



Article How Frugal Innovation Promotes Social Sustainability

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Abstract: There is a need to develop an understanding of how frugal innovation promotes social sustainability. The objective of this paper is to find the connections between the two concepts of social sustainability and frugal innovation, by reviewing the existing literature concerning both fields. This paper presents a framework that identifies essential themes of social sustainability and explores them through frugal innovation. The framework builds on the important themes of social sustainability and shows their relevance in practice through frugal innovation. The notion of frugal innovation can be viewed as an approach towards realizing social sustainability and fulfilling the United Nations' Sustainable Development Goals.

Keywords: social sustainability; frugal innovation; practice; Sustainable Development Goals

1. Introduction

Within the sustainability discourse, the social pillar is considered of utmost importance, alongside the other two pillars of sustainable development—environmental and economic. Social sustainability is focused on the development of programs and processes that promote social interaction and cultural enrichment. It emphasizes protecting the vulnerable while respecting social diversity and is related to more basic needs of happiness, safety, freedom, dignity and affection [1]. Notably, the key challenges of sustainable development reside at the interfaces and trade-offs between its various dimensions [2]. Therefore, it is essential to develop the concept of social sustainability by adopting the integrating framework of sustainability [3]. Both the environmental and economic aspects of sustainable development are intertwined with the social pillar. For example, it is perhaps not possible to either achieve happiness in a society that is economically disadvantaged or have a healthy community if air quality is poor. According to Torjman [4], "human well-being cannot be sustained without a healthy environment and is equally unlikely in the absence of a vibrant economy".

Keeping the above principle in view, this paper seeks to highlight how social sustainability is strongly linked to frugal innovation. "Frugal innovation refers to products (both goods and services), processes, or marketing and organizational methods that seek to minimize the use of material and financial resources with the objective of reducing the cost of ownership while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards" [5]. Through frugal innovation, economically disadvantaged communities have been able to solve various problems pertaining to health, education or energy and uplift their standard of living. Frugal innovation has made a significant impact on society because it has aimed to solve pressing societal problems through ingenuity while simultaneously generating revenue. It has been argued before that businesses can play a critical role towards achieving sustainable development [6,7] and do untold good for the society [8]. Furthermore, frugal innovation has the potential to improve a company's sustainability performance [9]. However, the social benefits that frugal innovation can offer to the society have not been discussed considerably.

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The researcher argues that the role of frugal innovation towards sustainable development should be studied in depth, better tools should be formed to analyze their relationship [10]; and a strong link should be established between the two concepts. Therefore, it is useful to link the concept of social sustainability empirically to frugal innovation as this connection will further broaden our understanding of the role of frugal innovation towards the promotion of Sustainable Development Goals (SDGs) especially concerning social sustainability. This article contributes to establishing connections by presenting a framework for understanding the link between social sustainability and frugal innovation.

The remainder of this paper is structured as follows: In the next section, the methodological approach is discussed. Section 3 gives an overview of the two important concepts: social sustainability and frugal innovation. Based on the social sustainability and frugal innovation literature, the argument for linking the two concepts is then justified. This section presents various examples of frugal innovations and shows their connection to the themes of social sustainability and SDGs. Thereafter, implications for theory and practice are discussed in Section 4 and the conclusion and future research directions are discussed in Section 5. For the purpose of this paper, the researcher has chosen Littig and Grießler's definition of social sustainability [11] which is described later in this paper and Tiwari and Herstatt's definition of frugal innovation [5] which is already described in the introduction.

2. Materials and Methods

A large volume of literature was scanned but a limited number of documents were reviewed and critiqued depending upon their applicability to the topic in discussion. The documents were selected from the social sustainability and frugal innovation literature. The aim was not to read everything written on the topic but to review a representative sample of papers from both bodies of literature in order to gain a sufficient understanding of the topics and establish connections. Two main databases were chosen for this research which include the Web of Science and Scopus. The initial search was undertaken using basic keywords in the beginning of January 2016. The study of the existing body of knowledge concerning two topics—social sustainability and frugal innovation—has been carried out systematically. Figure 1 shows the relative publication volume related to frugal innovation and social sustainability derived from Web of Science Core Collection. It is interesting to note that both the fields of literature have grown exponentially in the last couple of years. It is evident that there has been an increasing interest in both the fields of frugal innovation and social sustainability.



Figure 1. The relative publication volume related to frugal innovation (**a**) and social sustainability (**b**), as found in the Web of Science Core Collection.

Therefore, a systematic study was carried out regarding the above mentioned topics in three main steps: (1) material collection; (2) material selection; and (3) material analysis. These three phases are described in the following paragraphs.

2.1. Material Collection

In this step, the researcher aimed at identifying all the relevant material concerning frugal innovation and social sustainability. The main keywords searched in frugal innovation publications included 'frugal innovation', 'jugaad innovation', 'bottom of pyramid (BOP) innovation' and 'reverse innovation' because the publications related to these terms are central to the concept of frugal innovation. For publications about social sustainability, the search was conducted using the keywords 'social sustainability', 'social sustainability definitions' and 'social dimension of sustainability'.

The researcher also reviewed reference lists from articles to find additional material not previously identified and searched for working papers to explore recent issues regarding these topics. The researcher also identified the relevant studies by searching the journals that were most cited while using the terms frugal innovation and social sustainability according to the Web of Science. Figure 2 lists the most popular publications that included articles on frugal innovation and social sustainability.



Figure 2. The most cited publications on frugal innovation (**a**) and social sustainability (**b**) in Web of Science Core Collection.

Finally, 104 records for frugal innovation and 1593 records for social sustainability literature were identified thereby making the total count of 1697 papers.

2.2. Material Selection

An analysis was performed by reading through the titles and abstracts of the 1697 publications. The abstracts were reviewed to determine whether or not the publications were relevant to the topics in question. Repetitive records as well as multiple irrelevant publications were found. A large number of documents were from diverse fields, such as healthcare, agriculture, sports or operations management, using the term 'social sustainability' in the title. Such papers dealt with different research fields and did not address social sustainability. For this reason, most of such papers were excluded. Numerous articles tackled sustainability at a general level, incorporating environmental and economic sustainability perspectives in particular, even with 'social sustainability' as the search term. A large volume of articles concerned topics such as renewable energy, smart grids, tourism sustainability, sustainable supply chain management, fisheries and other sustainability issues in

general. Regarding frugal innovation, open innovation, crowdsourcing, product innovation, and other themes from the innovation management were also found, even though the search terms were precise. The researcher was primarily interested in those papers that helped with specifically understanding the nature and themes of social sustainability and frugal innovation. For frugal innovation publications, the aim was to select those publications that discussed the concepts/dimensions/characteristics of frugal innovation, jugaad innovation, BOP or reverse innovation through theory or practice. For social sustainability publications, the publication was expected to either understand or define the concept of the social dimension of sustainability, show its characteristics or its connections to other dimensions of sustainability.

At the end of this stage, all the perceived irrelevant publications were left out and 91 publications from social sustainability literature and 73 publications from frugal innovation literature were selected thereby making the total count of 164 publications. For the next step, two separate folders were created, one for each topic. All the relevant publications were downloaded in the folders. A set of relevant data was compiled that was thought to be suitable for the review.

2.3. Material Analysis

In this phase, the chosen publications were read carefully, and the characteristics and themes discussed in the frugal innovation literature and social sustainability literature were identified. The focus was on identifying the connections between the two bodies of literature. Important themes of social sustainability were derived from social sustainability literature. They were identified from the previous literature reviews and also from researcher's own analysis. These social sustainability themes were grouped together to form more profound themes. For example, themes such as 'equitable access to resources', 'equitable access to social services', 'equity' and 'equitable income distribution', were grouped together to form a larger theme called 'social justice and equity'. The aim was to limit the number of derived themes. In total, 23 themes were derived from the literature. Similarly, the characteristics of frugal innovations and their societal implications were also identified from the frugal innovation from the authors involved in theorizing frugal innovation were limited. Most of the material dealt with studying individual examples; therefore, the researcher derived the characteristics of frugal innovation from the work of chosen authors. The next step was to show their societal implications by linking them to the themes of social sustainability.

