*continued on next page*)

Table 1 (*continued*)

Cases	Year established	Products	Start-up motivation	Frugality characteristics	Social outcomes	Environmental outcomes	Economic outcomes
Pak Vitae	2017	Detachable water filters: -Point-of-use (POU) water filters *Products under development:* -Water dispenser bottle with pre-installed filter -The athlete water bottle with preinstalled filter	-Personal suffering of the founder from Diarrhoea after drinking contaminated water	flat-pack technique -Low fixed cost. -Superior lifespan of the filter with no maintenance cost. -Substantially less unit manufacturing cost. -Very lean organization with a headcount of only 14 employees -Low fixed cost	-Detachable water filters and point-of-use water purifiers for the low segments of the market -Enhanced access to clean drinking water due to the superior lifespan of the filter with no maintenance cost in rural areas	-Patented antimicrobial hollow fiber membrane technology to filter the water of bacteria and viruses. -Water filters with no electricity consumption -Replaces the use of plastic water bottles	-The parent company is registered in Singapore to facilitate trade and fundraising -Export of POU water filters to African countries

primary and secondary sources used to collect data. After significant research and discussions among the co-authors, the interview questionnaire was completed. A total of 22 in-depth interviews with co-founders, senior managers, partners, and experts from the selected organizations were conducted and audio recorded. Due to the Covid-19 pandemic, 15 out of 22 took place over Zoom. To gain a better knowledge of the businesses, the websites of the enterprises, and the profile of each founder studied before scheduling an interview. Afterward, each firm's co-founders were approached for interviews/conversations via email and LinkedIn. Two authors jointly conducted 20 interviews. Following each interview, the interviewers briefly discussed the interview notes and the quality of the data acquired. All the interviews were conducted in Urdu, Pakistan's national language; however, the interviewees occasionally used some English phrases. All the interviews were subsequently transcribed into English using a word processor by the same authors and evaluated by at least one of the other authors.

Additionally, two authors conducted three field visits. The first visit was hosted at the Jolta Electric factory in Lahore, Pakistan. The other two included detailed tours of Byonyks' factory and headquarters, both of which were in the city of Lahore. During the two factory visits, a senior company manager gave a guided tour of the factory, simultaneously discussing all the manufacturing processes in detail. To record the data, one author took photographic and video evidence. Similarly, the HR manager of Bynoyks gave a comprehensive tour of all the departments operating in Byonyks head office. This was followed by an in-person interview with the founder of the company. Lastly, one of the key American experts working with Boynyks was also interviewed to get insights on the portable dialysis machine.

The co-authors of this study also conducted exhaustive secondary research for this paper. As outlined in Table 2, for secondary data collection, the co-authors scanned 55 pages, including articles, blogs, and press releases, published in reliable newspapers and online forums. The information was then verified from the respective firms' official websites, Facebook, and LinkedIn pages. Moreover, videos referring to customer reviews, product specifics and co-founders' TV interviews were thoroughly examined by the co-authors, with a total duration of approximately 300mins, which was later transcribed.

3.5. Data analysis

For data analysis, we used NVivo, which is a powerful software to organize, code and analyze qualitative data. An inductive approach was used to develop a framework linking the under-explored relationship between FI and sustainable entrepreneurship (Eisenhardt et al., 2016). Considering sustainability literature, we made three aggregate dimensions: economic, social, and environmental (Hossain et al., 2021). To finalize the first-order categories, we applied open coding to interview transcripts to deduce examples fitting into the themes (Gioia et al., 2013). The initial set of codes was developed, focusing on the concepts discussed mainly in the literature on sustainable entrepreneurship and FI. We revisited data and theory multiple times to create new codes in a recurring manner (Hossain et al., 2021). Many codes emerged from the initial coding focusing on how sustainable entrepreneurship through FI has led to an enhanced standard of living and an environmentally friendly space while also leading to an inclusive growth of people and the economy. Next, we merged similar codes in accordance with our first-order categories. For instance, "*the kiosk by Ezshifa provides online and free general consultation to the people of Thar*" and secondly, "*the device has oximeter installed which otherwise is not available at the clinics in the remote areas of Pakistan*" were combined as a first-order category of "affordable and easily accessible online medical consultation." This first-order category led to the second-order theme of "*access to a healthy lifestyle which added to the aggregate dimension of "social outcomes*." Similar iterations were carried out for the remaining two aggregate dimensions. Fig. 1 outlines the structure of our data analysis in detail.

In total, we established 21 first-order categories that led to 7 s-order

Table 2
Summary of primary and secondary data sources.

Cases	Byonyks	Daisy	Ez-Shifa	Jolta Electric	Modulus Tech	Pak Vitae	Total
Primary data							
Interviewees title	• Co-founder *(02 interviews)* • Chief Technical Officer • Head of HR • Chief Medical Officer • International Expert	• Founder *(02 interviews)* • Head of marketing	• Co- founder • Co- founder • Franchisee	• Founder *(02 interviews)* • Chief Technical Officer • Marketing consultant	• Co- founder *(02 interviews)* • Co- founder	• Co-founder *(02 interviews)* • Co-founder	
No. of Interviews	6	3	3	4	3	3	22
Duration (minutes)	250	220	210	165	260	280	1385
Secondary Data							
Social media pages	6	2	4	2	3	3	20
Press releases/blogs	49	4	14	12	17	13	109
News articles	2	1	1	1	2	5	12
Videos	10	0	7	10	4	8	39

themes that we subsequently merged to form three aggregate dimensions – economic, social, and environmental outcomes.

4. Findings

Our research has identified many significant outcomes of sustainable entrepreneurship and FI. The first section briefly discusses the factors identified in our study that seem to influence the discovery and exploitation of opportunities for sustainable products. The second section then elaborates in detail on the economic, social, and environmental outcomes of entrepreneurship using FI. Based on our findings, we conceptualize a process of sustainable entrepreneurship as depicted in Fig. 2 and discuss its various elements as follows.

4.1. Identifying opportunities for sustainable solutions

Institutional voids, such as inadequacy of public goods and services, poor infrastructure and lack of access to financial institutions, often characterize a developing country. However, these gaps act as a source to sense entrepreneurial opportunities so entrepreneurs can come up with unconventional sustainable products to provide innovative and low-cost solutions to meet the needs of low-income customers. In such a context, factors like entrepreneurial alertness, social aspirations, and networks of the founders play a significant role in the identification and execution of FI for sustainable development so that the unmet needs of the poor can be met.

Firstly, entrepreneurial alertness plays a pivotal role in the development of FI, aiming to address their realized societal needs. Entrepreneurs could identify emerging needs and conceive innovative solutions, especially in the low end of the market, by combining advanced technologies available both from local and global sources. All entrepreneurs demonstrated a strong awareness of the changes, opportunities, and overlooked possibilities in their respective industries and markets. For example, despite having no direct experience in the automotive industry, the founder of Jotla Electric was ingenious enough to observe the increasing use of electric cars in China during his visit to the Beijing Olympics in 2008, as he recalled:

> "In 2016 when there was a lot of smog in Lahore, I thought how could I solve this problem? The idea of electric cars I got from China struck back, and we launched Jolta in 2017."

