
20. Advancing the measurement of frugal innovation

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20.1 INTRODUCTION

Frugal innovation (FI) has become an increasingly debated topic among academics, practitioners and policy makers. It is seen as a type of innovation targeted at relatively poorer consumers and characterized by overall cost minimization, lower resource intensity, robustness in design and a focus on core functionalities (Basu et al. 2013; Rao 2013; Rosca et al. 2017). In this chapter, we explore how FIs contain relatively differentiated characteristics from a stylized perception of ‘conventional’ innovations. The frugality of an innovation can manifest itself at the product level – for example, the design of an affordable water filter or portable electrocardiogram – or as a differentiated business model, production or distribution system – such as affordable solar-energy access through leasing models, self-constructed housing solutions or accessible virtual health services. Being aware of this spectrum of FI, we provide an overview regarding what are the specificities of FI, and how they might inform efforts to capture and measure it systematically.

Earlier studies have pointed out the utility of implementing a systems approach for the analysis and measurement of innovation (Gault 2018). We find this systemic view to be of particular relevance for alternative ways of innovation thinking like FI, where co-creation and collaboration across multiple kinds of actors are key features, because FI will seldom occur through the actions of a single actor. Thus, in our proposal towards capturing and measuring FI we take a systems approach that acknowledges the polycentric character of FI and considers the linkages across actors and the contextual specificities of these types of collaborative innovations, without ignoring power inequalities among the various actors involved in the development of FIs.

In Section 20.2 we use a systemic literature review to characterize FIs and we introduce four features on which FIs relatively differ from conventional innovations. In Section 20.3 we start from the observation that the FI literature is in need of a stronger measurement orientation. We present recent attempts by other authors to measure FI and propose a framework from which to move forward with a selective and harmonized set of FI indicators; highlighting the peculiar characteristics of FI as one of the ‘new’ innovation approaches. Section 20.4 concludes and identifies a next step.

20.2 CAPTURING FRUGAL INNOVATION

Interest in FI is growing rapidly among academics, practitioners and policy makers (Agarwal et al. 2017; Hossain 2017, 2020; Winkler et al. 2020). Although definitional consensus is

lacking, it can be largely understood as an innovation approach that aims to (re-) design products, services, systems and business models, providing affordable solutions with reduced complexity, a focus on core functionalities and minimal use of resources, targeted at low-income consumers (Leliveld and Knorrington 2018; Rao, 2013; Rosca et al. 2017). The early literature on FI focused on definitional issues and on presenting qualitative case studies. Moving beyond qualitative case studies, in this section we present a quantitative content analysis based on empirical peer-reviewed contributions to FI, which allows us to offer a more quantitative contribution to the discussion. We developed a Systematic Literature Review (SLR) based on the database Scopus, selecting all empirical papers published until 2018 that in the title, abstract or keywords included FI or related terms.¹ We further screened this list of articles by reading all abstracts, to ensure a focus on empirical papers, with a harvest of 130 peer-reviewed articles, describing 250 cases of FI.²

At the risk of exaggerating the differences, based on our own SLR and on other literature reviews (Agarwal et al. 2017; Hossein 2018; Pisoni et al. 2018), we identify four features on which FIs tend to differ from conventional innovations. Before moving into these differences, it is important to emphasize that we are discussing relative differences, matters of degree, and not absolute differences. After all, innovations are about something new that has the potential to improve outcomes, and this applies to all innovations, whether high- or low-tech, socially oriented or profit-oriented, and this also applies to FIs. Nevertheless, measurement frameworks for conventional innovations do not seem to fit well for describing and analysing FIs.

The first difference to explore is that FIs are specifically targeted at relatively low-income end users, while conventional innovations, at least initially, tend to target relatively higher-income end users. Second, FI design processes tend to involve an even higher multiplicity of actors: firms, non-governmental organizations (NGOs), social enterprises and, in some cases, low-income end users as innovators. Third, FIs are developed by a wide range of actors with different motivations: firms that develop FIs for profit, NGOs and social enterprises to address the UN Sustainable Development Goals, and individuals and communities to solve their own bottlenecks. Fourth, FIs need to perform in severely resource-constrained settings, so that they can, for example, be operated with less supporting infrastructure and fewer available local skills. These four features are strongly interlinked and need to be looked at in an integrated manner. Still, to take a first step we will look at these features separately, using specific variables from our SLR to show how these features have been dealt with in the early wave of empirical studies on FI.