Eight cases of frugal innovations were studied thoroughly and each case was evaluated according to the identified themes of social sustainability. The cases were selected based on three criteria. Firstly, these cases were prominent, having received significant media attention [12]. Secondly, as a group, they were selected to represent frugal innovations from a wide spectrum of organizations. For example, Aravind Eye Care and Narayana Hrudayalaya are hospital chains, Vortex Engineering (Solar Powered ATMs) is a medium sized firm, SELCO and Craftskills East Africa limited are social enterprises, Jaipur Foot is the product of a non-Governmental Organisation (NGO) and Kerala's palliative care is a charitable society. Lastly, they have all had a positive social impact.

3. Results and Discussion

3.1. What Is Frugal Innovation?

Frugal innovation is considered to be the future of the innovation management and a notion to look out for in the years to come [13,14]. The ultimate aim of innovation management is to create new concepts and move away from existing solutions [15]. Frugal innovation rethinks the nature of innovation. "It is an ability to do more with less by creating more business and social value while minimizing the use of resources such as energy, capital and time" [16]. Frugal innovation is developed in severe resource constraints; it involves good quality and reasonably priced products or services even for the customers with modest lifestyles. Frugal innovations are "good-enough, affordable products that meet the needs of resource-constrained consumers" [13].

Frugal innovation, which involves resource constrained product development, creates numerous benefits that are unavailable from traditional product development. It has the potential to enhance competitive advantage of a firm as well as green supply chain initiatives and be an ideal model to create green products [17]. Generally, frugal innovation is viewed as low cost innovation but it is much more than that. Frugal innovation uses the concept of simplification and strives for less instead of more by using clever technology. All the frugal solutions are characterized by affordability, robustness, user-friendliness, scalability and an attractive value proposition [18]. Frugal innovations are considered to be potentially disruptive and transformational [19] not only for emerging markets but also for developed markets [20].

Bhatti and Ventresca [21] combine historical and current analytical perspectives to define frugal innovation as means and ends to do more with less for more people. Frugal innovation as a term can act as an integrating mechanism to bring various concepts like disruptive innovation [22,23] lean innovation [24], BOP [25] jugaad innovation [26], grassroot innovations [27] and inclusive innovations [28] under one umbrella [29].

The term reverse innovation is often used as a synonym for frugal innovation. However, even though they signify the same notion and are interrelated [30], there is a difference that distinguishes one from the other. "Reverse innovation refers to the case where an innovation is adopted first in poor (emerging) economies before 'trickling up' to rich countries" [31]. "Reverse innovations are always built on cost, good-enough, or frugal innovations" [14]. They are clean-slate innovations which means that they have to be developed from the scratch and it involves reversing the way companies approach innovation [32,33]. Agarwal and Brem [34] make the distinction that frugal innovation involves designing solutions specifically for low-income market segments, while reverse innovation involves new products developed in emerging markets, which are then modified for sale in developed countries. "The development of frugal product innovation capabilities is a critical success factor in the development of reverse innovation" [35]. The ability of a firm to exploit the potential of reverse innovation makes it more likely to succeed in global innovation [36].

Frugal innovation is also referred to as Jugaad innovation. Jugaad is a Hindi word that means creative improvisation (thinking in a frugal way and being flexible), which requires quick adaptation to uncertain circumstances in an intelligent way [16,26,37]. However, this term has a negative connotation among innovation scholars due to its meaning—a simple work around—and its usage as opposed to the mainstream innovation process [38,39]. Jugaad, at heart, is about a new model of innovation, which is based on constraints. It means solving a customer problem in the most innovative way when your resources are constrained. Brem and Wolfram [40] present a comprehensive definition of frugal innovation whereby they define it as a "derived management approach, based on jugaad, which focusses on development, production, and product management of resource saving products and services for people at BOP by achieving a sufficient level of taxonomy and avoiding needless costs".

For developing jugaad or in other words frugal innovations, unusual skillsets and mindsets are required. The most important characteristic of jugaad innovation is that it challenges the standard model of innovation, which involves highly structured and costly research to create new innovations [26]. It is characterized by limited resources to create low cost innovations that are sustainable for the environment and communities. These resource constrained product development strategies have the ability to give rise to products which are environmentally friendly due to lower resource use and greater supply chain efficiencies as compared to conventional product development approaches [17]. Jugaad is a way of survival for consumers at BOP [41].

BOP refers to the largest, and usually the poorest proportion of the world's population which constitutes an estimated four billion people in the developing world who live on less than \$2 per day [42]. The BOP markets are uncertain and volatile [43] and characterized by institutional voids [44]. However, BOP has the potential to offer opportunities to create value for both the companies and the poor [45–47]. Multinational corporations (MNC) ignore the BOP market and focus on existing markets as they view the BOP as unprofitable demographic [48]. However, Prahalad and Hart [25] suggest that

it is possible to profit from the poor by treating them as self-respecting customers. These four billion micro consumers constitute a significant market and represent an engine of innovation, vitality, and growth [42]. By seeing poor as producers [49], co-producers of innovation [50,51], entrepreneurs or innovators [52,53] and not mere receivers, the firms can be successful in the BOP markets. Employing strategies like building local capacity and co-inventing custom solutions with non-traditional partners, these companies and their sustainable innovations can enter the BOP markets with ease [51,54]. Further, the lessons these established companies learn in BOP markets will serve them well in becoming globally competitive [55] and open the way to sustainable growth for the global economy [22]. According to Prahalad and Mashelkar [56], affordability and sustainability replace abundance and premium pricing as drivers for innovation in the developing countries.

Developing frugal innovations for the BOP market requires ingenuity and vision. Be it through MNC or social enterprise, non-governmental organisation (NGO) or small and medium sized enterprise (SME), any kind of entrepreneurial activity at BOP can help eradicate poverty in an economically feasible way [57,58] if the environment is conducive to meeting certain success criteria [59]. It requires an environment which begins with (a) understanding the fundamental needs of the BOP population; (b) creating an entrepreneurial eco-system that involves partnerships with other companies and the public sector; and (c) nurturing an 'innovation sandbox' that encourages new ideas [60]. Therefore, the strategies and processes that are delivered to this market have to cope with resource constraints and at the same time either maintain or improve societal, ecological and economic sustainability [21]. The firms that address strategic innovation in BOP markets and address the issues of product affordability, acceptability, availability and awareness can build enormous market value [61]. Over the years, BOP concept has provided a new direction to the thinking of the corporate world [62]. There has been a lot of discussion around poor donning different hats as consumers, entrepreneurs [63,64], producers or suppliers [44,65] across BOP literature. However, viewing poor as value-conscious consumers and creative entrepreneurs in BOP has been subjected to intense criticism. Criticism includes arguments such as it "presents a romanticized view of the poor, grossly underemphasizes the critical role and responsibility of the state in poverty reduction and ignores the vulnerability of the poor and underemphasizes the employability of the poor" [49,66–68], "obscuring unequal power relations at different societal levels and painting an optimistic picture of win-win outcomes" [69].

Frugal solutions are capable of uplifting the standard of living of individual communities to the next better level [5]. According to Basu, Banerjee and Sweeny [70], "Frugal innovation is a design innovation process in which the needs and context of citizens in the developing world are put first in order to develop appropriate, adaptable, affordable and accessible services and products for the emerging markets".

The frugal mindset was created in emerging markets, especially India and China. Some scholars consider India to be the lead market for frugal innovation [5], while others are of the view that India's potential as a 'laboratory for frugal innovations' is over-rated [71]. Emerging markets have witnessed the frugal mindset for different reasons. Firstly, a large emerging market with a growing middle class and massive purchasing power had needs that were not being met. Their sensitivity concerning product pricing required manufacturers to innovate frugally and keep prices low. Secondly, the expensive workforce in the Western companies made it impossible to develop low cost products and innovate frugally. Thirdly, the manufacturers from emerging Asian markets, especially India and China, focused on the real needs of the customers as opposed to manufacturers in the West, who focused on the wants more than the needs of customers. Therefore, they could not innovate frugally for customers in emerging markets, and the gap was then conveniently filled by companies in emerging markets [72]. Lastly, extreme conditions and major gaps in service provision stimulated demand for low-cost solutions in health, education and energy [12].