Overall, the entrepreneurial alertness of entrepreneurs pushes for the identification of FI opportunities for sustainable products. Secondly, entrepreneurs' ability to sense sustainable business opportunities is also essentially shaped by their passion and aspiration to do something for the greater good of their society. The main driving force for these entrepreneurs was their urge to create an inclusive society that would give every individual, regardless of socioeconomic class, an equal opportunity to fulfil their fundamental needs. The founder of Jolta Electric, for example, really stood out in expressing his compassion for and responsibility toward society:

> "I have this addiction to meeting human potential which I think is to serve. We came here to serve. We should intend to serve, superficial things like pay, designation and car and other things don't matter. Serve the world, be it for the God or for people, or and may be for yourself. God has blessed you with immense intelligence; it is our duty to pass it on to the world".

Likewise, a founder of Modulus Tech is highly motivated to design new technology for prefabricated houses, emerged from witnessing the Syrian refugees' crisis, compassionately expressed:

> *"To be honest, we started this venture for a social cause. It came from the Syrian crisis of 2016 where millions of people became homeless"*.

The self-realization of the founders for social responsibility and their natural compassion to serve societal needs instigated them to build

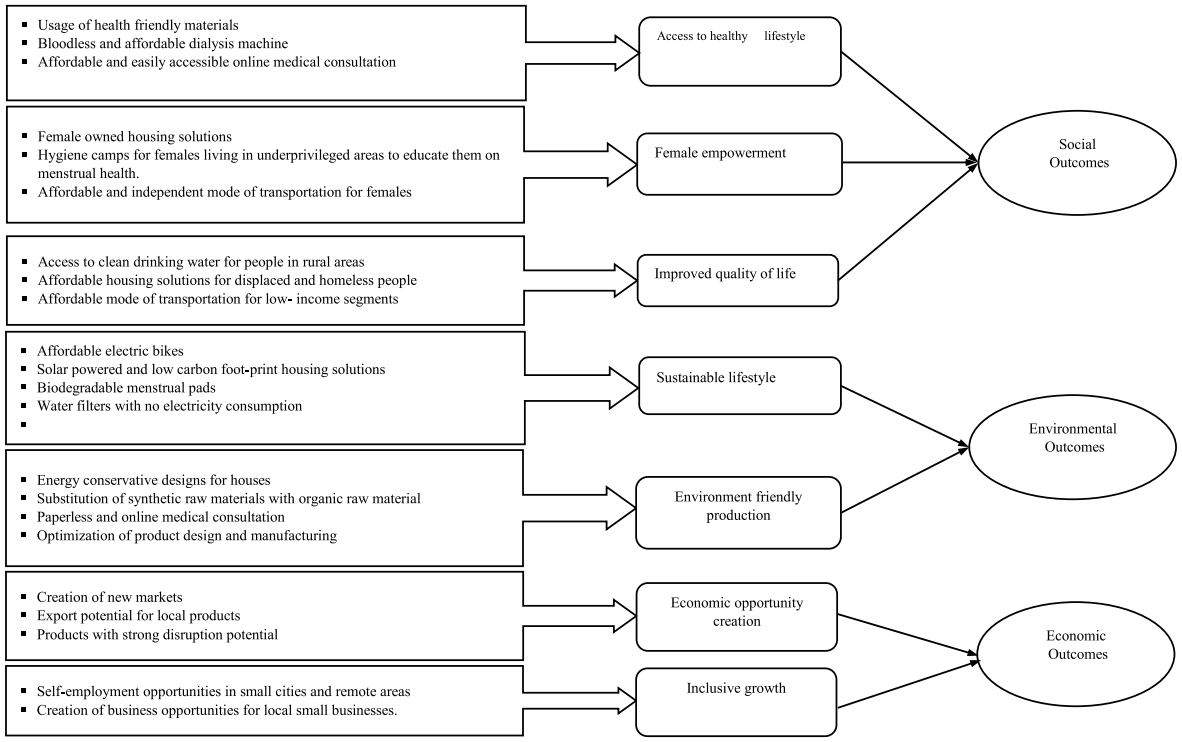

Fig. 1. Data structure.

sustainable products using FI. Moreover, we also observed a high degree of environmental consciousness among all the founders as they spoke about their motives for undertaking entrepreneurial ventures. Lastly, networking also plays a key role for entrepreneurs to turn their frugal ideas into reality with sustainable development. International networks and emerging partnerships played a decisive role in the product's initial development and its underlying technology for all six cases. For instance, in the case of Byonkys, the entire conceptualization of the dialysis machine and its peritoneal technology were an outcome of the founder's personal partnership with a team of international academics and industrial experts from the UK and USA, as fondly recalled by an American expert working as a consultant for Byonkys:

> "He (the founder) told me his passion for making an impact in Pakistan. We knew each other from the past so I got along".

In terms of local networks, entrepreneurs have especially acknowledged the role of incubation centers and universities. They help entrepreneurs develop their business models, marketing strategies, supply chains and raise seed capital. For instance, Jolta Electric collaborated with local vendors and dealers of conventional motorbikes in deciding on many design aspects of their electric bikes. Henceforth, in an emerging context, sustainable entrepreneurship with FI is efficiently executed with the help of international and local networks of the co-founders.

4.2. Sustainable outcomes of frugal innovation

Social outcomes: From a social perspective, sustainable entrepreneurship has led to inclusive growth, wellbeing, and social value creation (see Table 2). While conventional businesses and large organizations remain focused on high-growth and high-profit parts of the market, the entrepreneurs manufacturing sustainable products with FI serve the low ends of the market. As examined, entrepreneurs focusing on FI were concerned with the fundamental needs of

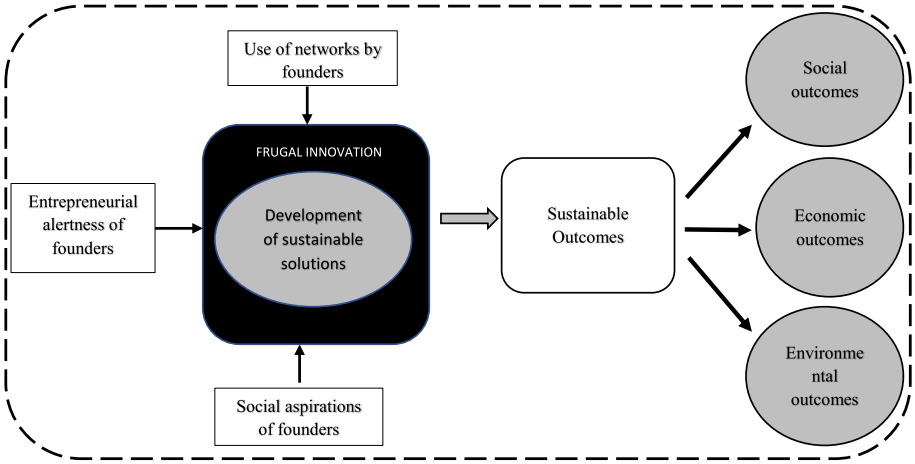

Fig. 2. Sustainable entrepreneurship through frugal innovation.

marginalized and poverty-stricken people, including problems such as providing clean drinking water, affordable housing, sustainable transportation, and lifesaving medical devices. Hence, they helped people break the vicious cycle of marginalization and expend their resources on productive activities. Moreover, most sustainable enterprises served the remote areas of Pakistan where people did not have access to conventional facilities. For example, most of the telemedicine kiosks from Ez-Shifa had been deployed to the rural and less developed regions of Pakistan. The remote areas of Mian Wali, interior Sindh, and areas in the rugged north of Pakistan are some of the prime locations where the kiosk was being operated to provide accessible and online health care to the residents. As one of the users of the kiosk from the highly impoverished areas of the Thar desert in Pakistan narrated:

> *"The kiosk has many facilities, and every kind of doctor is available. There are specialized doctors and upon the appointment, the patient can meet virtually. This distracts the patients from going to unqualified hakeems and quick doctors in the desert."* He further commented, "*another life saver is that the device has an oximeter attached which otherwise is not available in usual clinics in the desert.*"

In the case of Ez-Shifa, therefore, an affordable and online medical consultation along with the medical gadgets attached to the kiosk has made primary health care easily accessible for the people of underdeveloped regions. Sustainable development is particularly about promoting a healthy lifestyle for its users, complementing the overall wellbeing of people. Daisy, for example, relied on health-friendly materials to produce sanitary napkins for underprivileged women living in a resource-constrained environment who could not afford off-the-shelf sanitary pads sold mainly by multinational companies in Pakistan. Unlike the mainstream products that bleach their materials and leave carcinogenic waste as a by-product, Daisy does not use a bleaching process nor apply any chemicals during manufacturing, making their sanitary pads a healthier product for their customers.

