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Frugal innovation and sustainability outcomes: findings from a systematic literature review

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Abstract

Purpose – Advance the state-of-the-art on how frugal innovation links to sustainability outcomes and based on content analysis of empirical publications in the field of frugal innovation, analyzing when and how FI is connected with social, environmental and economic outcomes.

Design/methodology/approach – Quantitative content analysis on empirical papers published on frugal innovation, using data visualization techniques to disclose relationships among the constructs adopted. Materials were collected following a step-wise methodology. In total, 130 articles were identified, read in depth and coded according to five main categories: context; development; implementation, adoption, diffusion; characteristics; and impacts.

Findings – The potential of frugal innovation to drive sustainability outcomes is influenced by the type of actors developing the innovation, regarding their organizational form (large firms, small firms, non-firm actors), their geographical origin (foreign or local) or motivations (mostly profit-motivated or socially-oriented). Collaboration plays a key role along the various stages of the frugal innovation cycle and is thus relevant for its potential to drive sustainability outcomes. The results reaffirm the need for greater attention to where and when sustainability-enhancing outcomes of frugal innovation are more likely to occur.

Originality/value – This study provides a qualitative study based on content analysis of empirical studies to explore the associations between frugal innovations and improved economic, environmental and social sustainability outcomes. The key novelty of this study lies in the systematic coding of each paper regarding the features of the innovation, the innovators, and the outcomes achieved. This allows taking stock of the evidence emerging in such a scattered literature, quantifying the extent to which insights take place in the empirical

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literature, looking for correlations, and highlight research gaps to understand to what extent frugal innovation can contribute to sustainable development.

Keywords Frugal innovation, Sustainability, Literature review, Base of the pyramid, Environmental otucome, Social outcome

Paper type Literature review

Introduction

Can innovation drive sustainable development? While innovation tends to be conceived as a positive concept, there is clear evidence that innovations might also have (unintended) consequences that may lead to potentially harmful impacts on society and the environment (Biggi and Giuliani, 2021; Coad *et al.*, 2021). Innovations tend to both create new opportunities for growth and development, as well as disrupt existing practices and can lead, at least initially, to new or deeper inequalities. For example, a recent special issue by Coad *et al.* (2021) addresses 'the dark side of innovation', discussing different types of harm from innovation, like public health risks, and environmental degradation. Taking impacts on the environment as an example, there is clear evidence that while innovations reducing material use per unit of outputs or minimizing emissions on air are becoming more frequent, yet they still represent a minority of innovations. The most recent data on innovation activities at the European level reports that only 38% of innovative firms have introduced at least one innovation that effectively reduced their impacts on the environment [1]. Furthermore, positive and negative impacts on the environment might co-exist. The case of solar panels described by Hansen *et al.* (2021) is a clear case in point: while the possibility to rely on renewable energies is a clear advantage, the end-of-life disposal of solar panels is a great source of concern, especially in the context of developing countries (Cross and Murray, 2018; Xu *et al.*, 2018). Given this growing importance of sustainability for innovation, the study of sustainable innovation has emerged as a hot field of research, trying to understand how innovation activities and sustainability can be reconciled (Cillo *et al.*, 2019).

Frugal innovation (FI) is one of the categories of innovations that have been considered as inherently contributing to achieving sustainable development. Frugal, grass-root or bottom of the pyramid innovation is an increasingly relevant and debated topic for scholars, practitioners and policy makers (Agarwal *et al.*, 2017; Hossain, 2016). They are "cheap, tough, easy to use and developed with minimal amounts of raw materials" (Economist, 2009; Rao, 2013) that are targeting the Bottom of the pyramid (BoP) markets, developing products or services fit for resource-constrained environments. Given that frugal innovations are seen as lower cost, less resource intensive solutions targeted at resource-constraint settings, the negative side-effects of innovation are expected to be less or counterbalanced (Albert, 2019), due to their focus on core functionalities, user-oriented design, lower resource intensity, and overall cost minimization. The positive dynamics might be even larger than for conventional innovations, as frugal innovations are also often expected to create new market opportunities in previously 'underserved' markets. However, a review on 60 frugal innovations (Rosca *et al.*, 2017) stated that frugal innovations 'do not have an inherent sustainability impact' and very little is known as yet about the actual sustainability outcomes of frugal innovations (Hossain, 2017; Knorringa *et al.*, 2016; Levänen and Lindeman, 2016; Rosca *et al.*, 2017). What are the key features of FI that are connected with higher sustainability outcomes? Which factors, related to the innovation or the context in which it has been developed are connected with higher social, environmental, or economic results? When and under what circumstances sustainability outcomes are more likely to arise as a consequence of the implementation of frugal innovations? This is a major research gap, making it difficult for policy makers to identify in advance which kind of frugal innovations they may wish to support. Therefore, improving our understanding of when specific types of frugal innovations are more likely to lead to particular sustainability outcomes would offer a major step forward.

Against this background, the paper advances the state-of-the-art providing a deep analysis of how FI links to sustainability outcomes presenting findings from a quantitative content analysis based on the in-depth reading of empirical case studies published in the academic literature, which allows evaluating associations among the key variables at stake. Several FI literature reviews exist; however, they have mostly performed a bibliometric analysis of the literature (Agarwal *et al.*, 2017; Hossain, 2017) or adopted a non-systematic selection of papers and a narrative analysis of the evidence emerging (Cunha *et al.*, 2014; Hossain, 2016; Pisoni *et al.*, 2018). On the contrary, our analysis is based on a systematic review of the literature which quantifies the extent to which frugal innovations actually lead to improved economic, environmental and social sustainability outcomes. Our co-occurrency analysis allows identifying which features of the FI are more likely to be connected to higher economic, social or environmental performances, considering for the type of actor developing the FI, the network of relationship activated to develop it, and the context in which the FI has been activated. Providing such an in-depth analysis, we offer a launching pad for more evidence-based follow up studies that analyze under which circumstances frugal innovations are more likely to contribute to sustainable development, and discuss avenues for future research.