The concept of frugal innovation is gaining momentum as the experts have realized that frugality has to be the mindset of every business firm operating in the emerging markets or the developed world. Frugal innovations are becoming popular in developed economies due to their lower costs and no frills

structure [73]. In order to succeed in the emerging markets, the Western companies have to change their approach to innovation. So far, innovation has meant the development of new products with more advanced features at premium prices. However, in emerging markets, companies need to master the art of frugal innovation as economically disadvantaged people are extremely price sensitive [74]. Stripping products of non-essential features and applying sophisticated technologies in order to reduce costs and adopt products to local environments makes the difference between failure and success of such innovations [20]. Therefore, instead of offering outdated technologies from Western markets to emerging markets at lower prices, Western companies need to produce frugal innovations from scratch. These frugal innovators must devise low-cost strategies to handle resource limitations when innovating, developing and delivering products and services to low-income users in emerging markets, where affordability, resources and institutional constraints exist [75]. Frugal innovators need to build innovation capabilities by creating an innovation process that overcomes 'the deficiency problem' in generating cheap priced original products [76]. A frugal mindset is encouraged not only by a resource scarce environment but also a higher tolerance for uncertainty [77]. Poor customers in the rich countries also need to be served; to do so, a frugal mindset associated with BOP strategies must be instilled in firms' business models [78]. There are many reasons for the developed world to embrace frugal innovations which include (a) slow growth in developed economies, which will increase demand for frugal innovations; (b) environmental constraints, which will increase demand for more frugal models of production and consumption; (c) caring for rapidly aging societies, which will require new and frugal approaches to health and social care; (d) understanding that the fastest growing markets are in developing economies, where the demand for frugal products and services is high; therefore, there is a huge business opportunity for Western frugal innovators [12].

Table 1 identifies the characteristics of frugal innovations and also provides information about the societal implications. The purpose of Table 1 is to give a general idea about the characteristics of frugal innovations included in the literature. It also highlights the importance of societal benefits that result from frugal innovations.

Author	Characteristics	Implications for Society
Prahalad [42]	Price Performance Innovation: Hybrids Scale of operations Eco-friendly Identifying functionality Process innovation Deskilling of work Education of customers Designing for hostile infrastructure Interfaces Distribution: accessing the customer Unconventional way to deliver products	Making four billion poor people as customers and treating them as self-respecting citizens by understanding the fundamental needs of the BOP population and innovating for them. Building capacity for people to escape poverty and deprivation. Tackles basic needs, social inclusion, human dignity, participation.
Tiwari and Herstatt [5]	Affordable Robust User-friendly Easy to use Minimal use of raw materials Acceptable quality standard	Uplifting the standard of living of individual communities to the next better level. Tackles human well-being, quality of life, dealing with poverty.

Table 1. Characteristics of frugal innovation and implications for society—from the frugal innovation literature.

Author	Characteristics	Implications for Society
Basu, Banerjee and Sweeny [70]	Ruggedization Light weight Mobile enabled solutions Human centric design Simplification New distribution models Adaptation Use of local resources Green technology Affordability	Needs and context of poor citizens in the developing world are put first in order to develop appropriate, adaptable, affordable and accessible solutions for them. Tackles social coherence, equity, social justice.
Rajdou, Prabhu and Ahuja [26]	Creative improvisation Innovation based on constraints Unusual skillset and mindset Flexibility Simplicity Social Inclusion	Innovating for the margins of the society and bringing them into the mainstream. Tackles social inclusion, social justice.
Rao [73]	No frills, low cost products/services robust, sustainable design, ease of use, Strong tendency to disrupt incumbents.	Innovating to harness frugality and improve profitability in a world conscious of cost and sustainability. Tackles human well-being and dealing with poverty.
Govindarajan and Trimble [32]	Clean-slate innovations (developed from scratch in the developing world)	Closing the wide gaps between the rich and the poor world. Tackles equity and social justice.

Table 1. Cont.

3.2. What Is Social Sustainability?

Sustainable development recognizes the interdependence of environmental, social, and economic systems—the three pillars of sustainability which have appeared to understand, address and reduce current, and future potential problems [79,80]. However, achieving a balance between these three pillars is the need of the hour [81]. The social pillar has not received as much attention as the other two dimensions—ecological and economic [1,82–87]. Therefore, it is important to explore the role of organizations that organize the sustainability projects in shaping the balance between the pillars [88,89]. Nevertheless, social sustainability is considered to be the fundamental component of sustainable development [90]. Social sustainability is a multifaceted concept which has often been studied through the lenses of separate disciplines and theoretical perspectives [91,92]. It is a dynamic concept with a high possibility of change over time. It is unclear what social sustainability really means in practice and what its dynamics and breaks are [11,88,92–95].

Spangenberg and Omann [84] identified three analytical views that surround the social sustainability discussions. They include functional approach—popular in studies of rural, urban or community sustainability, capital approach—views from economic thinking, and system approach—views each domain as a system that should be capable of reproduction. During the last 15 years, many researches around social sustainability have focused mainly on the urban studies from both academic and policy perspectives [96]. Weingaertner and Moberg [91] reviewed social sustainability from the perspectives of urban development and the viewpoint of companies and products and identified that context dependency influences the relevance and interpretations of detailed aspects of social sustainability.

Many definitions of social sustainability have emerged so far, but its all-encompassing definition is still missing in policy and practice [96,97]. Sachs [98] states that "social sustainability must rest on the basic values of equity and democracy, the latter meant as the effective appropriation of all human rights—political, civil, economic, social and cultural—by all people". From a sociological standpoint, Littig and Grießler [11] state that "social sustainability is given, if work within a society and the related

institutional reproductive capabilities are preserved over a long period of time and the normative claims of social justice, human dignity and participation are fulfilled". Polese and Stren [99] stated, "social sustainability of a city is defined as development that is compatible with harmonious evolution of civil society, fostering an environment conducive to the compatible cohabitation of culturally and socially diverse groups and encouraging social integration, with improvements in the quality of life for all segments of the population".

One important focus of the definitions of social sustainability is future generations, in that improvement of a society should allow current and future generations to utilize social resources in a healthy way. According to Western Australia Council of Social Services, "Social sustainability occurs when the formal and informal processes, systems, structures, and relationships actively support the capacity of current and future generations to create healthy and livable communities" [100]. Chiu [101] expands on the notion of well-being of generations taken from Brundtland's definition of sustainable development. Chiu [101] describes social sustainability as the maintenance and improvement of the well-being of current and future generations. Other authors do not provide a definition of social sustainability but suggest the main themes [102], which can be found later in this paper. During the last 10 years, the concept of social sustainability has shifted toward being seen as dependent on social networks, making community contributions, creating a sense of place and offering community stability and security [92,103].

Some authors focus on the attributes of a socially sustainable community. For instance, Vallance et al. [104] describe a socially sustainable community as the one that has certain key elements which include social homogeneity, equitable incomes, access to goods and services, employment and cultural as well as political sustainability. Such a community is equitable, diverse, connected, and democratic and provides a good quality of life [100]. In a more recent study, Missimer, Robert and Broman [105] state that, in a socially sustainable society, people are not subject to structural obstacles to health, influence, competence, impartiality and meaning-making.

Social sustainability is also related to more basic needs of happiness, safety, freedom and dignity [1]. Magis and Shinn [106] define four central constituents of social sustainability: human well-being, equity, democratic government, and democratic civil society. Human well-being ensures the protection of basic needs, equity ensures mechanisms to guarantee equitable sharing of society's benefits and costs, democratic government ensures that the governance is oriented to the people and the democratic society empowers people to build democratic government.