> *"The absorbent layer of Daisy pads does not undergo harsh bleaching procedures that would result in the production of a toxic substance known as dioxin. Therefore, they are healthier for use."* (Founder, Daisy)

Similarly, the bloodless dialysis machine introduced by Byonyks was an affordable alternative for people willing to shift to peritoneal dialysis. The device helped kidney failure patients to own a dialysis machine that was affordable, pain-free, bloodless, and something that could be used in the comfort of their homes, enabling those patients to save significant treatment costs and continue earning their livelihoods and supporting their families. One of the users of the Byonkys' dialysis machine we interviewed, for instance, expressed his gratitude:

> "The quality of the treatment of a kidney disease in Pakistan is quite bad. With little or no attention given by the doctors to the patients, the patients are more prone to diseases like Hepatitis C which makes the entire healing process more painful and life threatening. However, Byonyks has saved me from the hassle and after shifting to the device I feel self-sufficient and safer".

Frugal initiatives like Byonyks have made healthy lifestyles easily accessible for people in developing countries. Such initiatives under FI in Pakistan have enabled people, especially from middle/low-income segments, to conveniently opt for a healthier and safer lifestyle for themselves and those around them.

Sustainable entrepreneurship with FI has drastically improved the quality of life for people from less privileged backgrounds. Another startup in our study, Modulus Tech, works to make dignified living accessible to everyone mainly targeting the segments for whom conventional housing solutions remain unaffordable. The construction cost in Pakistan has escalated many folds during the last few years due to an unprecedented rise in labor and construction materials, which have grown because of a surge in the industrial prices of gas and electricity. In the absence of an effective welfare state, constructing a house of their own is virtually impossible for someone from the middle to low-income class in Pakistan. The low-cost and sustainable housing options built on a proprietary technology by Modulus Tech, therefore, offer an innovative solution to tackle the growing problem of the housing crisis in the country.

> *"From refugees to people losing their homes due to earthquakes and flooding … Pakistan has seen many displacements and is currently facing a shortage of housing units. A large urban population lives in slums or shantytowns. Our enterprise was born out of this problem."* (Co-founder, Modulus Tech).

Apart from the housing issue, another significant problem that the poor in Pakistan face is a lack of clean drinking water. PakVitae provides low-cost detachable filters to purify water from water-borne bacteria, viruses, and other contaminants to cater to that. With the majority of their clientele being from small urban and rural areas, Pak vitae drastically improved the quality of life for such people by making clean drinking water easily accessible and affordable for them, substituting their need to buy expensive bottled water sold by large multinational companies. Keeping in mind that affordable and convenient commute is a central element of enabling people to strive for a socially and financially stable life, Jolta Electric had manufactured all made-in-Pakistan e-bikes to replace the less efficient gasoline bikes and more expensive imported e-bikes. By improving social mobility, Jolta has made it easy for daily wagers and low/middle-class segments to access a better quality of life without spending a fortune. As stated by the owner of Jolta Electric:

> "The purpose of the e-bike is to make commute hassle free, affordable and convenient for people from middle to low-income families who otherwise struggle a lot on the buses and vans."

Social sustainability cannot fully be attained unless it includes all social groups regardless of class and gender. Our cases, therefore, showed that FI is also filled with the essence of female empowerment. Modulus Tech, for example, devised a mortgage system such that the house constructed by them would have to be owned by a female member of the family for them to avail the facility of the mortgage.

> *"We want to promote female ownership of the houses to empower them (women) and make them self-sufficient and strong",* asserted a co-founder of Modulus Tech.

Daisy, meanwhile, worked tirelessly to remove the "social taboo" around the menstrual hygiene of females through their hygiene camps arranged in the rural areas of Pakistan. They encouraged open conversations and teachings on menstrual hygiene to create a safe and healthy lifestyle for females who otherwise were not sufficiently catered to by large organizations.

> "*One of our purposes is to alleviate the stigmas attached to menstruation",* commented the co-founder of Daisy, "*by letting women that it is perfectly okay to have periods, it is not an illness, neither something out of ordinary, nor shameful, you know?*".

Such initiatives have led to the acknowledgment that gender inclusion is vital in every realm of life. When it comes to empowerment, another significant aspect is stress-free mobility and accessibility to the public sphere, and for that, Jolta Electric introduced female scooties currently imported from China, which women could afford for an easy and reliable commute. The FIs in these aforementioned cases enabled females to access affordable transportation and property ownership while also enjoying a safe space for women-centric conversations, which when comes all together, helps females feel more included and empowered.

Environmental Outcomes: Sustainable entrepreneurship with FI has actively enriched the prospects of doing environment-friendly business. Frugal start-ups in Pakistan have played a central role in endorsing sustainable lifestyles as the ultimate choice of living. For instance, the

entire business model of Jolta is based on a sustainable approach to promote e-vehicles in the country and reduce carbon dioxide emissions through transport. Their bikes use energy-conservative materials like graphene, known for its battery storage quality. Simultaneously, the dry battery used in Jolta's electric bikes was specially manufactured to decrease air and noise pollution, as the founder proudly stated:

> "*Our bike is pollution and sound free and, surprisingly, people are enjoying these features a lot. Plus, there are no harmful emissions from our bikes due to our dry batteries, making the bike environmentally friendly … We purposefully made it affordable so that more people can opt for a sustainable lifestyle." (Founder, Jolta Electric).*

Another example is Modulus Tech which has been mindful of reducing the carbon footprint of its housing solutions to push for a sustainable lifestyle. Through their model, they aim to reduce the carbon footprint and emission of greenhouse gases by 50 times in contrast to the traditional construction methods. Their houses are carbon neutral (net zero carbon emission) and come equipped with their own insulation, renewable energy supply, and solar-powered water purification systems.

> *"Our houses are constructed in days, substantially reducing their carbon footprint and operate off-grid with their own renewable solar energy and solar charged water purification systems."* (Co-founder Modulus Tech)

Similarly, sanitary napkins by Daisy were made of a biodegradable material that reduced plastic waste. As the founder of Daisy regathered some thoughts from her past:

> "*I grew up looking at heaps of trash around me where they'd be napkins lying around as well which would become a vector for infection. So, I always knew I wanted to create something that is cost-effective and good for the environment.*"

Even the water filters manufactured by Pak Vitae purified water without any power requirement making them environment friendly. Enterprises relying on FI have paved new ways to encourage people to opt for a sustainable lifestyle without compromising their quality of life.