The paper is organized as follows. First, the state of the art on frugal innovation and sustainable development is reviewed, taking a contingency approach that leads to two research propositions. Next, an explanation of the research design and methodology is given. After this, our findings are presented distinguishing the key features of frugal innovators, the role of collaborations, and the factors that drive sustainability outcomes. The final section offers a discussion of main findings, concluding remarks, and an indication of future research lines.

State of the art

Frugal innovation and sustainable development

Frugal innovation represents a young and dynamic field of research with increased interest among scholars, practitioners and policy makers. The origin of the FI concept in academic literature is not clearly identified (Hossain, 2018a). Some argue that it derives out of the frugal engineering concept (Rao, 2013), while others affirm it has originated from India (Chataway *et al.*, 2014), or has its antecedents in bricolage (Baker and Nelson, 2005), and yet others have traced back its origins to Schumacher's idea of appropriate technology (Schumacher, 1973), or in the philosophical and religious roots of the idea of frugality (Albert, 2019). The first wave of studies on FI consisted of conceptual papers exploring how to define FI, illustrative cases studies, and studies that used illustrative cases to develop more grounded definitions. Initial definitions focused on the characteristics of the outcome of the innovation process: i.e. products characterized as combining low cost with high functionality and robustness (Tiwari and Herstatt, 2012). Later definitions added a focus on how the innovation process takes place under resource-constraints and that products, services and systems need to be affordable for poor(er) consumers (Zeschky *et al.*, 2014, Radjou and Prabhu, 2015). The present state of the art has embraced a further broadening that looks at FI as an approach (Prabhu and Jain, 2015) or a mindset (Soni and Krishnan, 2014) and not merely as a specific type of innovation outcome or process (Pisoni *et al.*, 2018). FI can be largely viewed as a novel innovation approach that aims to (re) design products, services, systems, and business models, providing reduced complexity, essential functionality and affordable solutions for underserved poor and new middle-class users (Basu *et al.*, 2013; Rao, 2013; Rosca *et al.*, 2017). Given these features, FI has been generally perceived as a notion associated with the BoP context of emerging and developing countries (Pisoni *et al.*, 2018; Weyrauch and Herstatt, 2016), where large groups of underserved communities have to face severe scarcity and resource constraint. However, the more recent FI literature includes authors that are also looking into the concept from the viewpoint of developed countries (Brem, 2017; Hossain *et al.*, 2016), as pressures of resource scarcity and the need for a more frugal lifestyle are also increasingly

present in these advanced economies. Works in this domain are mainly exploring the issue of reverse innovation, understood as innovations that emerge in a developing market context and are then taken into developed economies (Zeschky *et al.*, 2014); or are looking into the particularities of serving BoP populations in the developed economies (Angot and Plé, 2015).

As a concept, FI overlaps with and is frequently used interchangeably with various other terms (Hossain, 2017; Pansera and Sarkar, 2016). In fact, several studies, such as the works by Brem and Wolfram (2014), Zeschky *et al.* (2014) or Rosca *et al.* (2017), have explored and outlined the overlays among the various innovation concepts that have a relation with resource constraint and scarcity. Overlapping terms include disruptive innovation (Hart and Christensen, 2002), Jugaad innovation (Radjou *et al.*, 2012), pro-poor innovation (Berdegué, 2005), BoP innovation (Prahalad, 2012), resource-constrained innovation (Ray and Ray, 2010), below-the-radar innovation (Kaplinsky, 2011a), and inclusive innovation (Chataway *et al.*, 2014). As argued by Hossain (2018a), most of the characteristics of the overlapping concepts are indeed found in FI, having a common ground around the development of no-frills, low-cost but good products, services, systems, and business models for low-income population (Hossain, 2017).

A large part of the extant literature has focused on the search for the 'best' and most comprehensive definition of such a heterogeneous group of products, services, new processes or business models. A subgroup of these works has turned attention to the existence of a frugality – sustainability link yet paying very little attention to measuring the actual social, economic and environmental outcomes of such innovations. As documented by Albert (2019), the understanding of sustainability frequently used by FI scholars is based on three key references: the definition of sustainable development given by the World Commission on Environment and Development (1987), the triple bottom line approach proposed by Elkington (1997), and the UN Sustainable Development Goals, SDG, United Nations (2015). In this context, we could distinguish between a more descriptive/empirical stream in the literature (e.g. Rosca *et al.*, 2017; Albert, 2019; Shibin *et al.*, 2018) and a more normative approach to FI (Le Bas, 2016; Basu *et al.*, 2013; Brem and Ivens, 2013). The normative approach takes enhanced sustainability outcomes as a causal consequence of how frugal innovations are defined, while for the descriptive approach it is an empirical question under which conditions frugal innovations are more likely to contribute to specific sustainability concerns. Sustainability has been considered as inherent to FI due to its accessibility, simplicity and affordability features, hence being proposed as a solution for responding to the sustainability challenges of lower income communities (Levänen *et al.*, 2016). Authors such as Basu *et al.* (2013) have argued that FI may steadily drive progress in achieving sustainable solutions and, if scaled, can "contribute to a more sustainable world by aiding the efforts to end global poverty, world hunger, and social injustice, and to protecting the capacity of the planet to support our own and other species." (p 66). Particularly in the environmental dimension, it is claimed that frugal innovations may contribute to the adequate management of natural non-renewable resources by promoting energy and material savings which, tied up to reduced technological complexity, may enable green properties such as recycling or reparability (Le Bas, 2016). Similarly, Hassani *et al.* (2019) argue that environmental sustainability is an implicit FI criterion that is unintentionally considered throughout the design process, and thus indicate that the products of FI can also qualify as sustainable, as compared to other innovations. Brem and Wolfram (2014), categorize FI as having environmental effort as an important attribute, but consider it has little or no social sustainability. This contradicts with the general trend found in FI literature, which tends to see a more direct link with the social dimension of sustainability. However, the normative cases often ascribe environmental and social outcomes without actually measuring them (Albert, 2019). At this stage in the debate, all statements on outcomes and impacts are based on self-reporting by interviewed respondents. We aim to push the debate forward by explicitly distinguishing between economic, social and environmental outcomes and by considering the contingency that might support achieving such results.