Larsen [107] states that, "Social sustainability must (a) build inclusion at the level of the individuals, groups and society; (b) provide for basic human dignity which includes at least basic human sustenance, freedom from tyranny, freedom of association, and basic human liberty; (c) provide a means for people to influence their governance; and (d) create the capacity for learning at the level of individuals, groups, collectives, governments, corporations and society".

Social sustainability is also viewed as a process. According to McKenzie [100], social sustainability is a life-enhancing condition within communities, and a process within communities that can achieve that condition and this condition can be achieved through several factors like equity of access to key services, diversity, political participation at local level, transmitting awareness of social sustainability from one generation to the next, mechanisms of communities and societies live with each other and set out to achieve the objectives of development models they have chosen for themselves also taking into account the physical boundaries of their places and planet Earth as a whole" [90].

It has been argued that measuring and quantifying social sustainability has been quite challenging [2,108–110] as the indicators are less developed [111,112] because this concept is intangible and qualitative in nature [110] and there is no widely accepted scientific basis for analysis [113]. However, previously many scholars have developed indicators to assess social sustainability. For example, Spangenberg and Omann [84] refer to basic needs, social resources, equal opportunities, participation, sustaining oneself and cultural diversity as the most important indicators. Littig and

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Grießler [11] consider satisfaction of basic needs and quality of life, social justice, and social coherence as the three core indicators. Cuthill [82] considers social capital, social infrastructure, social justice and engaged governance as the key indicators of social sustainability. Vavik and Keitsch [1] stress three indicators, namely poverty, illiteracy and access. In a recent study, Tirado, Morales and Lobato-Calleros [114] refer to two indicators—efficiency and equity through which social sustainability can be best promoted. In yet another interesting study, scholars posit to add indicators that reflect the lived experience of disabled people [115]. However, scholars agree that a general consensus about the indicators has been difficult to reach due to its intangible nature and therefore, there is a need to quantify the already existing qualitative indicators [84,110].

Missimer et al. [105,116] even went a little further to question the existing framework for strategic decision making towards sustainability and demonstrated its dichotomies and lack of robustness in its social dimension and developed the 'Framework for Strategic Sustainable Development' which could be more cohesive and operational.

Social sustainability plays a strong role in business, and the role of socially driven businesses towards achieving social sustainability is also noteworthy. Currently, businesses are placing greater focus on social sustainability [117]. However, not much work has been done regarding social sustainability as it applies to business [118]. Therefore, more research that investigates the link between social sustainability and organizational effectiveness [119] should be done to obtain a better understanding of the links between business and society to fully address sustainable development [120] and, more importantly, its social dimension.

Theoretically, social sustainability as a concept covers broad societal issues [121] and has various interpretations in different fields [122]. Notably, regarding businesses, social sustainability is understood more generally as a business that influences individuals' or society's well-being [110,123] or in other words, a system that meets the expectations of stakeholders without causing harm to the well-being of society and its members [124]. Here, the idea of social sustainability is commonly interpreted as the ability to continue to stay in business through good relations with stakeholders [125]. Social sustainability reflects the development that protects the mental and physical health of the stakeholders, leads to social development and treats all stakeholders fairly [1]. It covers the broadest aspects of business operations and the effects that they have on employees, customers, suppliers, investors, local and global communities. It also focuses on respecting social diversity [1].

It has been argued that businesses adopt top-down approaches to assess sustainability [126] and sometimes create fake reputations regarding their level of sustainability [127]. The indicators used to measure sustainability in overall business do not effectively address social criteria [128]. However, scholars are attempting to address this problem by devising most suitable standards to assess social sustainability in a business. For example, McElroy, Jorna and Engelen [129] have proposed a social footprint method to quantitatively measure and report on the social sustainability of their operations. Another set of standards was proposed by Thomsen and King [130] after evaluating the best business practices of sustainable businesses that could act as a starting point to assess social sustainability. These are workplace practices, work-life balance, retirement benefits, healthcare benefits, safe workspaces, stable housing, support services for children, support for employees in their non-work lives, training and support for the larger community. In recent years, impact investing has become quite popular among business leaders, government, social organisations and philanthropists who are interested in assessing social sustainability of businesses/projects in order to solve some of society's most pressing issues [131,132]. Many common frameworks are used by impact investors which include Impact Reporting and Investment Standards (IRIS), Global Impact Investing Rating System (GIIRS), Social Return on Investment (SROI), PULSE Impact Investing Management Software, Acumen Fund's Best Alternative Charitable Option, Endeavor's Impact Assessment Dashboard, etc. These social metrics are useful tools to evaluate the social or environmental impact of a business and serve as guides for impact investors. These metrics provide guidance to an impact investor while making

investment decisions, identifying and mitigating risks, capturing long term value, tracking progress, improving the project/company, proving impact and attribution and reporting to stakeholders [133].

Businesses can help towards achieving social sustainability provided they fulfil the criteria of socially sustainable businesses. For instance, a socially sustainable business is that enterprise whose aim is to solve the pressing needs of society. It ensures that healthy relationships are maintained with all its stakeholders like employees, customers and community members. An interesting study by Galuppo et al. [134] has shown that building a socially sustainable business requires the management of multi-stakeholder processes that are often conflicting. Therefore, a socially sustainable business can contribute to the worthy goal of sustainability by crafting a "desirable future state for all stakeholders" [135]. It incorporates sustainability principles into everyday practices of a business [136] and, therefore, contributes towards the betterment of community and society at large.

Table 2 identifies the themes of social sustainability that different authors have highlighted thus far. The literature identifies the most important building blocks of what a socially sustainable society should entail. As it is evident from the table, numerous authors point towards similar themes as they remain the primary constituents of social sustainability. The purpose of Table 2 is to give an idea of the concepts included in various discussions of social sustainability. The literature outlined in Table 2 serves to identify what is generally understood by social sustainability.

Themes of Social Sustainability	Authors
Human health and well-being/well-being of generations	Boström [137], Polese and Stren [99], Magis and Shinn, [106], Chiu [101], McKenzie [100], Castillo et al. [138], Dempsey et al. [94], Gauthier [139], Geibler et al. [110], Tanzil and Beloff [140], Colantonio and Dixon [141], Rogers et al. [142], Partridge [3]
Basic needs and quality of life	Littig and Grießler [11], Polese and Stren [99], McKenzie [100], Magis and Shinn [106], Spangenberg and Omann [84], Baines and Morgan [143], Ancell and Thompson-Fawcett [144], Colantonio [102], Dempsey et al. [94], Carew and Mitchell [145], Partridge [3]
Social Coherence	Littig and Grießler [11], McKenzie [100], Vallance, Perkins and Dixon [104], Murphy [146]
Social justice and equity	Cuthill [82], Dempsey et al. [94], Littig and Grießler [11], McKenzie [100], Magis and Shinn [106], Vallance, Perkins and Dixon [104], Giddings, Hopwood and O'Brien [147], Spangenberg and Omann [84], Murphy [146], Chambers and Conway [148], Thin et al. [149], Koning [85], Chiu [101], Sachs [98], Holden [150], Baines and Morgan [143], Polese and Stren [99], Partridge [3], Ketschau [151]
Democratic/engaged government and democratic society	Cuthill [82], Magis and Shinn [106], Sachs [98], McKenzie [100], Larsen [107], Davidson and Wilson [152], Dempsey et al. [94]
Human rights	Bebbington and Dillard [113], Vavik and Keitsch [1], Sachs [98]
Social inclusion	Polese and Stren [99], Larsen [107], Davidson and Wilson [152], Ancell and Thompson-Fawcett [144], McKenzie [100], Dempsey et al. [94], Bramley and Power [153], Glasson and Wood [103], Partridge [3]
Diversity	Vavik and Keitsch [1], Polese and Stren [99], McKenzie [100], Spangenberg and Omann [84], Baines and Morgan [143]
Decline of poverty	Vavik and Keitsch [1], Vallance, Perkins and Dixon [104]
Social infrastructure	Cuthill [82], Chan and Lee [154]
Social capital	Cuthill [82], Lehtonen [2], Magis [155], Messer and Kecskes [156], Semenza [157], Baines and Morgan [144], Dempsey et al. [94], Vavik and Keitsch [1], Rogers, Gardner and Carlson [158], El-Husseiny and Kesseiba [159], Bramley and Power [153], Rocak, Hospers and Reverda [160], Colantonio and Dixon [141]
Behavioural changes	Vallance, Perkins and Dixon [104]
Preservation of socio-cultural patterns and practices	Vavik and Keitsch [1], Vallance, Perkins and Dixon [104], Davidson and Wilson [152], Colantonio and Dixon [141]

Table 2. Themes of social sustainability derived from the social sustainability literature.