> *"We have manufactured a low-cost, membrane-based solution for the water filter that requires no electricity or chemical cleaning therefore you can easily access clean drinking water without being dependent on the electricity supply."* (Co-founder, Pak Vitae)

FI not only promote a sustainable lifestyle by offering environmental-friendly products, but they also incorporate elements of sustainability in their production techniques. Most of the startups studied primarily opted to substitute synthetic raw materials with organic raw materials. For example, as the founder of Daisy explained, *"We use local cotton as the top layer of our pads to promote healthy and sustainable production."* Similarly, some of these start-ups placed great emphasis on optimizing the use of raw materials and incorporated certain measures in their manufacturing techniques to minimize the quantity of material used. For instance, Modulus Tech employed several passive and active strategies in its manufacturing processes to ensure that its production is sustainable and environmentally friendly. As fondly shared by a co-founder of Modulus Tech:

> "Our flat-pack assemblance technique guarantees energy conservation and by optimizing space and time, we efficiently ship more sets of housing in the same shipment. This optimization also reduces the fuel consumption yet again adding to the sustainability of their product"

Ez-Shifa's Apna Doctor Kiosk allowed their franchisees and patients to go completely paperless, with all the medical records being stored electronically on a centralized cloud server. It can, therefore, be argued that products based on FI cannot only enable resource-constrained people to improve their social well-being but also assist them in choosing a more environmental-friendly lifestyle.

Economic Outcomes: Our cases exhibited that sustainable development through FI also brought a general rise in inclusive economic growth and opportunity creation. In the case of Jolta Electric, for instance, the founders of the company clearly affirmed that their mission was to empower local people by teaching them skills of product assembly that can be applied in any manufacturing business, as well as to integrate their business with local value chain partners who were mainly comprised of small and micro enterprises.

> *"God has gifted me the wisdom to learn things at a faster pace so now it falls on me to spread my knowledge and enable people to become independent. I shall use my light to lit other people … We have strategically used the same small vendors who are making parts for other motorbike assemblers; it upgrades their (vendors) skills and saves my cost"* (Co-founder, Jolta)

Jolta Electric created an ecosystem of team leaders, researchers, assemblers, vendors, sellers, and manufacturers working under the network of electric vehicles in Pakistan. FI relies heavily on using local raw materials and labor, creating business opportunities for local small and micro businesses. For instance, the biodegradable pads manufactured by Daisy were made of local materials purchased from the markets on the outskirts of Lahore. Ez-Shifa, through its franchising model, created self-employment opportunities for locals in underprivileged areas. While Ez-Shifa was responsible for providing the kiosk, technological support, and arranging doctors for online consultation, the local franchisee would own the space and manage the on-ground operations. They worked on a revenue-sharing model where the franchisee would get 60% of the patient fee, and 40% would go to Ez-Shifa.

> *"We have deployed our kiosk in Tharparkar (an extremely impoverished area in the deserts of Sindh) where a PhD doctor bought it (Apna Doctor Kiosk) for the people of his village, the clinic assistant is also a local from that region."* (Co-founder, Ez Shifa)

Such mindful production steps to develop sustainable products unlocked new avenues for inclusive economic growth. The cases of sustainable entrepreneurship using FI not only allowed start-ups to flourish but also instrumental in creating new markets in a developing country. All the six cases of FI examined in this study have developed products based on proprietary technologies mostly conceptualized and designed by the co-founders themselves. As a result, they offered more economical, sustainable, simpler, and more efficient alternatives to existing products with a strong potential to replace the incumbents. For example, Pak Vitae's point-of-use filters have already eliminated the need for MNCs' traditional water dispenser bottles. As explained by a co-founder of Pak-Vitae:

> "One of our products in the pipeline is a fancy tap. It is a high-end product for the hospitality industry. Hashu group (a big hotel chain in Pakistan) has 3000 rooms, in different regions and we will basically use this tap in their washrooms essentially turning your tap water to drinking water, therefore, eliminating the use of conventional water bottles"

Similarly, Ez-Shifa's Apna Doctor Kiosk had rendered traditional clinics obsolete in rural areas due to its use of technology and significantly greater scalability potential. Appendix A outlines the market performance of these startups more specifically. The disruption potential of low-cost goods also boosts the export potential of developing countries such as Pakistan. Unlike traditional products, which often compete with more competitive products in mainstream markets, frugal products have the ability to access untapped markets in similar developing or undeveloped countries with greater ease. For example, Pak Vitae and Modulus Tech have already created a dealer network for their water filters and prefabricated housings in a few African countries. Byonkys, meanwhile, was in dialogue with certain distributors in Nairobi. Ez-Shifa was also developing a more advanced version of its product (an AI-enabled kiosk) for the South African, American, and Middle Eastern markets. By virtue of its export potential, sustainable entrepreneurship

using FI can improve the country's development prospects, leading to economic opportunities and inclusive growth and improving the quality of life for its citizens.

To summarize, when leveraged with FI, sustainable entrepreneurship can potentially lead to inclusive and progressive growth, especially in a resource-constrained context of a developing country. We found that targeting the needs of the low and middle segments of society remains to be the key motivation and focus of such businesses, unlike conventional entrepreneurship. Resultantly, it ensures the penetration of sustainable products to the lowest cadre of the market.

5. Discussion

This study adds a fresh theoretical perspective to the existing sustainable entrepreneurship literature by demonstrating how sustainable entrepreneurship with frugal solutions can serve low segments of society in a resource-constrained setting and plays a central role in developing products/services in a sustainable manner. The role of sustainable entrepreneurship has been extensively explored in adding value to the social, environmental, and economic well-being of people in the developing world. Through this research, we bridge two interrelated yet distinct streams of literature, i.e., sustainable entrepreneurship (Anand et al., 2021; Muñoz et al., 2018; Shepherd and Patzelt, 2011) and frugal innovation (Levänen et al., 2016; Albert, 2019; Hossain, 2021), and thereby contribute by theorizing FI as a source to nurture sustainable entrepreneurial opportunities that directly improve socio-environmental conditions (Muñoz et al., 2018). We also connect market imperfections and entrepreneurial opportunities in developing countries in line with the prior research suggestions (Cohen and Winn, 2007). Finally, our research reveals various factors that encourage FI-based sustainable entrepreneurship.

5.1. Theoretical implications

Our research enlightens that FI literature has several overlaps with sustainable entrepreneurship outcomes, yet scholars have not paid attention to integrating these two streams of research. Therefore, this study is the first of its kind to offer an integrated framework for sustainable entrepreneurship based on FI. Thus, the study offers three key contributions to the literature. *First*, scholars have a dominant understanding of additional risks and challenges associated with sustainable entrepreneurship (Dawo et al., 2022; Hoogendoorn et al., 2019). It could be difficult to discover sustainable opportunities (Argade et al., 2021a,b) due to perceived lower profitability (Shahid, 2022), customer buying behaviors (Shahid and Reynaud, 2022), market imperfection (Kuckertz and Wagner, 2010) and entrepreneurial ecosystem (Dawo et al., 2022) that impede sustainable entrepreneurship. The case for developing countries can be even worse in terms of exploiting sustainable business opportunities due to limited resources. Therefore, there is a need to advance the literature on sustainable entrepreneurship by focusing on its enablers rather than barriers, especially in resource-constrained settings (Hoogendoorn et al., 2019; Shahid, 2022). By theorizing FI as an inexpensive solution, we demonstrate that FI has the potential to encourage sustainable entrepreneurship in resource-constrained environments. Using in-depth case studies, we are able to demonstrate that despite limited resources, if entrepreneurs employ FI in exploiting business opportunities, they can achieve the triple-bottom-line objectives of sustainability. Furthermore, this theoretical link between FI and sustainable entrepreneurship calls for further research to identify some boundary conditions under which this association works in the best interest of sustainable business opportunities.