Our in-depth analysis of the literature finds cases pointing to the emergence of positive and negative socio environmental outcomes of frugal innovations. Studying four renewable energy cases in rural Kenya,Karjalainen and Heinonen (2018) note positive environmental outcomes in aspects like energy efficiency and reduction of emissions. However, they also point out mixed social outcomes after the innovation adoption due to aspects like creating local employment, not reaching the poorest of the poor, and clashing with the lifestyle of nomadic groups. Similarly, Levänen *et al.* (2016) analyze four frugal innovations from energy and water sectors, finding positive environmental results in terms of energy production and water purification, while noting a larger spectrum of results in terms of social sustainability, depending on the type of actors involved and the business models used for the adoption and implementation of the innovation. In contrast, the case study evidence presented by Dressler and Bucher (2018) suggests that the most distinctive contribution to sustainability is in the social dimension, noting that such a contribution is not always of the same kind, as social impacts have an important context specificity. Other works refer negative health and environmental effects of end products like sachets and cooking stoves, due to inadequate ventilation to reduce smoke, increased consumption, or greater waste generation (Hossain, 2018b; Singh *et al.*, 2012). These dissimilar findings further problematize the issue, and confirm the need exposed by Hyvärinen *et al.* (2016), who urge for deeper studies of the entire cycle of FI processes, and to better understand under which circumstances positive sustainability outcomes are more likely to occur.

A contingency approach to the understanding of FI potential for sustainable development

While there is not a quantitative evidence of what are the features of the FI process which are more likely to be associated to higher sustainability performances, there is a consensus in the literature that some features of the FI process are likely to play a role, in particular the type of innovators and their motivations. In their review of the FI literature that explicitly addressed sustainable development, Rosca *et al.* (2018) suggest that important differences emerge in terms of outcomes, depending on the type of actors that have been developing the innovation – i.e. multinational enterprises (MNC) or small and medium sized firms (SMEs). This argument goes in line with previous work stressing the existing differences in the contributions towards sustainability depending on company size, recognizing that large and small firms often have a distinct role to play (Hockerts and Wüstenhagen, 2010; Hörisch *et al.*, 2015). Zooming in on actors is important as they may have distinct motivations, logics and ways of acting to develop frugal innovations, which may influence the input, processes and outputs of innovation and may impact upon how these innovations are likely to contribute to for example sustainability. The few case study evidence that currently exists (e.g. Levänen *et al.*, 2016) suggests that sustainability outcomes can be different in case different actors are engaged in developing the FI.

Although extant literature is limited in its understanding of the type of actors engaged in FI, various types of frugal innovators might be identified, including firm and non-firm actors (Hossain, 2018a; Knorringa and Bhaduri, 2018; Pisoni *et al.*, 2018). Firm actors can be distinguished by their size. First, frugal innovations produced by large multinational corporations **MNC's** seeking to capture the rapidly growing global market segment of 'relatively poor and new middle class' consumers at locations all over the world. The firms that drive these FI processes have often a for-profit motivation, which can be combined with various levels of awareness and action in terms of their social and environmental responsibilities. For these firms, frugal innovations are a means of enhancing competitiveness and developing new business models for longer-term company growth. Common examples of frugal innovations by MNC that are repeatedly cited in current literature include General Electric's Mac 400 hand-held electrocardiogram – first popularized by The Economist (2010) - and GE's portable ultrasound device; Tata's water filter Swach, and Tata's Nano car; Nokia's low-end mobile handsets; or Siemens Computed Tomography Scanner (Brem, 2017; Leliveld and Knorringa, 2018; Rao, 2013;

Zeschky *et al.*, 2011). Second, **small firms, startups and social enterprises** with varied levels of engagement with major societal and environmental challenges. These enterprises develop innovations that are considered frugal, with simple no frills-designs, effective use of technology, and adequate functionality, all with and affordable price. SavvyLoo waterless toilet system, 5 Star Stoves biomass-based stoves franchise model, Moladi affordable housing solutions, and Selco solar energy system are examples in this category (Dressler and Bucher, 2018; Levänen and Lindeman, 2016). Finally, non-firm actors can include **NGOs, local associations or communities**. Frugal innovations developed and implemented by NGOs and other non-profit organizations tend to have a more philanthropic and donor-based approach as opposed to social enterprises that exhibit a hybrid model of operation using market forces to enable their social goals. FIs developed by communities or individuals to solve their own bottlenecks are often labeled as bottom-up frugal innovations, grassroots innovations, informal sector innovations (Bhaduri and Talat, 2020), or what Chataway *et al.* (2014) refer to as innovation from below. Non-firm frugal innovations are usually developed without a commercial or scaling objective in mind. Cases found in current literature that illustrate this third group include Arunachalam Muruganantham's low-cost machine to make sanitary pads, Zeta's Mitticool refrigerator, or no-frills simple machines to automatize walnut and cotton deshelling created by farmers in rural India (Pansera and Sarkar, 2016; Sarkar, 2018).