Themes of Social Sustainability	Authors		
Participation (Including stakeholder participation)	Littig and Grießler [11], Boström [137], Giddings, Hopwood and O'Brien [147], Spangenberg and Omann [84], Murphy [146], Thin et al. [149], Baines and Morgan [143], U.O'Hara [161], Bramley et al. [162], Dempsey et al. [94], Vavik and Keitsch [1], Galuppo et al. [134], Funk [135], Lindgreen et al. [124], Labuschagne, Brent and Erck [128], Brown, Dillard and Marshall [125], Colantonio and Dixon [141], Partridge [3]		
Human dignity	Littig and Grießler [11], Larsen [107], Vavik and Keitsch [1]		
Safety and security	Thin et al. [149], Bramley et al. [162], Dempsey et al. [94], Vavik and Keitsch [1], Glasson and Wood [103], Gauthier [139], Geibler et al. [110], Tanzil and Beloff, [140]		
Sense of place and belonging	Bramley et al. [162], Dempsey et al. [94], Glasson and Wood [103], Bramley and Power [153], Colantonio and Dixon [141], Yung, Chan and Xu [163], Yung and Chan [164]		
Education and training	Spangenberg and Omann [84], Dempsey et al. [94], Colantonio and Dixon [141]		
Employment	Sachs [98], Spangenberg and Omann [84], Dempsey et al. [94]		
Community involvement and development, community resilience	Bramley et al. [162], Woodcraft, Hackett, and Caistor-arendar [165], Castillo et al. [138], Bramley and Power [153], Colantonio [102], Landorf [95], Magis [155], U. O'Hara [161]		
Fair operating practices	Bebbington and Dillard [113]		
Capacity for learning	Larsen [107]		
No structural obstacles (to health, influence, competence, impartiality and meaning-making)	Missimer, Robert and Broman [116]		

Table 2. Cont.

3.3. Establishing a Connection between Social Sustainability and Frugal Innovation: Practical Cases of Frugal Innovation and Their Links to the Social Sustainability Themes and SDGs

Social sustainability takes place when the work within a society and the related institutional arrangements satisfy an extended set of human needs [11]. Therefore, satisfying human needs is the priority of every socially sustainable society where the human well-being forms the foundation of every effort undertaken by society. Frugal innovation is a process whereby the needs of the citizens in the society are put first in order to solve some pressing societal problems. This section consists of practical examples of frugal innovations and shows the connections between frugal innovations and various themes of social sustainability. The researcher tries to illustrate with examples the link that each frugal innovation has with social sustainability and how each frugal innovation promotes the uptake of certain SDG. What emerges from each practical example of frugal innovation is the view that shows the societal benefits of frugal innovations and how such innovations tackle the big concept of social sustainability in their own little ways. Through this connection, the researcher is not trying to show that all the issues of social sustainability will be resolved by frugal innovations, but the purpose is to demonstrate the positive societal effects these frugal innovations have on a society and their potential to fulfill some pressing societal needs.

Following are some practical examples of frugal innovations. This section expands our understanding of the frugal innovations by showing their connections to social sustainability themes and SDGs.

3.3.1. Aravind Eye Care

Aravind Eye Hospital began as a modest hospital with 11 beds and four medical officers; it was created by Dr Venkataswamy in 1976 in India after his retirement, with the mission of eradicating needless blindness. Today, it is one of the largest facilities in the world for eye care and has grown into a network of eye hospitals, which have treated a total of nearly thirty-two million patients and performed nearly four million eye surgeries, the majority of which were inexpensive or free [42].

The Aravind Eye Care System now serves as a model for India and the rest of the world. From the beginning, a policy was put into place—some patients would pay while others received free care. Frugally innovative methods were employed to improve efficiency and help doctors save valuable time between surgeries such as that nurses prepare the next patient while the doctor is operating on a different one; the doctor moves directly from one patient to the next. Each doctor at Aravind performs about 2600 surgeries per year. These measures have pushed down the average cost of surgery [166]. The high level of quality at Aravind attracts patients from all over the world who are willing to pay the market price for their treatment and surgeries. The profit generated from these patients is then used to cross-subsidize and fund free surgeries for poor patients. At Aravind, every patient who can pay covers the costs of two who cannot. Because of high patient numbers, the revenue from paying patients not only covers costs for Aravind's free services but also generates a surplus that funds growth and expansion. Aravind pays for all its expansion projects from its profits, even though two-thirds of its patients receive free or subsidized care [31].

Aravind started an intraocular lens production facility, Aurolab, in 1992. In the 1990s, there were no lens manufacturers in India. With lenses costing \$200, they were not affordable for people in most developing countries. Aurolab devised efficient methods for creating lenses as per international standards. Today, Aurolab provides lenses at the low price of just \$2 each and also produces a wide range of ophthalmic products, exporting them to 130 countries around the world [166]. Frugal techniques also dramatically increased the number of cataract surgeries at Aravind and made it possible to deliver high quality eye care, even to the poorest people.

Table 3 illustrates how Aravind Eye Care, a practical example of frugal innovation, promotes social sustainability by addressing its different themes.

Themes of Social Sustainability	Promotion of Social Sustainability through Frugal Innovations (Aravind Eye Care)	Promotion of SDGs	
Human health and well-being/well-being of generations	The eyesight of 45 million people worldwide has been snatched away, often needlessly [42]. Eradication of needless blindness contributes to human well-being.	SDG 3: Aravind Eye Care ensures healthy lives and promotes well-being by providing eyesight to millions of people. SDG 8: Aravind Eye Care promotes sustained inclusive and sustainable economic growth and provides productive employment to numerous people.	
Basic needs and quality of life	By empowering the blind people with the precious gift of eyesight, their quality of life improves.		
Social coherence	By seeking out and catering to the poor blind population and providing them with free treatment, social coherence is being achieved.		
Social justice and equity	Both rich and poor receive this treatment. Poor patients who would otherwise spend their lives in blindness receive the wondrous gift of eyesight free of cost.		
Social inclusion	By empowering poor and marginalized people with eyesight, Aravind Eye Care eradicates needless blindness thereby promoting social inclusion.	 SDG 9: Aravind Eye Care has built a resilient infrastructure. It promotes inclusive and sustainable eye care and fosters innovation. SDG 10: Aravind Eye Care reduces inequality within the 	
Decline of poverty	Poor people regain their sight and receive another opportunity to earn a living.		
Social infrastructure	Aravind Eye Hospital accommodates social services thereby making it an excellent example of social infrastructure.		
Social capital	Community accountability and participation, which are distinct indicators of social capital, are clearly evident.	country by empowering blind people with the gift of eye sight.	
Participation	Marginalized people are given a second chance at becoming contributing members of society.	 SDG 12: By employing sustainable Aravind Eye Care model each doctor at Aravind 	
Human dignity	People regain their sight and are able to live a productive life.	Eye Care performs about	
Employment	Aravind Eye Care caters to the problem of unemployment by employing numerous people in India.	 2600 surgeries per year. SDG 16: Aravind Eye Care has 	
Education and training	Aravind Eye Care collaborates with the World Health Organization to design and offer structured training programmes to eye care professionals at all levels.	emerged as a highly effective and inclusive institution, which promotes social inclusion.	