20.2.1 Low-Income End Users

The aspects and characteristics that matter most to an average user of FIs would differ from those interested in conventional innovations. Mainstream innovation thinking tends to target relatively wealthy consumers that are able and willing to consume – initially at premium prices – innovative products and services. In contrast, FIs target resource-constrained contexts, offering solutions targeted at relatively lower income end users and mostly – but not exclusively – in emerging and developing countries (Pisoni et al. 2018; Weyrauch and Herstatt 2016). Affordability for the end user is seen as a key indicator of successful FIs in the literature. This affordability of products and services can be reflected in the purchase price and/or increasingly through new business models by suppliers that offer innovative financing models like leasing, renting or pay-per-use options for end users that are unable or unwilling to pay an upfront full

purchasing price. Next to affordability, a range of other indicators are seen as important in how the innovation is designed, produced, implemented and used. The contrast with conventional innovations lies in counteracting the over-engineering that is often associated with innovations targeting luxury market segments. It is important to note that there is a wide variation across what ‘conventional’ means, depending on the context. In fact, as will be noted later in the chapter, context plays a crucial role in FI. There is no universal uniformity in innovation, and its understanding needs to take into account the specific characteristics of local innovation systems. Innovation is embedded in and permeated by socio-economic, institutional, technical, cultural and environmental conditions that influence its development and adoption. For the purpose of this discussion, we refer here as ‘conventional’ innovations to those that are most commonly studied and addressed in mainstream innovation studies.

FIs have been identified as being rugged, lightweight, adaptable and simple (Basu et al. 2013; Kroll and Liefner 2021). Moreover, frugal products and services are expected to eliminate unessential functions and sophisticated and sensitive technological features, concentrating on core functionalities, maintaining quality and maximizing value (Brem and Wolfram 2014). Another description of frugal products is given as robust by requiring low maintenance and being durable, stable, sturdy, tough and easy to use (Weyrauch and Herstatt 2016). It is important to recognize that easy to use for the consumer can still involve complex technologies in the ‘back-office’, like with mobile money systems that are easy to use through SMS messages on first generation mobile phones.

To achieve affordability, FIs are also characterized by providing a substantial cost reduction from a customer perspective (Weyrauch and Herstatt 2016). Frugal products and services have a much lower price or significant lower costs and lower input of resources and operation costs compared to ‘conventional’ products and services (Basu et al. 2013; Brem and Wolfram 2014). Although extensive quantitative studies are lacking, extant empirical evidence has indicated that the cost reduction of FI as compared to their conventional counterparts can be between 50 and 95 per cent (Rao 2013). Such cost reductions refer to so-called ‘stripped versions’ of already existing products and services offered by firms. The other main type of FIs are developed from scratch, for example, by local communities using readily available materials and tools in new ways to solve local bottlenecks.

Moreover, FIs do not require sophisticated local resources and advanced supporting institutions (Bhatti 2012). Instead, in a stylized fashion, FIs are seen as being fit for purpose, with a FI design process that is user-oriented and having multiple constraints in sight, including resource scarcity and institutional voids (Bhatti and Ventresca 2013). That is why scholars have indicated that frugal innovators need to operate with local organizational structures that enable them to better understand the needs of its low-income end users as well as the resource-constraint characteristics of the local context (Zeschky et al. 2011).

From our SLR (Table 20.1), affordability as key characteristic is by far the element most mentioned in FI case studies (characterizing 59.8 per cent of the cases; while simplicity was mentioned in 41.4 per cent of cases, and functionality in 30.5 per cent). Those features apply across product, process or business models innovations, but to somewhat different degrees. For example, while affordability is a key feature of product and business models innovations, it is less often reported in cases that focus on process innovations. Another interesting result emerging from Table 20.1 is that simplicity is mostly a feature mentioned in cases that focus on a product innovation, while high functionality has been reported especially in cases that focus on business model and process innovations.

Table 20.1 *FI types and FI features*

	FI types			FI features*	
	No.	%	Simplicity	Functionality	Affordability
Product	122	49.0%	47.5%	23.8%	64.8%
Business model	58	23.3%	37.9%	37.9%	63.8%
Process	52	20.9%	30.8%	34.6%	44.2%
Mixed	17	6.8%	41.2%	41.2%	58.8%
<i>Share of total**</i>			41.4%	30.5%	59.6%
<i>Valid observations</i>	249		136	162	161

Notes:

* Reporting the share of cases, for each specific type of FI was a very important one of the FI analysed. Not all papers reported on the features of FI, so that the number of valid observations varies among the features.