These various types of frugal innovators are also discussed in different research streams. Frugal innovations developed by for-profit firms are mostly discussed in the management literature focused on how to penetrate BoP markets (Casado Cañeque and Hart, 2015;Gutiérrez and Vernis, 2016; Kolk *et al.*, 2014;Reficco and Gutiérrez, 2016), where 'new fortunes' are to be found (Prahalad, 2004; Prahalad and Hart, 2002). The NGO and social enterprise discourse is within the debate on how to achieve the Sustainable Development Goals (SDGs). The local community innovators are discussed in the grassroots innovation literature, and more broadly as part of the bricolage (Janssen *et al.*, 2018; Santos *et al.*, 2020), informal sector (Darbi *et al.*, 2018; Kaplinsky, 2011b) literature, and as part of sustainable livelihood strategies (Chambers and Conway, 1992; Molina-Maturano *et al.*, 2020) among the poor, who act both as producer and consumer of these frugal innovations. These literatures attach different levels of importance to whether the frugal innovations are more likely to lead to more sustainable outcomes. The main motivation for for-profit firms tends to be in making sustained profits, with possibly enhanced sustainability outcomes as an appreciated side effect. In turn, while local community innovators are perhaps more likely to develop frugal innovations with higher inherent sustainability outcomes (Pansera and Martinez, 2017; Pansera and Sarkar, 2016), such innovations are often more difficult to scale. It is also important to note that all actors might not only be the protagonists of the FI development, but also key enablers of its success, providing complementary knowledge, resources or capabilities to the organizations developing them. Accordingly, we could synthetize this discussion in the following research proposition:

Research proposition 1. The potential of FI to drive sustainable development outcomes depends on the type of actors that co-develop and implement the FI.

To get a fuller understanding of the FI innovation potential, it is important to understand that such innovations are not taking place in a vacuum, as also emerges from the general literature on innovation (Chesbrough, 2006; Laursen and Salter, 2006) and more in particular on the literature on innovation for sustainability (Cainelli *et al.*, 2015; Ghisetti *et al.*, 2015; Niesten *et al.*, 2017). The development and adoption of FI tends to take place thanks to the collaboration among several actors, with complementary resources and networks. Rosca *et al.* (2018) has highlighted this collaboration tendency as a crucial aspect of FI, but in much of the FI literature the image of the individual hero-inventor-entrepreneur remains intact. As we will show below, by far most frugal

innovations are not developed and implemented by one (type of) actor in isolation, but a key characteristic of frugal innovations lies in the intensive collaboration between different kind of actors in both the development and the implementation or diffusion of the FI. While it is uncommon for MNCs to work together directly with community level innovators, most other types of combinations are quite common (Arnold, 2018). Moreover, a stream of literature on co-creation and synergetic or polycentric innovation emphasizes the value-added in terms of co-ownership and contextual specificity of frugal innovations that are developed and implemented through a variety of actors. The importance of collaboration might emerge both in the development and in the implementation and diffusion of innovation, as different stages that should be considered separately.

Research Proposition 2. The potential of FI to drive sustainable development outcomes depends on the collaborations enacted to support its development and implementation.

Methodology

In order to get a better understanding under what circumstances FI enables positive social, economic and environmental outcomes, we perform a quantitative content analysis on the empirical papers published on FI. Particularly, starting by a systematic scanning of all empirical papers on FI, we have performed an in-depth analysis of the evidence reported, comparing all cases across the same dimensions to identify common paths. Most of the literature on FI took a case study approach, or a survey one. While those methods allow a more fine-grained analysis, they do not allow generalization, which is instead one of the key advantages of basing the analysis on a large number of cases via content analysis. Furthermore, with respect to narrative review, content analysis can provide more accurate estimates and have a stronger ability to validate the emerging findings (Hunter and Schmidt, 2004; Stanley *et al.*, 2008). Indeed, content analysis can 'combine the qualitative approach retaining rich meaning with powerful quantitative analyses' (Seuring and Gold, 2012). In this way, content analysis serves the same goal of meta-analysis. Content analysis can be used to compare qualitative features across studies, by coding qualitative evidence into numerical values, as we did in this study. To identify relevant papers, we adopted a systematic literature review approach (Denyer and Tranfield, 2009; Khan *et al.*, 2003), which allows for the analysis to be consistent, replicable and credible, given it adopts standardized methodologies and guidelines in the searching, filtering, reviewing, critiquing, interpreting, summarizing and reporting of findings from multiples publications. Furthermore, following the suggestions by Ertug *et al.* (2018) we are using data visualization techniques to disclose the relationships among the constructs adopted, aiming at adopting an informative way to report the rich data collected.

Several literature reviews have been performed so far on FI (Agarwal *et al.*, 2017; Hossain, 2016, 2017; Pisoni *et al.*, 2018), also specifically addressing the link with sustainable development goals (Albert, 2019; Rosca *et al.*, 2018). The key novelty of this study lies in the systematic coding of each paper regarding the features of the innovation, the innovators, and the outcomes achieved, that allows to take stock of the evidence emerging in such a wide and scattered literature, quantify to what extent the insights they are referring to are taking place in the empirical literature and to look for correlations. Indeed, our in-depth reading and scoring of key variables on the existing empirical cases also allows us to study co-occurrences or coherence between key variables in our database.

Search method and selection procedure

A step-wise methodology has been adopted to collect materials, following the PRISMA method (Liberati *et al.*, 2009). Such a selection allows for being both selective, by including

only high-quality contributions, and broad, by considering sources focused on different fields and based in different geographical contexts.