Table 3. Promotion of social sustainability through frugal innovations (Example: Aravind Eye Care).

3.3.2. Jaipur Foot

One of the best known examples of frugal innovation is Jaipur Foot. It is a prosthetic foot tailored specifically for the poor who otherwise have no access to expensive prosthetics. In the world today, there are approximately 25 million amputees, with that figure growing by approximately 250,000 each year [42]. For the poorest of the poor people in the developing world, losing a limb is devastating; it could impact their ability to provide livelihood for themselves and their families. The original Jaipur Foot was developed in 1968 by Ram Chandra, a sculptor in Jaipur, India. He was frustrated with the lack of an affordable supply of prosthetic limbs. Costing up to \$12,000, existing models were completely unobtainable for the majority of the Indian population [12]. Using rubber, wood and tire cord, he designed and manufactured a prosthetic foot for under \$45 that had great functionality. Today, over 20,000 individuals each year receive a free Jaipur Foot in India. This is an example of a frugal innovation that has the potential to empower the poor and marginalized people by allowing them to participate in the society, despite their limitations. Table 4 illustrates how Jaipur Foot, a practical example of frugal innovation, promotes social sustainability by addressing its different themes.

Table 4. Promotion of social sustainability through frugal innovations (Example: Jaipur Foot).

Themes of Social Sustainability	Promotion of Social Sustainability through Frugal Innovations (Example: Jaipur Foot)	Promotion of SDGs	
Human health and well-being/well-being of generations	Empowering the poor by allowing them to take control of their lives.	_	
Basic needs and quality of life	Amputees who receive Jaipur Foot have a better quality life.	SDG 3: Jaipur Foot	
Social coherence	Promotes solidarity by helping poor sections of society.	promotes well-being by	
Social justice and equity	Rich and poor alike receive this treatment. Poor people, who have no means to afford expensive prosthetics, can still receive the Jaipur Foot free of charge.	serving amputees.	
Social inclusion	Social inclusion is about closing the distance that separates people; this frugal innovation does just that by allowing the amputees to live a more productive life.		
Decline of poverty	People have better employment prospects to therefore support their families.	SDG 10: The Jaipur Foot	
Social infrastructure	The organization offering Jaipur Foot to the disabled, Bhagwan Mahaveer Viklang Sahayata Samiti (BMVSS) is the world's largest organisation serving the disabled and a great example of a social infrastructure.	the country by empowering amputees with a prosthetic foot and allowing them to lead	
Participation	Poor people who lose their limbs become unable to provide for themselves and their families; however, with the help of the Jaipur Foot, they are able to participate in society, despite their limitations.	a more productive life.	
Human dignity	It empowers people and helps them continue their lives with dignity.	-	

3.3.3. Kerala's Palliative Care

Kerala's Neighbourhood Network in Palliative Care is a system for social care delivered in Kerala, India whereby volunteers from the local community are trained to identify the problems of the chronically ill in their areas and to intervene effectively [12]. The network looks after more than 6000 patients at any given time and all their services are free. More than 5000 community volunteers offer their services without any remuneration. Tens of doctors and nurses who provide expert support are employed by the community. All the resources needed for medicines, food or support for children and salaries are raised from local community donations [167].

Kerala's palliative care is an excellent example of frugal innovation that promotes social sustainability. This network recognizes the importance of social relationships, feels compassion towards old, sick and needy patients in their society and delivers help selflessly in order to make their society a better place.

Table 5 illustrates how Kerala's Palliative Care, a practical example of frugal innovation promotes social sustainability by addressing its different themes.

Table 5. Promotion of social sustainability	v through frugal innovations (Example: Kerala's Palliative Care).
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Themes of Social Sustainability	Promotion of Social Sustainability through Frugal Innovations (Example: Kerala's Palliative Care)	Promotion of SDGs	
Human health and well-being/well-being of generations	Social care delivered to the chronically ill by volunteers from the local community is an excellent example of promoting human health and well-being.		
Basic needs and quality of life	Through Kerala's Palliative Care, quality of life of the acutely sick people is improved.		
Social coherence	It is an excellent example of social coherence, where importance of community is recognized.		
Social justice and equity	Through palliative care, access to basic services for health and well-being to all sick people, irrespective of their differences in status, religion or creed is possible.	SDG 3: Kerala's Palliative Care promotes	
Social inclusion	It promotes inclusion at the level of individuals, groups and society.	the well-being of severely sick people.	
Social infrastructure	Kerala's Palliative Care is an excellent example of a social infrastructure delivered through communities.		
Social capital	It shows community accountability, responsibility, compassion and social service.		
Behavioral/ Attitude changes	Thinking selflessly about the old and sick members of the society and working towards the welfare of the society is the attitude that all communities need.	SDG 16: Kerala's Palliative Care is an	
Preservation of socio-cultural patterns and practices	This innovation preserves the socio-cultural practices of old India, which urban India has forgotten over time. Collectivism has been the essence of Indian culture.	inclusive institution that works on the principles of social inclusion and	
Participation	Approximately 5000 community volunteers participate in community welfare without a salary and care for more than 6000 patients.	social justice.	
Human dignity	Palliative care aids chronically ill people and helps them live the rest of their lives with hope.		
Community involvement and development	It is an excellent example of how a community can get involved to deliver social care.		

3.3.4. Narayana Hrudayalaya

The Narayana Hrudayalaya Group in India provides world-class cardiac care at radically low costs by applying the philosophies of mass production and lean manufacturing. Heart surgery through this group costs between \$2000 and \$5000, compared with \$20,000-\$100,000 in the US. Poor patients are operated on free of charge. At least 60 operations a week are provided to poor patients; yet, the group still manages to maintain a higher profit margin than the average American hospital. The success of the Narayana Hrudayalaya Group is a striking example of frugal innovation in India [12].

This example reflects how frugal innovations and techniques help solve societal problems. Frugal and innovative techniques have helped Narayana Hrudayalaya to not only deliver high quality cardiac care but also address societal needs by helping the poorest sections of society. Even though poor patients receive free treatment, this chain of hospitals maintains a high profit margin due to efficient and innovative techniques and strategies. Further, it also works towards human well-being and helps achieve social sustainability. Table 6 illustrates how Narayana Hrudayalaya, a practical example of frugal innovation, promotes social sustainability by addressing its different themes.

Themes of Social Sustainability	Promotion of Social Sustainability through Frugal Innovations (Narayana Hrudayalaya)	Promotion of SDGs	
Human health and well-being/well-being of generations	Offering world class cardiac care at radically low cost promotes human well-being by all means.	SDG 3: Narayana Hrudayalaya ensures healthy lives and promotes well-being.	
Basic needs and quality of life	By allowing access to the best healthcare, even to those who otherwise cannot afford it, Narayana Hrudayalaya improves quality of life.	SDG 8: Narayana Hrudayalaya promotes sustained inclusive and sustainable economic growth, and	
Social coherence	Offering free cardiac care to thousands of patients, social coherence is being achieved.	provides productive employment to numerous people.	
Social justice and equity	Both rich and poor receive this treatment. Poor patients who otherwise cannot dream of highly expensive surgeries, such as those performed in the US, receive it free of charge in India.	SDG 9: Narayana Hrudayalaya has built resilient infrastructure, promoted inclusive and sustainable world class cardiac care at radically low cost and has employed a highly innovative healthcare model.	
Social inclusion	By curing poor and marginalized people, Narayana Hrudayalaya promotes social inclusion.		
Decline of poverty	Poor people regain their health and get an opportunity to earn a living again.	 SDG 10: Narayana Hrudayalaya reduces inequality within the country by operating people free of cost. SDG 12: Narayana Hrudayalaya represents an excellent case of sustainable production and consumption; it drastically lowers heart surgery costs through 	
Social infrastructure	Narayana Hrudayalaya accommodates social services thereby making it an excellent example of a social infrastructure.		
Social capital	Community accountability and participation which are distinct indicators of social capital are clearly evident.		
Participation	By providing a micro-insurance scheme that allows poor people to access quality healthcare at INR 5 (11 cents) per month, Narayana Hrudayalaya promotes participation.	employing the principles of mass production and lean manufacturing.	
Human dignity	Poor people get a chance to live their lives with dignity.	has emerged as a highly effective and inclusive institution that	
Employment	Narayana Hrudayalaya provides employment to numerous people.	promotes social inclusion.	