** Reporting how many cases are reporting this feature on the total number of cases analysed.

Table 20.2 allows us to take a closer look at the characteristics of the beneficiaries of FI. Half of the FIs (52.0 per cent) are directly targeting lower income users. Low-income people are the key target especially of the FI developed by non-firm actors (e.g. NGOs) and by small firms 69.9 per cent and 51.6 per cent, respectively, have been targeting lower income users when introducing FIs. (See the next paragraph for a detailed discussion of the actors developing the FI.) Interestingly, a significant share of 24.8 per cent of FIs has targeted the emerging middle class (24.8 per cent). These emerging middle classes are an especially important target group for large firms (40.2 per cent). This offers an important nuance to the perception that FIs are only targeting those at the lowest income levels. Leaving aside that few of the reported case studies go into defining low income or emerging middle class, it seems clear that FIs by and large target the less well-to-do in a society, but that these are not limited to those who would, by for example World Bank statistics, be labelled as poor.

Table 20.2 *Actors developing the FI and target beneficiaries*

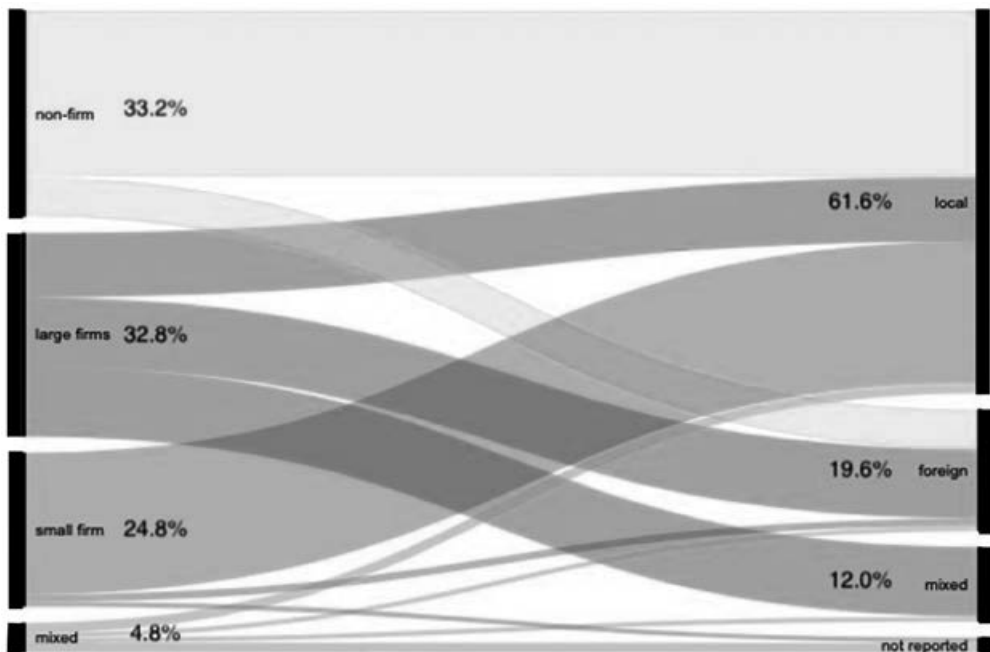
Target beneficiaries	Developing actor						
	No.	%	Non-firm	Large firms	Small firms	Mixed	Not reported
Low income	130	52.0%	69.9%	34.1%	51.6%	58.3%	45.5%
Emerging middle class	62	24.8%	16.9%	40.2%	19.4%	25.0%	0.0%
Both	9	3.6%	2.4%	3.7%	6.5%	0.0%	0.0%
Not reported	49	19.6%	10.8%	22.0%	22.6%	16.7%	54.5%
<i>Valid observations</i>	250		83	82	62	12	11
<i>Share of total</i>			33.2%	32.8%	24.8%	4.8%	4.4%

20.2.2 Multiplicity of Actors in Developing the Innovations

The second relatively distinctive feature found in FI refers to who is developing the innovation. FI includes traditional actors that are frequently present in conventional innovation, such as multinational enterprises (MNEs), local firms and public and private knowledge institutions, next to other actors that are relatively less central in innovation literature, like NGOs and local communities. Extant FI literature identifies at least four types of actors engaged in FI, all of which may differ in their motivations and ways of operation. First are large multinational firms. Second, small firms, startups and social enterprises. Third, NGOs, industry associations

and other non-firm organizational actors; and lastly grassroots actors like communities and individuals who innovate to solve their own needs (Hossain 2018; Knorringa and Bhaduri 2018; Pisoni et al. 2018). According to our SLR, non-firm actors (mostly industry associations, NGOs or individuals) are the main drivers behind the introduction of FI cases in our sample. A majority of those actors are local actors, but a small percentage is foreign (Figure 20.1). Large firms represent a similar percentage of cases (32.8 per cent) – of such firms almost a third is local, a third foreign and a third has both a local and a foreign base. Small firms, mostly local, are associated with the introduction of FI in 24.8 per cent of the cases.