Our literature comprises English-written peer-reviewed articles, published until 2018 in Scopus. In order to identify the papers that are relevant regarding the scope of this analysis, a comprehensive list of keywords has been adopted, developed based on the existing literature reviews. Papers considered in the identification phases include in the title, abstract or key terms at least one among the following keywords: "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." Additionally, the following keywords have been searched for, in combination with the keyword innovation: "base of the pyramid" and "Jugaad". In total, 726 articles have been identified, who responded to these features. Subsequently, additional steps were needed to ensure that the identified papers were appropriate to the purpose of this article (screening). Two researchers in the team read all the abstracts in order to exclude papers that clearly did not report on two eligibility criteria: i) being focused on frugal innovation ii) being an empirical paper (accordingly, we excluded literature reviews or theoretical papers). Accordingly, 407 papers were excluded from the analysis. Following, the 297 contributions that passed the screening stage were read in full-length; to make sure they were indeed fit for the analysis, based on the two eligibility criteria reported above. In case the full text was not available, articles were excluded from the analysis. This stage drove the exclusion of 167 articles, so that the final universe considered is composed by 130 articles. Figure 1 summarizes the process of paper identification and selection.

Material evaluation

The 130 articles identified were read in depth and coded to enable to perform associations among the variables considered in the content-analysis. Five main categories have been considered: i) FI context; ii) FI development; iii) FI implementation, adoption, diffusion; iv) FI

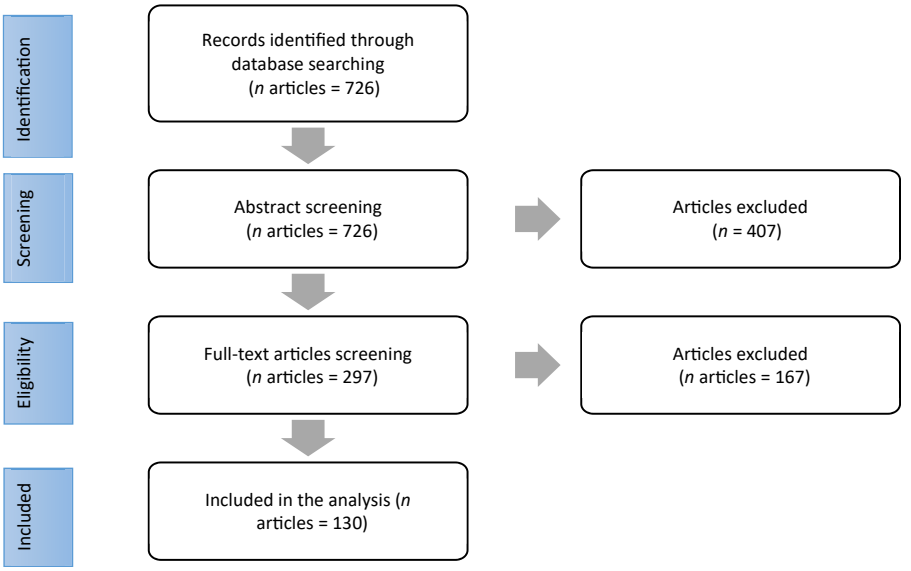

Figure 1.
Paper selection process according to the PRISMA method

characteristics; v) FI impacts. The full list of variables and the way they have been captured is reported in Table 1. A theoretically based categorization scheme with predefined categories, each defined clearly, was created based on intensive discussions within the research team. In order to ensure reliability and replicability of the coding, researchers in the team read the same paper – in case of differences in the coding a discussion was taken with the entire team to ensure finding a common view on the issue, to be applied also in other papers. While not fully avoiding subjectivity – this effort was aimed at ensuring an 'alignment of interpretation' (Seuring and Gold, 2012), so to ensure consistency in the generation of our data set [2].

Unit of analysis of the data collected are the single cases described in the paper; given often papers addressed more than one cases we finally have data on FI 250 cases (described in 130 articles) [3]. In such an analysis, we collected data both on FI development and diffusion, acknowledging that innovation is a process consisting in different steps, each entailing different specificities, in line with Pisoni *et al.* (2018) and Zanello *et al.* (2016).

Findings

Key features of frugal innovators and the role of collaborations

As reported in the first research proposition, we expect that the features of the FI developers influence the possibility for the innovation to produce sustainable development outcomes. Based on features of the developers identified in the literature (and presented in previous

Category	Variables included
FI Context	- Country where developed/adopted; - Geographical feature (rural, peri-urban, urban) - Industry; - Key focus of the paper (FI development, FI adoption, outcomes of the FI)
FI development	- Who developed; - Motivations of developer/other actors (profit motivated, social oriented, both); - Intensity of collaboration with local actors* (high, med, low, not reported); - Intensity of collaboration with foreign actors** (high, med, low, not reported);
FI implementation/adoption/ diffusion	- Intensity of collaboration with local actors* (high, med, low, not reported); - Intensity of collaboration with foreign actors** (high, med, low, not reported);
FI characteristics	- Innovation-type (product, process, business model); - Group targeted (poor, emerging middle class); - Simplicity (high, med, low, not reported); - Functionality (high, med, low, not reported); - Affordability (high, med, low, not reported); - Social goal addressed;
FI outcomes	- Economic outcomes (positive, negative, not reported); - Environmental outcomes (positive, negative, not reported); - Social outcomes (positive, negative, not reported); - Economic outcomes measurement (yes/no); - Environmental outcomes measurement (yes/no); - Social outcomes measurement (yes/no);

Table 1.
Variables analyzed in the content analysis

Note(s): *Local actors include firms, NGOs, governments, firms' associations, research centres/universities; community/consumers. **Foreign actors include institution/university, firms, NGOs

paragraphs), in our analysis we have recorded both the type of actors and its location, as reported in Table 2. More in particular, we have considered both firms (distinguishing between small firms and large ones); and non–firms (including both NGOs, local associations or communities) or a combination of the two. Furthermore, we considered if the actors (being a firm or not) are based in the same country where the FI is further adopted ('local') or foreign, or a combination of the two ('Mixed').