Table 6. Promotion of social sustainability through frugal innovations (Example: Narayana Hrudayalaya).

3.3.5. Vortex Engineering (Solar Powered ATMs)

Vortex Engineering Private Limited is an innovative Indian company that develops and manufactures Automated Teller Machines (ATMs), which are "highly reliable, rugged, easy to use and eco-friendly" [168]. Their ATMs are specially designed to suit the challenging environment prevalent in rural and semi-urban areas, e.g., unreliable power supply and higher illiteracy levels of end-users [29]. To overcome unreliable power supplies prevalent in rural areas, Vortex Engineering designed and built an ATM with a solar panel that consumes approximately 10% of the total energy requirement of a conventional ATM [168]. The solar model generates less heat and thus eliminates the need for continuous air conditioning [12]; it can cope with temperatures ranging between 0 °C and 50 °C [29]. Vortex ATMs also have a built-in fingerprint identification system, a feature that works well for the uneducated rural masses, which eliminates the need for a personal identification number (PIN). The total cost of ownership for Vortex machines comes to 50% less than that of conventional ATMs [29]. Table 7 illustrates how solar powered ATMs from Vortex Engineering promote social sustainability by addressing its different themes.

Themes of Social Sustainability	Promotion of Social Sustainability through Frugal Innovations (Vortex Engineering ATMs)	Promotion of SDGs
Social inclusion	It promotes social inclusion by providing the BOP population with easy access to ATM technology.	SDG 9: Vortex Engineering is considered a highly innovative company, which designs highly reliable and eco friendly technology
Social justice and equity	It provides poor people with an opportunity to use technology.	SDG 10: It gives poor people an opportunity to
Basic needs and quality of life	The quality of life of rural population improves.	SDG 12: Solar powered ATMs are the most
Capacity for learning	Provides illiterate people a chance to learn to operate previously unfamiliar technology and build new skills.	approximately 10% of the total energy of a conventional ATM and reduce CO_2 emissions by at least 18,500 kg per annum [29].

Table 7.	Promotion	of social	sustainability	through	frugal	innovations	(Example:	Vortex
Engineering	g ATMs).							

3.3.6. SELCO

SELCO Solar Private Limited is a social enterprise in India that works to bring solar power to underserved businesses and households. This company is making solar power a feasible option for the rural population. Its business model is highly innovative, whereby solar power is sold as a service to the poor customers, and micro-loans for these low-income customers are arranged by SELCO itself through the local banks or microfinance organizations, with SELCO acting as a guarantor [169]. SELCO's model allows the full costs of solar power to be covered over time [12]. Thus far, SELCO has sold over 200,000 solar systems in India [169]. Table 8 illustrates how SELCO, a practical example of frugal innovation promotes social sustainability by addressing its different themes.

Table 8. Promotion of social sustainability through frugal innovations (Example: SELCO).

Themes of Social Sustainability	Promotion of Social Sustainability through Frugal Innovations (SELCO)	Promotion of SDGs	
Human health and well-being/well-being of generations	Less dependency on conventional non-renewable energy resources has a positive effect on the health and well-being of people.	SDG 3: SELCO ensures good health and well-being by enabling people to use clean energy instead of traditional fossil fuels.	
Basic needs and	44% of the Indian population lack electricity. SELCO has provided reliable electricity to millions who otherwise had no or limited access to electricity. This has	SDG 4: Due to uninterrupted power supply, poor students have an increased opportunity to spend more hours studying in the evenings.	
quality of life	resulted in a better quality of life. Further, working for longer hours has a positive impact on the income level of BOP population.	SDG 7: Solar power is a renewable, non-polluting energy resource. In the absence of such an inclusive business model, it would not have been possible to involve the BOP	
Social justice and equity	Provided an opportunity to BOP population to become respected customers.	SDG 8: SELCO has promoted sustained, inclusive and sustainable economic growth	
Social inclusion	Enabled the poorest segments of the population to buy solar electric systems through an innovative business model. Electricity enables them to work for longer hours, which was previously impossible.	and provided employment to many. SDG 9: SELCO's innovative potential and inclusive business model have been appreciated worldwide. This is evident from the fact that the founder of SELCO received the 'Asian.	
Behavioral changes	Shifting to green energy has resulted in promotion of ecofriendly behavior.	Nobel Prize' in 2011 as well as the Ashden Award and the Outstanding Achievement	
Education and training	Poor students who had no or limited access to electricity in the evenings can now study longer.	Award [12,170]. SDG 10: SELCO has been successful in reducing inequality in society by enabling	
Employment	SELCO has not only provided employment to its own employees but also to many rural entrepreneurs who rent out solar lights to vendors and institutions.	poor customers to build links to financial institutions and enabling them to use solar electric systems.	

3.3.7. M-Pesa

M-Pesa is a mobile phone-based money transfer service, launched in 2007 by Vodafone for Safaricom and Vodacom in Kenya and Tanzania. Since its launch in 2007, M-Pesa has expanded to other countries like Afghanistan, South Africa, India, Romania and Albania. M-Pesa allows users to deposit, withdraw, transfer money and pay for goods and services easily with a mobile device [171]. The service enables its users to deposit money into an account stored on their cell phones, withdraw or transfer money to other users and non-users, pay bills and purchase airtime. Users are charged a small fee for sending and withdrawing money using the service. It is a branchless banking service whereby the M-Pesa users can deposit and withdraw money from a network of agents like airtime resellers and retail outlets [171].

M-Pesa has become the most successful mobile financial service in the developing world. This service has given access to the financial system to millions of people and it has been recognized for reducing crime in an otherwise largely cash-based society [172]. Table 9 illustrates how M-Pesa, a practical example of frugal innovation, promotes social sustainability by addressing its different themes.

Themes of Social Sustainability	Promotion of Social Sustainability through Frugal Innovations (M-Pesa)	Promotion of SDGs
Basic needs and quality of life	M-Pesa has improved the quality of life of millions of BOP customers by empowering them with branchless banking service.	 SDG 1: M-Pesa has reduced poverty in the regions of its operation. SDG 3: M-Pesa has been involved with Bridge International Academy which provides education to poorest areas of Kenya at a very low cost (\$4 in monthly tuition per student). SDG 8: M-Pesa has promoted sustained, inclusive and sustainable economic growth. SDG 9: M-Pesa is a highly innovative solution, which has dramatically improved the lives of millions of people. SDG 10: M-Pesa has succeeded in reducing inequality in society by enabling BOP customers to build links to financial services. SDG 12: M-Pesa is an excellent case of sustainable mobile phone based financial service.
Social justice and equity	It provides an opportunity to millions of poor people to become respected customers.	
Social inclusion	It promotes social inclusion by providing the poor population with an access to financial services that they were otherwise devoid of.	
Decline of poverty	M-Pesa program has transferred more than US \$1.4 trillion in electronic funds and significantly contributed to poverty alleviation [173].	
Capacity for learning	It provides people with an opportunity to operate mobile phone technology and build new skills.	
Safety and security	Research has indicated that services like M-Pesa might play a significant role in anti-money laundering and counter-terrorist financing efforts [173]. It is also a safe alternative to travelling with large amounts of cash.	
Human dignity	This service has improved the lives of millions of Kenyans.	
Participation (Including stakeholder participation)	Since the launch of M-Pesa in 2007, over 15 million users have been using the service [173].	

Table 9. Promotion of social sustainability through frugal innovations (Example: M-Pesa).