The greater relevance of informal actors has some overlap with other discourses like social and informal innovation. Research on informal sector innovation (de Beer et al. 2016; Kaplinsky and Kraemer-Mbula 2022; Kraemer-Mbula and Wunsch-Vincent 2016) suggests that informal enterprises embrace an innovative dynamic character in order to survive, as they usually operate under major constraints that stimulate them to engage in product and process innovation. These innovations tend to be incremental, occurring without formal R&D structures or formal knowledge appropriation dynamics. Similarly, FI studies suggest that local firms in developing countries exhibit a less structured and more flexible and agile innovation process under scarcity conditions, often associated with FI (Radjou and Prabhu 2015; Radjou et al. 2012).



Note: The left side of the figure reports the type of actor developing FI (see Table 20.2); the right side of the figure reports data on where the actors are located (local = same as place where FI is adopted; foreign = a different one; mixed = when actor has a local and a global footprint). The figure is built considering just the cases for which both information were available. The larger the line, the bigger the share on the total.

Figure 20.1 The main actors developing FI

In order to more fully grasp the relevance of the variety of key actors in the FI process, it is important to consider that – similarly to what has been mentioned in the open innovation literature (Chesbrough 2006; Laursen and Salter 2006) – a majority of FIs are not developed and implemented by one single actor. Rather, they tend to occur via collaboration among several actors, with complementary skills and resources. Although collaboration in the development and implementation of innovations is of course not new to the conventional innovation literature, the variety and the types of actors engaged with FI appear to be even more diverse. As reported in Table 20.3, more than three out of four FIs have been developed by collaborating with other types of actors, and a similar share also regards the local diffusion or adoption of the FI. Firms are key collaborating partners when it comes to developing FIs (reported to be a very important or medium important partner in 64.6 per cent of the cases reviewed) but not when it comes to the diffusion or adoption of FI. In this context (but also in the case of the development of FI) other partners are also very important: industry associations, community leaders, consumers (relevant in 62.1 per cent of the cases when it comes to development and 75.8 per cent to diffusion/adoption) and NGOs (38.5 per cent and 47.2 per cent, respectively). We also have anecdotal evidence that some FIs are developed in one setting and then implemented, with significant adjustments, in another local context. Especially actors with deep local knowledge, commercial and non-commercial, can provide invaluable support to outside innovators to make their FIs successful in the local context. This is similar to processes in user-driven and open innovation but taking place in extremely resource-constrained settings (see also Section 20.2.4).

Table 20.3 Actor collaboration on development and diffusion/adoption of FI

	Collaborations* on innovation			
	Development		Diffusion/adoption	
	No.	%	No.	%
Firms	126	64.6%	119	66.9%
Others (e.g. Industry associations, individuals, ...)	121	62.1%	135	75.8%
NGOs	75	38.5%	84	47.2%
Universities/Research centres	70	35.9%	47	26.4%
Total	195		178	
<i>Share of total observation</i>		78.0%		71.2%

Note: * Reporting cases for which collaboration on FI development and/or diffusion/adoption was reported to be very important or medium important.

20.2.3 Diversity in Motivations

Innovation literature has focused on the distinctions among innovations in terms of the type of innovation (e.g. product versus process) and the degree of novelty of the innovation (e.g. incremental versus radical innovations). In the context of FI and of some other new innovation approaches, it has been suggested that the motivation of the innovator is also a relevant aspect to consider. A broad range of goals can be observed, ranging from a straightforward profit motivation (firms) to addressing the SDGs (NGOs) to solving one's own problems (individuals, communities), and a variety of blended organizational goals like with social enterprises. The early case studies on FI tended to prioritize one specific type of goal and made that part of the definition of what FIs are. For example, Khan (2016) posits that FIs have

a social orientation, developing products, processes and business models to tackle societal problems and satisfy basic needs. Likewise, Hossain (2020) puts forward that FIs are mostly developed to improve social conditions and meet personal, social and community constraints. Another framing is that FIs are supposed to be designed with a user-centred approach taking into consideration the specific needs of its users and the characteristics and constraints of the setting in which it will be deployed. In terms of the degree of novelty, grassroots FIs have been found to be more incremental in nature, given their local base, small scale and adaptation to resource-constraint settings (Bhaduri and Talat 2020).