In general, most of the innovations are developed by firms (in 34.3% of the cases being large firms, in 25.9% being small ones); non-firm actors (including NGOs, industry associations, research centers) have been the leading actors developing the innovation in 34.7% of the cases. In very few instances, firms and non-firm actors co-developed the FI (4.2%). As for where those actors are located, with respect to where the innovation is developed, in the majority of the cases (66.1%) they are indeed locals – having a deep understanding of the local needs, they are developing products or services that are tackling them. Interestingly, in 12.9% of the cases analyzed local and foreign actors are developing innovation together, coupling complementary resources and expertise. The prevalence of local actors is high particularly when it comes to non-firm actors, being 80.7% of the total cases, as emerges from Figure 2 [4], which allows a deeper understanding of this analysis, by visually connecting developer types and their geography. The vast majority of small firms (91.9%) are local, and so is when it comes to non-firms actors (80.7%), whereas the situation is more mixed when it comes to large firms. Large firms represent indeed the 57.1% of the overall cases in which FI has being developed by a foreign entity; the 93.3% of the mixed cases (this is the case of subsidiaries of global multinationals).

Table 2 also allows disentangling for the major motivations to the development of the FI. 37.9% of the innovations analyzed are profit-motivated, i.e. driven by the interest to target an untapped market and profit from selling a targeted product or service; a similar share (40.6%) is instead socially-motivated, i.e. mostly driven by the need to alleviate poverty or improve well-being. Interestingly, an important share of innovation (21.5%) was developed to address both goals, hybridizing the social and the economic sphere, in line with the view of Battilana and Dorado (2010), Battilana and Lee (2014). A difference exists among the actors considered, in terms of what motivates their activities: as depicted in Figure 2 the majority of non-firm actors develop FI in order to asses social problems (77.1% of the cases for which information on the motivation was reported). Indeed the majority of socially motivated FI that are purely developed by non-firm actors. The contrary holds true for firms, especially foreign ones, which are rather profit oriented (57.3% vs the 45.2% of smaller firms).

Another key factor that we are zooming on, in order to better understand the potential of FI for sustainable development, is the type of collaborations that were activated by

Actors		Freq.	Percent	Valid observations
Developer type	Large firm (MNE)	82	34.3%	239
	Small firms	62	25.9%	
	Non-firm	83	34.7%	
	Mixed	12	5.0%	
Developer geography	Local	154	66.1%	233
	Foreign	49	21.0%	
	Mixed	30	12.9%	
Major motivations to develop FI	Profit-motivated	83	37.9%	219
	Social-oriented	89	40.6%	
	Both	47	21.5%	

Table 2.
Actors driving the development of FI

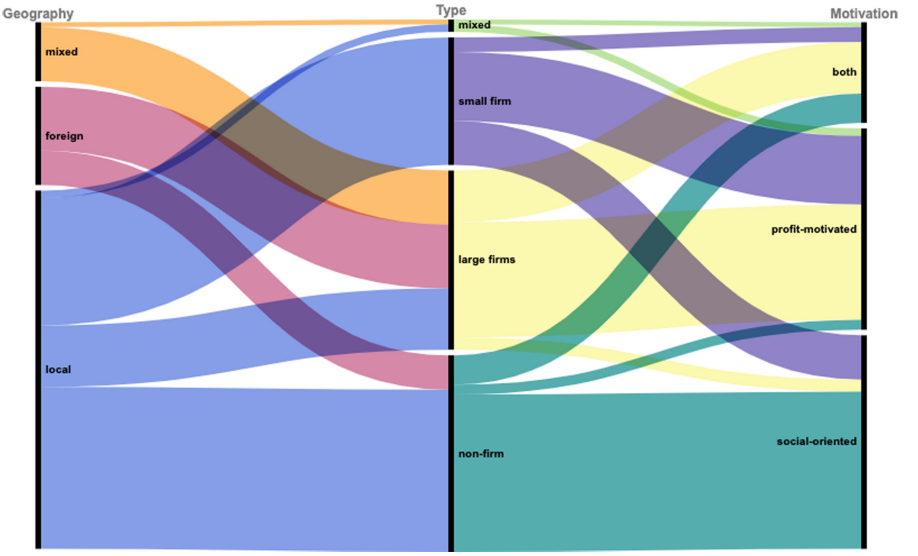

Figure 2. Investigating motivations considering for the geography and type of developers

Note(s): This analysis has been performed on 210 observations (84% of the sample), those for which information were available for all the three dimensions considered

innovators in order to develop the new product, process or service. Considering the high diversity in our sample, including different types of innovations and spanning very different industries and markets, we have been measuring if the innovators have been developed with any other relevant actor: other firms, universities, NGOs or other. Given that those different actors are entailing quite a diverse knowledge base and expertise, however, we have also measured if the collaboration activated could be defined as cross-partner, i.e. if it is engaging, for example, a firm and a NGO, or a NGO and a university. We performed this analysis distinguishing between different stages of the innovation process, i.e. development and adoption. For an improved understanding of the various ways in which FI and sustainable development are related, we need to give careful consideration to the entire innovation cycle, because even if sustainable practices can be identified during the development or adoption stage of FI, it does not directly imply that its implementation will lead to improved sustainability outcomes, as also noted by Halme *et al.* (2020). In the research and development stage, when developing the innovations, frugal innovators might need complementary resources on the local market and its peculiar needs or on how to technically develop it. Once the innovation has been developed, however, and especially when it has been developed in a different country than the one in which it will be adopted, innovators might need to access complementary resources and capabilities to have it accepted or distributed in the local context.