Second, we contribute to FI literature (Albert, 2019; Hossain, 2021; Levänen et al., 2016) by offering prospective elements that could trigger FI leading to sustainable entrepreneurship. As such, we unfold that entrepreneurs' personal characteristics, networks, and inspirations are factors that assist them in identifying and exploiting sustainable business opportunities in resource-constrained environments. This provides a more holistic view to understand better the mechanism behind the origins of FI and its influence in identifying and exploiting frugal innovations with socio-environmental benefits. Given that resources are challenging to obtain for sustainable businesses, our study contributes to FI literature by revealing aspects that can foster sustainability-oriented FI.

Finally, Pakistan's context represents developing countries in the mainstream literature on sustainable entrepreneurship, which is mainly explored in developed countries (Argade et al., 2021a,b; Terán-Yépez and Marín-Carrillo, 2020). Given the pressing challenges of resource scarcity in developing countries, our research shows that FI-based sustainable entrepreneurship has the potential to offer cost-effective solutions that have economic, social, and environmental benefits. For instance, we find that sustainable entrepreneurship empowers access to a healthy lifestyle, manufacturing affordable yet quality health care, housing solutions, water filtration, and transportation solutions. The easy access to affordable products has considerably improved the quality of life of underprivileged people residing in remote areas. Likewise, our study demonstrates several ways in which sustainable entrepreneurship facilitates an environment-friendly business approach, which is ignored in conventional business practices. Climate change has become a global issue, however, due to the environment-friendly approach, sustainable entrepreneurship has paved the way for a sustainable environment for business growth. For example, energy-conservative housing designs, powerless manufacturing, usage of local and raw materials, optimal operations, and substitution to renewable energy consumption have cultivated a sustainable lifestyle. In the context of Pakistan, sustainable entrepreneurship has helped consumers opt for online medical consultation, electric transportation, solar-powered and low carbon-footprint housing options, biodegradable menstrual pads, and zero-power water filters. All the frugal products have paved the way for a sustainability-driven and environmentally friendly lifestyle. Furthermore, this study also adds to the existing economic-centric view of sustainable entrepreneurship. The outcomes suggest that sustainable entrepreneurs contribute to the social and economic growth of the developing world by creating new markets with affordable quality products for low-income customers.

5.2. Practical implications

This study has crucial implications for practitioners to promote sustainable development by integrating frugal innovation with sustainable entrepreneurship. Our study demonstrates numerous ways in which sustainable products can serve low-income customers in resource-constrained developing countries. The essence of FI with sustainable development is to meet the needs of low-income customers by offering affordable and quality solutions, promoting cleaner production processes, using recycled materials, and encouraging sustainable goods and services. In such cases, FI shows ways to substitute costly products with affordable products entailing desirable characteristics, for example, ease of use and reparability. As our cases demonstrate, sustainable entrepreneurship based on FI leads to technological development to meet the social and economic needs of developing countries that conventional entrepreneurship tends to ignore. Therefore, focusing on FI can teach entrepreneurs ways to enhance inclusive growth and sustainability in developing countries. In addition, entrepreneurs need resources to exploit business opportunities (Muñoz and Cohen, 2018), in that essence, FI suggests identifying and exploiting sustainable business opportunities that could be developed with limited means, helping both the entrepreneurs and society.

Sustainable entrepreneurship considers factors such as social needs, context, and environment to develop frugal products by closely engaging with the customers and community to ensure their feedback is incorporated into product development. They pay close attention to the pressing social issues to create a sustainable place for the customers.

Sustainable entrepreneurship with FI leads to social and business growth while also meeting the needs of low-income customers. Therefore, practitioners must acknowledge the growth that comes with FI and devise strategies to create an inclusive business environment for FI. Conventional firms may learn from the entrepreneurs practising FI to revise their sustainability orientation, production mechanisms, and efficient use of resources that ultimately promote sustainable business practices and inclusive growth. FI can be viewed to generate new sustainable models to strengthen the positive impact that businesses can create. Researchers and policymakers can study frugal ventures to learn how grand challenges can be addressed through entrepreneurial intervention and promote sustainable development goals in developing countries by creating a conducive environment for FI.

5.3. Limitations and future research avenues

There are several limitations of this study, which open future research avenues. We selected six cases to explore sustainable entrepreneurship with FI in Pakistan. However, exploring more cases from diverse sectors would provide a more holistic understanding of FI. Another limitation is that we did not explore the customers' perspectives. Due to resource and logistical constraints, such as physically conducting interviews, identifying relevant customers, seeking consent from selected cases, and time constraints, we could not approach the customers of our cases. The customer's perspective will help revealing more realistic insights into how FI contributes to their social and economic wellbeing.

Future research can refine and extend this relationship in a different setting. Moreover, it provides a qualitative narrative to solidify the link between sustainable entrepreneurship and FI. However, a quantitative research approach can further testify to this link. Future research may explore how the products and services developed under FI contribute to the prosperous growth of all social groups. Our empirical work can be seen as a call for an in-depth analysis of how FI can lead to sustainable development and how it can solve issues like access to healthcare (Agarwal et al., 2020), women empowerment (Hossain, 2021), access to energy (Bas, 2020) and safe housing (Dressler and Bucher, 2018). Similarly, future research can develop frameworks to identify how sustainable entrepreneurship with FI can help a community grow on economic, social, and environmental fronts and therefore help tackle sustainable goals directly by stressing on sustainable business models. The existing literature on the relationships identified in this study is limited; therefore, future research in other contexts to compare the findings of this study and develop a strong policy landscape for FI and sustainability is necessary to tackle the growing grand challenges.

6. Conclusions

Sustainable entrepreneurship has emerged as a way to solve many environmental issues. Likewise, many aspects of FI are associated with sustainability (Levänen et al., 2016). Our study aims to theorize FI as a source of sustainable entrepreneurship, depicting these two as intertwined phenomena in a resource-constrained setting. We conclude that *first*, there are individual specific elements, such as personal characteristics, networks, and inspirations that help entrepreneurs identify FI opportunities that further leads to sustainable entrepreneurship. *Second*, in our cases, the sustainability aspect meets the triple bottom line perspectives, indicating that FI-based entrepreneurship simultaneously contributes to economic, social, and environmental fronts. *Finally*, as our study shows, sustainable entrepreneurship in a resource-constrained and developing country context is a means of sustainable economic growth. Creating new customers, new market segments, self-employment opportunities, and business opportunities for local small and micro businesses all result in inclusive economic growth and opportunity creation.

CRediT authorship contribution statement

Muhammad Shehryar Shahid: Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Mokter Hossain:** Conceptualization, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Subhan Shahid:** Writing – original draft, Discussion, Implications, Validation, Writing – review & editing. **Tehreem Anwar:** Conceptualization, Formal analysis, Data curation, Writing – original draft.

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.

Data availability

Data will be made available on request.

Acknowledgements

Open Access funding provided by the Qatar National Library.