With more research on FI becoming available, it is increasingly clear that a variety of actors develop and implement FIs for a variety of reasons that can also be conflicting. At the same time, quite a few frugal innovators pursue a hybrid economic and social goal instead of a unique focus on profit maximization or on addressing social goals. This hybridization of social good and financial gains has also been found in prior research on innovation for ‘below the radar’ innovations, for example, in the work by Kaplinsky (2011). Similarly, many social innovations also show this dual interest of responding to social needs and creating economic gains, although the relative weights given to the two goals might be different.

Table 20.4 Motivation to introduce FI by the main actor developing the innovation

	Motivation		Main actor				
	No.	%	Large firms	Small firms	Non-firm	Mixed	Not reported
Social-oriented	89	35.6%	6.1%	30.6%	77.1%	0.0%	9.1%
Profit-motivated	83	33.2%	57.3%	45.2%	4.8%	33.3%	0.0%
Both	47	18.8%	25.6%	11.3%	14.5%	41.7%	18.2%
Not reported	31	12.4%	11.0%	12.9%	3.6%	25.0%	72.7%

As emerges from Table 20.4, even if the majority of FIs have been introduced mostly to achieve a social goal (35.6 per cent); this share is similar to the share (33.2 per cent) of cases introduced mostly to achieve economic benefits. Moreover, almost one innovation out of five has explicitly stated that both goals co-exist. It is also interesting to see how cases of large and small firms still report significant percentages of a primary social orientation or blended goals. Not surprisingly, firms are more often profit motivated, being especially the case with large firms (57.3 per cent) but also with smaller firms (45.2 per cent). Non-firm actors, instead, are mostly motivated by social goals. Interestingly, the combination of those actors is the case in which it is more likely to identify an integration of these two aspects (41.7 per cent).

Table 20.5 lists the most often mentioned social goals addressed by the FI case studies. Examples include solutions to health conditions such as the leveraged freedom chair (LFC), a low-cost, high-performance, off-road wheelchair originally designed to provide access to people in rural areas in developing countries (Judge et al. 2015); or easy to use and low-cost devices and mobile apps to address maternal health challenges in less developed countries (Firoz et al. 2017). Poverty alleviation and empowerment are found in cases like the implementation of information and communication technologies (ICTs) to provide access to financial services for low-income people (Berger and Nakata 2013; Onsongo 2019); or the development of a grassroots solid waste management programme to tackle the needs of marginalized populations in Peru (Tello-Rozas 2016).

Moreover, a good number of cases are also aiming to address the environmental dimension of sustainable development through focusing on innovations in the energy and water sector.

For example, low-cost reverse osmosis water filters (Annala et al. 2018), affordable energy solutions to serve the needs of low-income population, such as Selco in India (Goyal et al. 2017), or innovative business models based on women-to-women entrepreneurial energy networks like The Solar Sister (Heuër 2017).

With a multiplicity of actors taking part in the development and adoption of FIs, and a broad range of motivations for their participation, issues of power (im)balances across the various groups become important. The existing power structures that mediate relations between different actors in innovation processes should be accounted for. It is necessary to critically explore issues of agency and the interactions and distribution of influence, responsibilities and gains between the various actors involved in these innovation processes (Knorrington et al. 2016; Leliveld and Knorrington 2018).

Table 20.5 The most recurrent social goals of FI

Social goal	No.	%
Health	64	25.6%
Energy	39	15.6%
Empowerment	27	10.8%
Agro-food	22	8.8%
Poverty	20	8.0%
Water	13	5.2%
Other	9	3.6%
Not reported	56	22.4%
Total	250	100.0%

20.2.4 Embedded in a Resource-Constrained Context

The fourth and last distinctive element of FI that we want to highlight is that they tend to be embedded in very specific and extremely resource-constrained contexts. Given its purpose of offering solutions for relatively poorer groups of people in such resource-constrained settings, the majority of FIs need to fit with the needs of disadvantaged communities that may be isolated in geographic, infrastructural or economic terms. As product and process innovations tend to reflect the social and economic conditions under which they are conceived, developed and made available (Kraemer-Mbula and Wunsch-Vincent 2016), it is important to be aware that context matters a lot, and that intimate know-how about extremely resource-constrained contexts is needed to develop successful FIs.

Table 20.6 reports on the geographical and industrial context in which the FI case studies were developed. It suggests that the majority of cases were developed for a rural context (34.4 per cent); while only few are developed for urban (12 per cent) or peri-urban (4 per cent) contexts, but we do need to recognize that this variable has a high rate of cases that do not report their geographical context (36.4 per cent). Table 20.6 also reports the cases by sector: by far the most cases are found in services. For example, almost one case out of four are in health-care, entailing for example innovations like Aravind Eye Care hospital that provides quality eye care at a minimal cost, the offering of good quality and affordable telemedicine solutions, or the battery-operated portable Mac 400 electrocardiography (ECG) machines developed by GE Healthcare division (Angeli and Jaiswal 2016). Interestingly, also 6 per cent of cases are found in advanced services, namely, ICT.