Such an expectation is supported by our analysis, as reported in Table 3. Indeed, having relevant collaboration with other partners – being other firms, institutions or with local communities – is particularly relevant for the development of FI (it was reported in 83.6% of the cases) and to a lower, yet still quite significant level for FI adoption (78.1%). Interestingly, when it comes to the adoption stage, however, such collaborations are more likely to involve different partners; cross-partner collaborations are occurring in 89.3% of the cases, vs the 50.5% of the cases for FI development.

The sustainability outcomes of FI

As noted earlier in the state of the art section, the more normative stream in the literature (Le Bas, 2016; Basu *et al.*, 2013; Brem and Ivens, 2013) takes for granted that FI has important sustainability outcomes, as a causal consequence of how frugal innovations are defined. However, more recent descriptive/empirical literature is rather challenging this view (Albert, 2019; Rosca *et al.*, 2018). Table 4 reports on the number of cases that explicitly focus on outcomes, considering for different aspects: i) which type of outcome is reported – among economic, social and environmental; ii) how many, of these three aspects, are considered – distinguishing among cases for which just economic outcomes are reported vs. cases in which just non-economic outcomes are reported vs both. Of the 68% of papers, which explicitly mentioned outcomes of FI, the majority bespoke of economic outcomes (75.3%) such as a significant cost reduction in the access to products or services from a customer perspective (Bhattacharyya *et al.*, 2017) or the profitability, growth and scalability of business (Angeli and Jaiswal, 2016; Annala *et al.*, 2018; Gebauer *et al.*, 2017). 68.2% reported social outcomes, such as improved health conditions (Angeli and Jaiswal, 2016; Firoz *et al.*, 2017) or local engagement, increased local empowerment and trust (Goyal *et al.*, 2017; Heuër, 2017). Less explored is the relationship between FI and the reduction of environmental problems (32.4%) in line with the results by Albert (2019). The majority of outcomes reported in the studies were positive, but negative reports are also found, such as discussing the negative environmental/social effects of using materials such as bamboo, mud and un-burnt bricks for low-income housing, which include lack of basic sanitation facilities, inadequate ventilation and higher vulnerability to natural hazards (Singh *et al.*, 2012). One fourth of the cases report only on economic outcomes related to FI introduction (i.e. increased turnover, export, ...) and a similar percentage reports just on non-economic aspects, i.e. on social, environmental or both. By far the largest group (50%), reports on a combination of the two (e.g. economic and social; or economic and environmental, or all three). This combined reporting can be seen in cases like the experience of a yoghurt production in Argentina that uses biotechnologies for inclusive development, as documented by Bortza and Thomas (2017). The authors report the case as a highly functional innovation process that engaged and empowered the local

Actors		Freq.	Percent
Collaboration for development*	Having relevant collaboration	163	83.6%
	Involving cross-partner collaborations	98	50.5%
	Valid observations	*194*	*77.6%*
Collaboration for adoption or diffusion*	Having relevant collaboration	139	78.1%
	Involving cross-partner collaborations	158	89.3%
	Valid observations	*177*	*70.8%*

*does not add to 100%

Table 3. Collaboration in the development and adoption or diffusion of FI

Outcomes		Freq.	Percent	Valid observations
Sustainability outcomes	Economic	128	75.3%	170
	Social	116	68.2%	
	Environmental	55	32.4%	
Co-occurrences	Only economic	43	25.3%	170
	Only social and/or environmental	42	24.7%	
	Both economic and social/env.	85	50.0%	

Table 4. Outcomes of frugal innovations

community, increased local producer's income, and resolved a societal problem by tackling child malnutrition led diseases. The work on Husk Power Systems by Gupta (2013) also exemplifies the reporting on all three aspects. Authors mention profitability, new market entrance and growth, cleaner energy and reduced CO2 emissions as compared to the existing market alternative and increased rural employment and local income. Landrum (2011) discusses negative unintended consequences or outcomes of BoP strategies on all three dimensions, which include deteriorated economic conditions, rise in e-waste under existing hazardous recycling conditions, and loss of social capital.

Which FI factors connect with sustainability outcomes?

One of the key benefits of the quantitative approach to content-analysis, which we have adopted to analyze the empirical FI cases, lies in the possibility to not only count the instances but also to verify to what extent they are related. To this purpose, as illustrated in Figure 3, we are proposing a bivariate analysis, to see to what extent cases on which two or three sustainability related outcomes are reported vs. cases on which just one outcome is reported [5], which is used to test our propositions 1 and 2. In Table 5, we report the statistics analyzed, classifying the cases according to the type of outcomes reported. A chi-square test is then performed, to assess the significance of the difference emerging. Accordingly, elements for which a statistically significant difference is reported testify of a correlation between each considered variable (type and origin of development, major motivations, presence of collaborations and cross-partner collaborations in development and adoption) and the introduction of a FI having a multi-dimensional outcome in terms of sustainable development, i.e. not driving just economic outcomes but also social and/or environmental outcomes, or vice versa.

The emerging analysis suggests that indeed considering the type of actors developing the FI is very important to understand the type of outcome we might expect that innovation to deliver, supporting proposition 1. In particular, Table 5 suggest that FI for which are reported