Appendix A. Overview of the cases

Case Name	Description
Byonyks	Byonkys is a medical device firm founded and managed by a passionate computer scientist who graduated in 2003 from a renowned university in Pakistan and has had extensive experience of 15 years working for medical device companies in the USA. Operational since 2017, it provides a portable and bloodless dialysis machine (Byonyks X1) targeted at patients living in a resource-constrained environment of a developing country. Having been rejected by US companies to launch their portable dialysis machine in Pakistan, which they deemed to be a low-margin market, the founder of Byonyks, as passionate as he was, took it upon himself to develop and manufacture a portable dialysis machine in Pakistan that would cost around 10 times less expensive than the American version. Given the lack of local expertise, Byonkys has capitalized on seasoned American industrial experts and academicians to be able to design, develop and assemble the dialysis machine in their labs in Pakistan. Having run successful prototyping with six local patients and two private hospitals for almost a year, the company is all set to commercialise its frugal product. The current headcount of the company is 80. A state-of-the-art factory has already been established in Lahore, Pakistan, with all the regulatory approvals attained. Byonkys also maintains an R&D and Innovation centre one each in Lahore and Chicago, USA.
Daisy	Having observed and personally experienced the social taboos associated with menstrual issues and hygiene for females in Pakistan, a final-year female medical student established a company called Daisy in 2016. Daisy developed an affordable and eco-friendly sanitary napkin mainly sold to poor women living in rural areas of Pakistan. Although the venture has remained mainly self-funded to meet its operational expenses, there were some successful crowdfunding campaigns organized by the founder in her school and university to raise the startup capital. Distributed through partnerships with local NGOs, the sanitary napkins by Daisy give rural women access to an economical but equally efficient substitute for expensive off-the-shelf products, a market largely dominated by multinational companies. A part of Daisy's sales also comes from affluent women living in urban areas who would buy these sanitary napkins through the social media pages of the company. While the founder herself does the product designing internally, the manufacturing is completely outsourced to small vendors in the outskirts of Lahore. 100% of the raw material is sourced locally from places in close proximity to manufacturing sites. The value proposition of the product does not only lie in its low price, but also in its

(*continued on next page*)

(*continued*)

Case Name	Description
	three-layered product design and substitution of synthetic materials with a more eco-friendly material like cotton. It was a service designed to address the underlying social taboo.
Ez-Shifa	Ez-Shifa is a Seattle, WA, USA-based technology start up making "quality healthcare" accessible to all. Founded in 2018 by three technologists and entrepreneurs from the UK, USA and Pakistan to make primary healthcare ubiquitous, especially concerning the underprivileged people in Pakistan. Using cutting-edge technologies such as video conferencing, computer vision, AI/ML and NLP, Ez-Shifa brings about the integration of healthcare services by connecting doctors with patients, and patients with pharmacies, labs, and other services, all from one platform. The product under investigation, however, is Apna Doctor, a technology-enabled Kiosk for medical consultations. Integration of simple off-the-shelf gadgets in a wooden structure backed by a SaaS-based digital platform has enabled people from underprivileged areas of Pakistan to seek healthcare consultations from doctors based in developed countries. By installing 30 Kiosks through a franchising model mainly at rural or suburban sites, Ez-Shifa had so far served about 500 patients for only one-fourth of the price generally charged by a private doctor in Pakistan. With two Kiosks of Apna Doctor already in Nigeria, Ez-Shifa is geared to solve healthcare problems in other resource-constrained environments too.
Jolta Electric	Climate change and pollution are becoming issues of a disastrous magnitude in Pakistan, most commonly manifested as floods, food insecurity and dismally poor air quality index in urban areas. Responding to these challenges, two engineers from Pakistan launched Jolta Electric in 2021, which is claimed to be the manufacturers of Pakistan's first approved electric bike. The incumbent Prime Minister of Pakistan at the time of the interview inaugurated Jolta's factory, which proved to be a major hype-catching event and gave it a kick-start. Together with their vast entrepreneurial and industrial experience both locally and in China, the two co-founders developed a proprietary electric kit that could fit in any existing conventional bike to turn into an electric vehicle. To maintain the frugality of the product, Jolta avoided the need to innovate around design at this stage and simply replicated the design of existing bikes with their proprietary electric kit installed in them. With the network of 100 dealers across Pakistan, Jolta was selling on average 5000 units per months in 2021, whereby all the bikes are assembled in-house at their Lahore based factory. Jolta's frugal innovation has made electric bikes, which otherwise are all imported and very expensive in Pakistan, a product for the masses.
Modulus Tech	Modulus Tech is a Karachi based company in Pakistan, which manufactures prefabricated sustainable and affordable houses using their proprietary inter-mesh technology. With little money and tons of passion, and inspired by the Syrian refugees crises, three final year students of civil engineering, founded Modulus Tech in 2016 to provide sustainable living and housing facilities for displaced and homeless people in developing countries. With their families already being in the construction business gave the co-founders a good knowledge of the industry and its value chain. The industry of prefabricated housing in Pakistan is dominated by players who import standard structures from China and use them to construct either industrial buildings or small luxury houses. Modulus Tech with their 100% local production, better technology, lower cost and significantly less processing time, is rather targeting low-income workers living in urban areas (e.g. domestic workers, electricians, and drivers). Till the mid of year 2021, Modulus Tech had constructed 70 units (300–400 sft in size) in various parts of Sindh and Baluchistan, while 17 community houses were under construction in Karachi, Pakistan. Moreover, a house constructed by Modulus Tech, if financed through their mortgage partner, must be owned by a female member of the family applying for the mortgage. Besides promoting female empowerment, Modulus Tech directly contributes to solving environmental problems by making all their houses energy-efficient and solar-powered.
Pak Vitae	Founded by two chemical engineers in 2017, Pak Vitae is a company driven by the mission to provide innovative and sustainable technological interventions that can alleviate the waterborne disease burden and save millions of lives around the globe. Triggered by the personal passion and suffering of one of the founders with chronic diarrhoea after drinking contaminated water during his university time, the idea of developing an affordable detachable water filter was conceptualized. Their Point-of-Use (POU) water filer is built on proprietary anti-bacterial hollow fibre member technology. Operating within an environment characterised by the lack of scientific knowledge on fibre technology, testing facilities and manufacturing equipment, the founders of Pak Vitae aggressively established and leveraged international networks constituting of academicians, industrial experts and designers of hollow fibre membrane. For fund raising and business mentoring, however, they relied largely on local partners. Grants and the prize money of various competitions funded the initial product development and testing. Given the institutional inefficiencies of Pakistan, the company, though based in Pakistan, is currently registered in Singapore in their bid to raise international funding and avoid certain complications related to taxation. Targeting the lower-middle customers, Pak Vitae had sold approximately 7000 units of their POU filters, where 75% of those were sold in either small cities or rural areas of Pakistan until the start of 2022.

References

Agarwal, N., Oehler, J., Brem, A., 2021. Constraint-based thinking: a structured approach for developing frugal innovations. IEEE Trans. Eng. Manag. 683, 739–751.

Agarwal, S., Lenka, U., Singh, K., Agrawal, V., Agrawal, A.M., 2020. A qualitative approach towards crucial factors for sustainable development of women social entrepreneurship: Indian cases. J. Clean. Prod. 274, 123135.

Agnihotri, A., 2015. Low-cost innovation in emerging markets. J. Strat. Market. 23, 399–411.

Albert, M., 2019. Sustainable frugal innovation - The connection between frugal innovation and sustainability. J. Clean. Prod. 237, 117747.