Table 20.6 The empirical setting

Empirical area	No.	%
Rural	86	34.4%
Multiple	33	13.2%
Urban	30	12.0%
Peri-urban	10	4.0%
Not reported	91	36.4%
Total	250	100.0%
Sectorial context	No.	%
Services	131	52.4%
Manufacture	48	19.2%
Agriculture	39	15.6%
Advanced services	15	6.0%
Multiple	13	5.2%
Not reported	4	1.6%
Total	250	100.0%

The relevance for innovations to be embedded in the local context has also been emphasized in the BoP (bottom of the pyramid) innovation literature (e.g. London and Hart 2004), documenting various cases in which foreign MNEs have decided to hire local labour and set up R&D centres in their subsidiaries in developing and emerging countries in an effort to enhance their context sensibility and be better able to respond to the local context and local needs. While workers and entrepreneurs from the country itself are often expected to be more sensitive to local cultural and social behavioural expectations, one needs to also recognize that when these workers and entrepreneurs originate from a very different socio-economic strata as the target group of the FI, they may still find it very difficult to understand and appreciate the needs of the target group.

Chakravarty (2021) notes that the complexity of resource-constrained settings that are typical to FI requires understanding the context and innovation system beyond the technical and physical environment, having a holistic consideration that integrates attention for its people, culture, power relationships, natural environment, etc. It is important for FI to be embedded in the local context and be appropriate, not only in technical terms, but also acceptable in its socio-cultural features as that enhances the likelihood of its adoption and diffusion. Moreover, the innovated products, services and systems need to actually be available in the local market, and it should be possible to operate them with the present imperfect available infrastructures.

To conclude this section, it is important to note again that these four distinctive elements of FIs are not isolated but strongly interconnected, and together characterize the development and adoption of FI. It is therefore necessary to consider them jointly when capturing and measuring FI. In order to further systematize our attempt to offer measurement indicators for FI, we feel it is useful to further consolidate the four elements discussed in this section. In the next section we will combine the first feature on ‘Low-income end users’ and the fourth feature on ‘Embedding in a resource-constrained context’ under the more generic heading of ‘Resource constraints’. The second feature of ‘Multiplicity of actors’, and the third feature on ‘Diversity in motivations’ of actors involved in the innovation process will be combined under the heading of ‘Actor diversity’. In this way we will depict the two major more generic features that in our view distinguish FIs from conventional innovations.

20.3 MEASURING FRUGAL INNOVATION

This section moves towards measuring FI. It starts with a brief overview of how the attention for measurement in FI literature has developed, and summarizes how other authors have so far proposed to measure FI, after which we present our own framework from which a set of indicators can be derived.

Three initial stages in the evolution of the FI discourse can be identified in the literature. The first stage consisted of conceptual papers with a focus on how to define FI. In this stage illustrative case studies were presented as a way to improve conceptual understanding and provide more comprehensive definitions, focusing on the outcomes of the innovation process. FI products were described as those that combine high functionality and robustness with an affordable cost (Tiwari and Herstatt 2012). The second stage added attention to the innovation processes, looking into the particularities of innovating in resource-constrained settings. The discourse also expanded beyond the initial product focus, paying attention to the way in which services, systems and business models become affordable for lower income people (Radjou and Prabhu 2015; Zeschky et al. 2014). The third and current stage has broadened the discourse by including an interpretation of FI as a mindset (Soni and Krishnan 2014) or an approach (Prabhu and Jain 2015), expanding the view of a specific type of innovation outcome or process (Pisoni et al. 2018). Only very recently, authors have started to do more quantitative studies on FI (Ploeg et al. 2021), and this is also stimulating a discussion on the need for measurement frameworks.

Before presenting our own contribution, we briefly introduce other very recent initial attempts to measure FI. Niroumand et al. (2020) propose a framework to evaluate the enablers of FI in small and medium-sized enterprises (SMEs). Their proposed model includes 14 dimensions of FI enablers: world-class design, human aspect (management, employees and customers), marketing, support (government and management support), knowledge, social aspect, initial prototyping, cultural change, environmental aspect, distinct brand creation, core functions focus, local R&D, a cost-cutting business model and low-cost production dimensions. The authors argue that the framework provides a practical basis for managers and decision makers in SMEs to evaluate their capabilities in implementing FI.