3.3.8. Craftskills East Africa limited

Craftskills East Africa limited is a social enterprise in Kenya that sells renewable energy equipment to farms, village collectives and small businesses in East Africa. It builds wind power generation devices from local materials to supply energy to small, dispersed off-grid African villages [174,175]. The local materials include old motorcycle engines, which are essential components of wind turbines. Craftskills' wind turbine is an excellent example of an affordable and resource-scarce solution that serves the customers of Kenya with a reliable and easy-to-use product at a low price [176]. Craftskills has been successful in supplying equipment that in some cases light the whole village and, in other cases, the electricity generated is used for water pumps that supply irrigation and clean drinking water [174]. Craftskills East Africa limited solves the pressing problem of lack of electricity in Kenya by making cheap yet efficient wind turbines for the Kenyan people and supplies affordable clean energy to them. Table 10 illustrates how Craftskills East Africa limited, a practical example of frugal innovation, promotes social sustainability by addressing its different themes.

Table 10. Promotion of social sustainability through frugal innovations (Example: Craftskills East Africa limited).

Themes of Social Sustainability	Promotion of Social Sustainability through Frugal Innovations (Craftskills East Africa Limited)	Promotion of SDGs
Human health and well-being/well-being of generations	Use of wind power has positive health benefits compared to non-renewable energy resources.	 SDG 3: Craftskills ensures good health and well-being by enabling people to use clean wind energy instead of traditional fossil fuels. SDG 7: Wind power is a renewable, non-polluting energy resource. Craftskills ensures access to affordable, reliable and clean energy to Kenyan people. SDG 9: Craftskills' ability to generate frugal innovation in a resource constrained environment and create more from less is a step towards building resilient infrastructure. SDG 10: Craftskills has been successful in reducing inequality in society by providing poor people an access to electricity.
Basic needs and quality of life	Craftskills has provided clean electricity to people who otherwise had no or limited access to electricity. They have also supported farms by selling them electricity equipment for water pumps used for agricultural purposes.	
Social justice and equity	It provides an opportunity to BOP population to become respected customers.	
Social inclusion	Poor segments of population get an opportunity to buy reliable wind turbines at low costs and electrify their homes.	
Behavioral changes	In Africa, renewable energy is perceived as second class [175]. Motivating people to use electricity generated through green wind energy turbines is a positive behavioural change that promotes ecofriendly behaviour.	
Human dignity	Electrifying villages or supplying power to schools, health facilities, market places or hotels has changed the lives of people in BOP market like Kenya.	

From the discussion above, it can be argued that frugal innovation can be considered as one practical step towards realizing social sustainability. Figure 3 shows the connection between frugal innovation and social sustainability through linking frugal innovation to the social sustainability themes. Every frugal innovation promotes various social sustainability themes.

For example, the social sustainability themes shown in Figure 3 can be seen as consequences of the frugal innovations, with some themes recurring in almost all the cases such as social inclusion, human well-being, quality of life, equity and so on.



Figure 3. Connection between frugal innovation and social sustainability.

4. Implications for Theory and Practice

This study is an attempt to show a connection between frugal innovation and social sustainability. The researcher believes that frugal innovation and social sustainability are intertwined, and this study is one of the initial attempts at this integration. Eight cases of frugal innovation were analyzed in the light of social sustainability themes. Based on the findings drawn in relation to social sustainability, the implications of this study will be discussed.

In almost all the cases of frugal innovation, important themes of social sustainability are visible. Through these practical cases, it is seen that issues like human well-being, basic needs and quality of life, social justice, social inclusion, poverty reduction, learning capacity and many other social sustainability themes are being addressed. All the frugal innovation cases offer solutions to existing societal problems. Firstly, frugal innovation helps in closing the distances that separate people by promoting connectedness within and outside the community, which is one of the most important principles of social sustainability [100]. Frugal innovation is one way to solve the challenges of social inclusion in BOP markets. Secondly, human well-being is also an essential outcome of frugal innovations. In all the examples mentioned above, human well-being is being promoted. An interesting example is Neusoft, China's IT service provider which has developed telemedicine applications for millions of Chinese living in rural areas that deliver affordable healthcare to poor people [26]. Thirdly, in BOP markets, where there is unequitable distribution of resources, through some frugal innovations, even the poorest sections of society also gain access to essential services. Jaipur Foot, Aravind Eye care, Vortex ATMs, SELCO, M-Pesa and Narayana Hrudayalaya are examples of such frugal innovations. Equity ensures mechanisms that guarantee equitable sharing of society's benefits and costs [106]. Through frugal innovations, it has become possible to provide opportunities and access to the basic

amenities for the poorest of the poor. Lastly, frugal innovations work towards the goal of social coherence, whereby members of a society play an active role in assisting marginalized communities. Social coherence is a measure of solidarity among the members of a society. Social sustainability of a society can be evaluated in terms of how well the society is involved in activities and how tolerant its members are towards, for instance, marginalized groups [11]. Through some frugal innovations, such as Kerala's Palliative Care, the goal of social coherence is achieved, and a feeling of passion towards helping community members is evident. Frugal innovation plays an important role in fulfilling social sustainability; it promotes SDGs and contributes towards the larger goal of sustainable development. The most common SDGs promoted by the frugal innovation cases presented above include SDGs 1, 3, 4, 7, 8, 9, 10, 12 and 16. Therefore, it can be implied that application of frugal innovation in a society is a tiny step towards realizing sustainable development.

With regards to managerial practice, this research may be useful for frugal innovators who could benefit from this knowledge. Most often, frugal innovators innovate to solve a pressing societal need; if they become aware of this link between frugal innovation and social sustainability, they could perhaps market their products even better and show the impact of these products from a larger perspective. They can more easily evaluate the benefits of the connection between these concepts and use this information while promoting their frugal innovations.

5. Conclusions

The literature concerning social sustainability and frugal innovation was reviewed, and it was discovered that the two fields of study are connected. The essential themes of social sustainability were studied, and their relation to frugal innovation was explored. The results of this study are particularly novel in that frugal innovation has not been linked solely to social sustainability prior to this research. Social sustainability is one of the most important pillars of sustainable development and, through this paper, it is possible to realize social sustainability goals via the application of frugal innovation. The role of frugal innovation towards promoting SDGs concerning social sustainability is emphasized.

Socially sustainable societies provide equal access and opportunities to all members for both survival and the fulfilment of their development potential [147]. In the business context, MNCs have failed to give equal access to their products and services. They have innovated for the top of the pyramid customers, who can afford their innovations. However, thus far, they have ignored the BOP customers, treating them as unprofitable sections of the population [42]. In contrast, frugal innovators intentionally seek out opportunities with these underserved customers. Frugal innovators pull poor customers into the mainstream, innovate for them and provide affordable and viable solutions to their needs. Therefore, businesses that innovate frugally contribute towards societal goals alongside economic ones.

This article argues that social sustainability may be expanded to incorporate a stronger emphasis on practical ways to fulfil socially sustainable goals. For instance, practical contributions of frugal innovation towards solving certain pressing social needs have been explored in this paper. Many examples have been provided that show the exemplary contribution of such frugal innovations towards society while also showing connections between social sustainability and frugal innovation.

This study may have its limitations. The researcher did not have any access to better instruments to measure the social sustainability of frugal innovations. Therefore, the researcher was limited to deriving social sustainability themes and using SDGs as a basis for measuring social sustainability. It is certainly a little-researched field and therefore, a good follow-up study is recommended that can demonstrate a stronger relationship between the two researched concepts. Some frugal innovation case studies from different BOP countries and their links to social sustainability could be studied. This could enrich our understanding of these innovations and their links to positive societal transformation in different BOP markets. It would also be beneficial to study the role of socially driven businesses and innovations towards achieving social sustainability. Measuring the social sustainability of frugal

innovations is challenging; hence, to enhance the understanding of this relationship, it is important to devise better indicators, which will make it possible to measure this relationship more accurately.

The multidisciplinary nature of social sustainability has made it possible to view this field through a different angle. The essential themes of social sustainability presented, along with the practical examples from frugal innovations, offer a different viewpoint on the connections between the two different fields.

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