Albert, M., 2022. Assessing the sustainability impacts of frugal innovation–A literature review. J. Clean. Prod. 365, 132754.

Anand, A., Argade, P., Barkemeyer, R., Salignac, F., 2021. Trends and patterns in sustainable entrepreneurship research: a bibliometric review and research agenda. J. Bus. Ventur. 36, 106092.

Argade, P., Salignac, F., Barkemeyer, R., 2021a. Opportunity identification for sustainable entrepreneurship: exploring the interplay of individual and context level factors in India. Bus. Strat. Environ. 308, 3528–3551.

Argade, P., Salignac, F., Barkemeyer, R., 2021b. Opportunity identification for sustainable entrepreneurship: exploring the interplay of individual and context level factors in India. Bus. Strat. Environ. 30, 3528–3551.

Bapoo, M.A., Tehseen, S., Haider, S.A., Yusof, M., Motaghi, H., 2022. Sustainability orientation and sustainable entrepreneurship intention: the mediating role of entrepreneurial opportunity recognition. Acad. Enterpren. J. 28, 1–23.

Barrachina Fernández, M., García-Centeno, M.del C., Calderón Patier, C., 2021. Women sustainable entrepreneurship: review and research agenda. Sustainability 13, 12047.

Bas, C.L., 2020. Frugal innovation as environmental innovation. Int. J. Technol. Manag. 831–3, 78–96.

Basu, R.R., Banerjee, P.M., Sweeny, E.G., 2013. Frugal innovation. J. Manag. Global Sustain. 12.

Belz, F.M., Binder, J.K., 2017. Sustainable entrepreneurship: a convergent process model. Bus. Strat. Environ. 261, 1–17.

Bound, K., Thornton, I.W., 2012. Our Frugal Future: Lessons from India's Innovation System.

Brem, A., Wolfram, P., 2014. Research and development from the bottom up-introduction of terminologies for new product development in emerging markets. J. Innov. Entrepreneurship 31, 1–22.

Brieger, S.A., De Clercq, D., 2018. Entrepreneurs' individual-level resources and social value creation goals: the moderating role of cultural context. Int. J. Entrepreneurial Behav. Res. 25, 193–216.

Chakravarty, S., 2022. Resource constrained innovation in a technology intensive sector: frugal medical devices from manufacturing firms in South Africa. Technovation 112, 102397.

Chliova, M., Ringov, D., 2017. Scaling impact: template development and replication at the base of the pyramid. Acad. Manag. Perspect. 311, 44–62.

Choi, D.-Y., Gray, E.-R., 2008. "The venture development processes of 'sustainable' entrepreneurs". Manag. Res. News 31, 558–569.

Cohen, B., Winn, M.I., 2007. "Market imperfection, opportunity and sustainable entrepreneurship". J. Bus. Ventur. 22, 29–49.

Dabić, M., Obradović, T., Vlačić, B., Sahasranamam, S., Paul, J., 2022. Frugal innovations: a multidisciplinary review & agenda for future research. J. Bus. Res. 142, 914–929.

Davies, I.A., Chambers, L., 2018. Integrating hybridity and business model theory in sustainable entrepreneurship. J. Clean. Prod. 177, 378–386.

Dawo, H.L.A., Long, T.B., de Jong, G., 2022. Sustainable entrepreneurship and legitimacy building in protected areas: overcoming distinctive barriers through activism. Bus. Strat. Environ. 32, 72–95.

Dixon, S.E., Clifford, A., 2007. "Ecopreneurship – a new approach to managing the triple bottom line". J. Organ. Change Manag. 20, 326–345.

Dressler, A., Bucher, J., 2018. Introducing a sustainability evaluation framework based on the Sustainable Development Goals applied to four cases of South African frugal innovation. Bus. Strategy Develop. 14, 276–285.

Drori, I., Manos, R., Santacreu-Vasut, E., Shenkar, O., Shoham, A., 2018. Language and market inclusivity for women entrepreneurship: the case of microfinance. J. Bus. Ventur. 334, 395–415.

Eisenhardt, K.M., 1989. Building theories from case study research. Acad. Manag. Rev. 144, 532–550.

Eisenhardt, K.M., Graebner, M.E., Sonenshein, S., 2016. Grand challenges and inductive methods: rigor without rigor mortis. Acad. Manag. J. 594, 1113–1123.