Based on a Schumpeterian approach, Lim and Fujimoto (2019) propose a four-dimensional framework to capture FI by focusing on performance of the innovation. The authors look into the design aspect of innovation by considering technical and economic properties, and two effects of innovations by considering both demand- and supply-side issues. In turn, von Janda et al. (2020) interpret FI as a multidimensional construct and propose an index of product frugality with four dimensions: cost of consumption, sustainability, simplicity and basic quality. Based on the validation of their index with a large consumer data set, the authors argue that it provides an operationalization of product frugality and forms a basis for subsequent quantitative analyses.

Particularly for FI in developed markets, Winkler et al. (2020) propose a criteria-based evaluation model to better understand the reasons for success or failure of the innovations. The authors take as a starting basis the three criteria proposed by Weyrauch and Herstatt (2016) – that is, substantial cost reduction, concentration on core functionalities, and optimized performance level – and modify them by expanding the model to analyse not only products but services as well. Thus, their proposed evaluation model for FI in developed markets considers four features: Substantial cost reduction, Concentration on core functionalities, and

Optimized performance level which is subdivided into Product-related performance level and User-related performance level.

Building upon these insights, and the findings from our SLR, we propose the following set of indicators to measure FI (see also Table 20.7). We distinguish between two basic sets of indicators, one related to ‘Resource constraints’ and one related to ‘Actor diversity’. In terms of measurement, the ‘Resource constraints’ indicators are relatively easier to measure once benchmarks have been established. The ‘Actor diversity’ indicators require more qualitative and in-depth information and are not easily measurable through survey instruments.

Table 20.7 Capturing and measuring frugal innovation

Capturing		Measuring
		Indicators
Resource constraints	A. Low-income end users	Affordability, Core functionalities, Simplicity of use, Robustness, Minimal resource use, Cost minimization
	B. Embedding in a resource-constrained context	Appropriateness, Acceptability, Availability, Adaptability
Actor diversity	C. Multiplicity of actors	Involvement of non-commercial actors and citizens in design and implementation, Co-creation and Power differentials
	D. Diversity in motivations	FI for profit, to address SDGs or to solve ‘own’ bottle-necks

Source: Compiled by the authors.

The ‘Resource constraints’ indicators are linked to the observation that the end users are relatively of a low-income level (A), leading to the need for products, services or systems to be affordable, focus on core functionalities, be simple to use, robust, make minimal use of resources and cost minimization. Affordability is by far the most mentioned indicator in the literature, and it is important to note that many FIs achieve affordability through being offered as a service or through leasing, renting or pay-per-use, instead of requiring end users to initially purchase any hardware. Such elements are not investigated in surveys addressing ‘conventional’ innovations, such as the Community Innovation Survey (CIS) – where they focus on capturing the type of the innovation (product, process, organizational, marketing) or the degree of innovativeness (‘new to market’ versus ‘new to firm’). This does not allow us to capture the specificities of FIs and distinguish within them.

The ‘Embedding in a resource-constrained setting’ indicators (B) are about the ‘fit’ with the resource-constrained setting. This relates to appropriateness and acceptability, which are about the fit with the cultural and social context, and availability and adaptability, which are more about the extent to which a FI can operate in spite of a lack of supporting infrastructures like electricity from the grid. Acceptability is about the users within a resource-constrained environment, which can be culturally very diverse. Thus, acceptability is not generalizable to all lower income people in a setting, but refers to individual users who may exhibit diverse attitudes towards the FI. The *Bogota Manual* gives a sense of indicators that shed some light

on measuring ‘fit’ with the local context, by aiming at incorporating idiosyncratic aspects of innovative processes that are relevant to developing countries. It considers aspects like ‘local technological capabilities’, ‘technological effort’ or ‘innovative activity management’, assessing learning processes and intangible resources. This, however, does not fully account for the specificities of FIs and its embeddedness in a resource-constrained setting.

As is also an issue with social or informal sector innovation, one of the difficulties for its measurement comes from its high context specificity, making it a challenge to try to generalize indicators because they have to be flexible and dynamic enough to be context specific. Context specificity becomes even more important when considering that there is a vast heterogeneity across emerging and developing countries (Kaplinsky and Kraemer-Mbula 2022), which constitute the main market for FIs. As has been suggested for socially oriented types of innovation (Kleverbeck et al. 2019; Mihci 2020; Mustapha et al. 2021) FI indicators and measurements shall be conceived not only as hard quantitative metrics based on numeric data, but also with the incorporation of qualitative dimensions that can elucidate the soft and intangible components of the innovation and its fit with a local context. This responsiveness and adaptability to multiple contexts poses a clear challenge for measuring purposes. However, as it occurs with methodologies like developmental evaluation (Patton 2011), the measurement of FI shall be conceived using an ample range of data and methods; acknowledging that the diversity and specificity of innovation contexts makes a too rigid standardization of indicators and metrics neither possible nor desirable.