Fischer, B., Guerrero, M., Guimón, J., Schaeffer, P.R., 2020. Knowledge transfer for frugal innovation: where do entrepreneurial universities stand? J. Knowl. Manag. 25, 60–379.
Gast, J., Gundolf, K., Cesinger, B., 2017. Doing business in a green way: a systematic review of the ecological sustainability entrepreneurship literature and future research directions. J. Clean. Prod. 147, 44–56.
George, G., Howard-Grenville, J., Joshi, A., Tihanyi, L., 2016. Understanding and tackling societal grand challenges through management research. Acad. Manag. J. 596, 1880–1895.
Gioia, D.A., Corley, K.G., Hamilton, A.L., 2013. Seeking qualitative rigor in inductive research: notes on the Gioia methodology. Organ. Res. Methods 16, 15–31.
Goodman, J., Korsunova, A., Halme, M., 2017. Our collaborative future: activities and roles of stakeholders in sustainability-oriented innovation. Bus. Strat. Environ. 266, 731–753.
Gregori, P., Holzmann, P., 2020. Digital sustainable entrepreneurship: a business model perspective on embedding digital technologies for social and environmental value creation. J. Clean. Prod. 272, 122817.
Hockerts, K., Muñoz, P., Janssen, F., Nicolopoulou, K., 2018. Advancing sustainable entrepreneurship through substantive research. Int. J. Entrepreneurial Behav. Res. 242, 322–332.
Hockerts, K., Wüstenhagen, R., 2010. Greening Goliaths versus emerging Davids—theorizing about the role of incumbents and new entrants in sustainable entrepreneurship. J. Bus. Ventur. 25, 481–492.
Hoogendoorn, B., van der Zwan, P., Thurik, R., 2019. Sustainable entrepreneurship: the role of perceived barriers and risk. J. Bus. Ethics 157, 1133–1154.
Hossain, M., 2018. Frugal innovation: a review and research agenda. J. Clean. Prod. 182, 926–936.
Hossain, M., 2020. Frugal innovation: conception, development, diffusion, and outcome. J. Clean. Prod. 262, 121456.
Hossain, M., 2021. Frugal innovation and sustainable business models. Technol. Soc. 64, 101508.
Hossain, M., Levänen, J., Wierenga, M., 2021. Pursuing frugal innovation for sustainability at the grassroots level. Manag. Organ. Rev. 172, 374–381.
Hossain, M., Simula, H., Halme, M., 2016. Can frugal go global? Diffusion patterns of frugal innovations. Technol. Soc. 46, 132–139.
Hussain, M., Butt, A.R., Uzma, F., Ahmed, R., Irshad, S., Rehman, A., Yousaf, B., 2019. A comprehensive review of climate change impacts, adaptation, and mitigation on environmental and natural calamities in Pakistan. Environ. Monit. Assess. 1921.
Invest2innovate, 2021. Pakistan Startup Ecosystem Report PSER 2021. I2i INSIGHTS. https://www.insightsi2i.com/pser-21.
Isaak, R., 2002. "The making of the ecopreneur". Greener Manag. Int. 38, 81–91.
Iyer, G.R., LaPlaca, P.J., Sharma, A., 2006. Innovation and new product introductions in emerging markets: strategic recommendations for the Indian market. Ind. Market. Manag. 35, 373–382.
Khan, R., 2016. How frugal innovation promotes social sustainability. Sustainability 810, 1034.
Kirzner, I.M., 1973. Competition and Entrepreneurship. University of Chicago Press.
Knizkov, S., Arlinghaus, J.C., 2020. Frugal processes: an empirical investigation into the operations of resource-constrained firms. IEEE Trans. Eng. Manag. 683, 667–684.
Kuckertz, A., Wagner, M., 2010. The influence of sustainability orientation on entrepreneurial intentions - investigating the role of business experience. J. Bus. Ventur. 25, 524–539.
Levänen, J., Hossain, M., Lyytinen, T., Hyvärinen, A., Numminen, S., Halme, M., 2016. Implications of frugal innovations on sustainable development: evaluating water and energy innovations. Sustainability 81, 4.
Lim, C., Fujimoto, T., 2019. Frugal innovation and design changes expanding the cost-performance frontier: a Schumpeterian approach. Res. Pol. 484, 1016–1029.
Lim, C., Lee, J.H., Sonthikorn, P., Vongbunyong, S., 2021. Frugal innovation and leapfrogging innovation approach to the Industry 4.0 challenge for a developing country. Asian J. Technol. Innovat. 291, 87–108.
Linnanen, L., 2005. An insider's experiences with environmental entrepreneurship. Making ecopreneurs: Develop. Sustain. Entrepreneurship 38, 72–88.
Lüdeke-Freund, F., 2020. Sustainable entrepreneurship, innovation, and business models: integrative framework and propositions for future research. Bus. Strat. Environ. 292, 665–681.
Mair, J., Marti, I., Ventresca, M.J., 2012. Building inclusive markets in rural Bangladesh: how intermediaries work institutional voids. Acad. Manag. J. 554, 819–850.
Markman, G.D., Waldron, T.L., Gianiodis, P.T., Espina, M.I., 2019. E pluribus unum: impact entrepreneurship as a solution to grand challenges. Acad. Manag. Perspect. 33 (4), 371–382.
Mendes, A.C., Ferreira, F.A., Kannan, D., Ferreira, N.C., Correia, R.J., 2022. A BWM approach to determinants of sustainable entrepreneurship in small and medium-sized enterprises. J. Clean. Prod. 371, 133300.
Muñoz, P., Cohen, B., 2018. Sustainable entrepreneurship research: taking stock and looking ahead. Bus. Strat. Environ. 273, 300–322.
Muñoz, P., Dimov, D., 2015. The call of the whole in understanding the development of sustainable ventures. J. Bus. Ventur. 30, 632–654.
Muñoz, P., Janssen, F., Nicolopoulou, K., Hockerts, K., 2018. Advancing sustainable entrepreneurship through substantive research. Int. J. Entrepreneurial Behav. Res. 24, 322–332.
Nhemachena, C., Murimbika, M., 2018. Motivations of sustainable entrepreneurship and their impact of enterprise performance in Gauteng Province, South Africa. Bus. Strategy Develop. 12, 115–127.
Nicolopoulou, K., 2014. "Social entrepreneurship between cross-currents: toward a framework for theoretical restructuring of the field". J. Small Bus. Manag. 52, 678–702.
Patton, M.Q., 1990. Qualitative Evaluation and Research Methods. SAGE Publications, inc.
Rantala, T., Saunila, M., Ukko, J., Rantanen, H., 2019. Identifying strategies for sustainable entrepreneurship. Innov. Sustain. 213–229.
Rao, B.C., 2013. How disruptive is frugal? Technol. Soc. 351, 65–73.
Rosca, E., Arnold, M., Bendul, J.C., 2017. Business models for sustainable innovation–an empirical analysis of frugal products and services. J. Clean. Prod. 162, 133–S145.
Sarango-Lalangui, P., Santos, J.L.S., Hormiga, E., 2018. The development of sustainable entrepreneurship research field. Sustainability 10, 10062005.
Schaefer, K., Corner, P.D., Kearins, K., 2015. Social, environmental and sustainable entrepreneurship research: what is needed for sustainability-as-flourishing? Organ. Environ. 284, 394–413.
Schaltegger, S., 2002. "A framework for ecopreneurship: leading bioneers and environmental managers to ecopreneurship". Greener Manag. Int. 38, 45–58.
Schaltegger, S., Wagner, M., 2011. Sustainable entrepreneurship and sustainability innovation: categories and interactions. Bus. Strat. Environ. 204, 222–237.
Schlange, L.E., 2009. "Stakeholder identification in sustainability entrepreneurship". Greener Manag. Int. 55.
Schumpeter, J., 1934. Capitalism, Socialism, and Democracy. Harper & Row, New York.
Shah, A.M., 2012. Business strategies in the emerging markets. J. Asia Pac. Bus. 13, 4–15.
Shahid, S., 2022. Perceived barriers and entrepreneurial exit intentions: moderating role of regular versus sustainable entrepreneurship. Eur. Bus. Rev. 35, 39–56.
Shahid, S., Reynaud, E., 2022. Individuals' sustainability orientation and entrepreneurial intentions: the mediating role of perceived attributes of the green market. Manag. Decis. 60, 1947–1968.
Shepherd, D.A., Patzelt, H., 2011. The new field of sustainable entrepreneurship: studying entrepreneurial action linking "what is to Be sustained" with "what is to Be developed." entrepreneurship: Theor. Pract. 35, 137–163.
Stubbs, W., 2017. Sustainable entrepreneurship and B corps. Bus. Strat. Environ. 263, 331–344.
Terán-Yépez, E., Marín-Carrillo, G.M., del Pilar Casado-Belmonte, M., de las Mercedes Capobianco-Uriarte, M., 2020. Sustainable entrepreneurship: review of its evolution and new trends. J. Clean. Prod. 252, 119742.
Thelken, H.N., de Jong, G., 2020. The impact of values and future orientation on intention formation within sustainable entrepreneurship. J. Clean. Prod. 266, 122052.
Tilley, F., Young, W., 2009. "Sustainability entrepreneurs: could they be the true wealth generators of the future?". Greener Manag. Int. 55, 79–92.
UNDP, OPHI Oxford Poverty, Human Development Initiative., 2022. 2022 Global Multidimensional Poverty Index MPI: Unpacking Deprivation Bundles to Reduce Multidimensional Poverty. New York.
Urbaniec, M., Sołtysik, M., Prusak, A., Kułakowski, K., Wojnarowska, M., 2022. Fostering sustainable entrepreneurship by business strategies: an explorative approach in the bioeconomy. Bus. Strat. Environ. 311, 251–267.
Urbano, D., Aparicio, S., Audretsch, D., 2019. Twenty-five years of research on institutions, entrepreneurship, and economic growth: what has been learned? Small Bus. Econ. 531, 21–49.
Winterhalter, S., Zeschky, M.B., Neumann, L., Gassmann, O., 2017. Business models for frugal innovation in emerging markets: the case of the medical device and laboratory equipment industry. Technovation 66, 3–13.
World Bank Data., 2021. Pakistan. https://data.worldbank.org/country/pakistan. (Accessed 5 January 2023).
Yin, R.K., 2014. Case Study Research: Design and Methods, fifth ed. Sage, Thousand Oaks.
Zeschky, M., Widenmayer, B., Gassmann, O., 2011. Frugal innovation in emerging markets. Res. Technol. Manag. 544, 38–45.