The ‘Actor diversity’ indicators are even more difficult to measure through standardized instruments, as they require in-depth information about how the various actors collaborate and who benefits in which ways from developing and implementing the FI. Nevertheless, as a first attempt we do feel it is important to try and identify some of the key indicators related to the actor diversity in FIs (C), which tends to be even higher than the actor diversity in conventional innovation processes. In FIs often non-commercial actors like NGOs and social enterprises are also involved, as well as citizens that aim to creatively address their own challenges. While these various actors work together in co-creation processes to design, produce and implement FIs, due to power differences between the various actors, the actual benefits are likely to be captured more by the relatively more powerful actors in these co-creation processes. Moreover, these various actors will have distinct goals in the first place, and these are important drivers for how FIs are designed, produced and implemented (D). Similar to what has been noted in prior research on informal sector innovation (Kraemer-Mbula and Wunsch-Vincent 2016), the measurement of FI requires the adoption of a systemic and integrated approach to innovation. It requires the acknowledgement that the development and adoption of FIs occur with the engagement of a variety of individual, organizational and institutional actors with different levels of (in)formality, who collaborate in multiple ways through often cross-sectorial interactions. It is therefore important to consider the types of collaboration and the stage of occurrence when capturing and measuring FI, as well as looking critically at who benefits more from the FI. While the focus on features of the actors developing the innovation, and on the collaborations activated, is shared with existing surveys aimed at measuring ‘conventional’ innovation (such as the CIS); scholars aimed at understanding FIs need to find ways to adapt them to better capture the variety of actors and to account also for actors in the informal sector.

20.4 CONCLUSION

This chapter started from the recognition that we need to develop better ways to capture and measure FI. Through using data from a SLR, we distilled two main features on which FIs tend to differ from conventional innovations. First, the key role of resource constraints in characterizing FIs, both because end users tend to have a relatively low income and because FIs are predominantly used in resource-constrained settings, and thus need to fit to such contexts. Second, the diversity of actors involved in developing, producing and implementing FIs, in terms of the importance of non-commercial actors and citizens, the crucial importance of co-creation and of power differences among actors, and the fundamentally distinct motivations of actors involved in FI processes.

The other main part of the chapter provides a framework from which sets of indicators can be derived that can be used to more effectively measure FIs, building upon the key elements from the SLR and from other attempts by various authors at developing such indicators. A main indicator is affordability for low-income end users, which is also the indicator that most clearly distinguishes FI from conventional innovations, as the latter tend to be developed for end users who are willing and able to pay a premium for the ‘new’ thing. Affordability for end users comes with a set of accompanying indicators that ensure that besides cost-effectiveness and a minimal use of resources, the product, service or system is also robust, simple to use and focuses on core functionalities. Such frugal products, services and systems also need to fit within a resource-constrained context, that is, they need to be appropriate for the setting, culturally acceptable, locally available and adaptable to local circumstances. We have also tried to suggest measurement indicators for the diverse range of actors, the need for them to co-create and the need to identify how power differences impact upon who benefits in what ways from these FIs. We have also emphasized how the need for context-specific measurements, and the need to go into difficulty to measure issues of co-creation and power, imply that a too rigid standardization of measurement tools may not be possible.

In our attempt to capture and measure FI we have focused on how FIs are different from ‘conventional innovations’. A next step could be to focus on the outcomes and impacts related to FIs, like impacts on sustainability. While research on frugal innovation has initially focused more on how to define, design and implement FIs, more recently the discussion has also moved towards a focus on measuring not only FIs themselves, but also their potential contribution to addressing major societal challenges like climate change, the energy transition, global health and food security. Where and when FIs are more likely to contribute to positive social, environmental and economic outcomes for society is an empirical question, and we need to also develop instruments to measure these possible contributions.

NOTES

1. The keywords used to identify all the relevant contributions are: ‘Indigenous Innovation’, ‘Frugal Innovation’, ‘Frugal Engineering’, ‘Grassroot Innovation’, ‘Inclusive Innovation’, ‘Reverse Innovation’, ‘Low Cost Innovation’, ‘Innovation for Inclusive’, ‘Pro Poor Innovation’, ‘Catalytic Innovation’, ‘Resource Constrained Innovation’, ‘Trickle-Up Innovation.’
2. Several articles described more than one case of FI; the unit of analysis we use is the case, not the article.

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