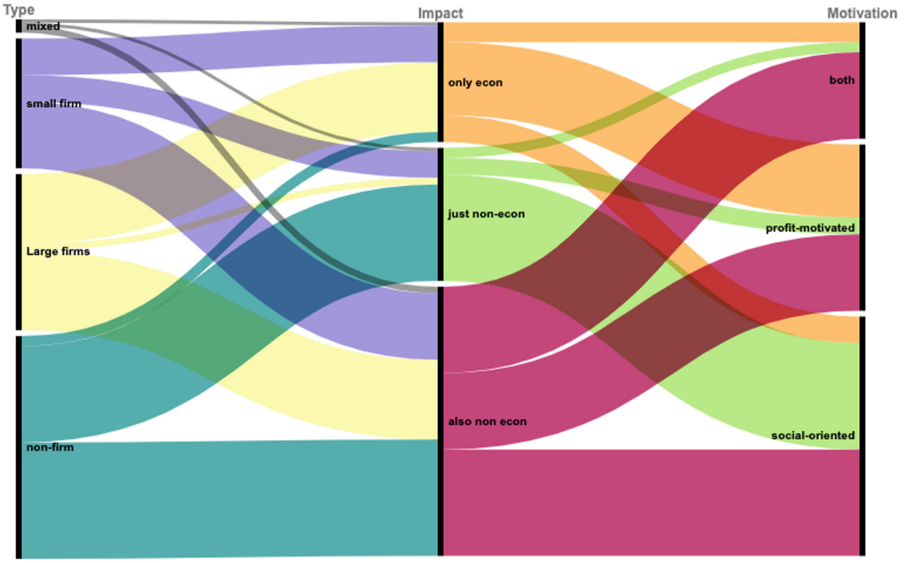

Figure 3.
Investigating the outcome considering for the type of developers and their motivations

Note(s): This analysis has been performed on 157 observations (62.8% of the sample), those for which information were available for all the three dimensions considered

	Reported impact	Only econ	Only non-econ	Both	Sig.	Valid obs.
Developer-type	Large firm (MNE)	*50.0%*	3.8%	46.2%	***	166
	Small firms	29.3%	19.5%	*51.2%*		
	Non-firm	4.5%	*43.3%*	*52.2%*		
	Mixed	33.3%	16.7%	*50.0%*		
Developer geography	Local	17.7%	29.4%	*52.9%*	***	164
	Foreign	30.8%	19.2%	*50.0%*		
	Mixed	*68.4%*	0.0%	31.6%		
Major motivation to develop FI	Profit-motivated	*44.0%*	10.0%	46.0%	***	158
	Social-oriented	11.1%	*44.4%*	44.4%		
	Both	16.7%	11.1%	*72.2%*		
Important collaborations for developing FI (Y/N)		68.8%	94.9%	94.2%	***	140
Cross-partners collaborations for developing FI (Y/N)		21.9%	78.9%	57.1%	***	140
Having important collaborations for adopting FI (Y/N)		82.6%	87.9%	83.1%		127
Cross-partners collaborations for adopting FI (Y/N)		78.3%	96.9%	90.1%	*	126

Note(s): *** Significant at the 1% level. * Significant at the 10% level. Percentages calculated on the valid observations

Table 5.
Multivariate analysis, comparing distribution of firms across type of outcome

only economic, only non-economic or both type of outcomes differs in a statistically significant manner in terms of the type of FI developers, their location with respect to the local market and their motivations. In fact, results clearly suggest that when the key developer are large firms, FI are reported to drives only economic results (50%) or eventually both economic and social or environmental ones (46.2%). The contrary holds in case of non-firm developers. Interestingly, small firms represent a mid-ground result, in which in the majority of cases it is reported on both economic and non-economic results (51.2% of cases) but there are also quite a good number of cases in which there is not mention to non-economic ones (29.3%).

The analysis of the geographical origin of developers reveals that a mixed outcome is the dominant outcome for both local (52.9%) and foreign (50%) actors, with a secondary prevalence of only economic outcomes for foreign developers (30.8%) and only non-economic outcomes for local developers (29.4%) Intriguingly, when local and foreign actors develop innovations together, economic outcomes are dominating (68.4%), with the absence of only non-economic outcomes. As a result, only 31.6% of FI of mixed origin have some non-economic outcome. Considering the motivations of developers shows that, if most of the cases attain their main purpose, in more than half of the cases there are positive side effects both for profit-motivated developers having some non-economic outcomes (56%) and for social-oriented ones having some economic outcome (55.5%).

Results support the expectations on the importance of collaborations, yet with interesting differences across collaborations for development vs. implementation. The three types of outcomes considered differ significantly in terms of likelihood to have been developed in collaboration with external partners, with the two outcomes including non-economic results being the most similar; however, they do not when it comes to collaboration for adoption or diffusion. Having relevant collaboration with external actors during the development stage seems to be particularly relevant in order to introduce FI having some non-economic outcome: 94.9% of FI with only non-economic outcome and 94.2% of those with mixed outcomes were developed through some major collaboration (vs the 68.8% of the case reporting just on economic outcome). The same is true for cross-partner collaborations: 78.9% of FI with only

non-economic outcomes were produced through cross-partner collaborations vs the 21.9% of those with economic outcome. These results might be interpreted in light of the evidence spanning from the innovation literature on environmental innovation. Being more complex, such innovations require a diverse set of competences to be developed, so that the collaboration with external partners (firms, universities, knowledge intensive business services) is more likely to take place than for the development of other innovations (Cainelli *et al.*, 2015; De Marchi, 2012). This is however not the case when we study collaboration for the adoption/diffusion stage. Collaboration with other partners (i.e. with local community leaders or NGOs) is quite diffused, especially when it comes to cross-partner collaboration, yet no significant differences emerge if we compare the cases with only economic, only non-economic or mixed results.

Discussion and conclusions

Although FI has sometimes been considered to inherently contribute to sustainable development, our point of departure has been that this needs to be empirically investigated, to better understand when and under what conditions positive contributions to sustainability outcomes are more likely to arise following the implementation of FI. This is a major research gap in current literature so improving our understanding of when specific types of FIs are more likely to lead to particular sustainability outcomes would offer a major step forward. We have advanced the state-of-the-art providing a deep analysis of how FI links to sustainability outcomes presenting findings from a content analysis of empirical cases in the academic literature, which allowed to identify associations among key features of the FIs, the actors developing them, and the sustainability outcomes related to the introduction of FIs.

First, our analysis confirms that social and environmental outcomes should not be taken for granted in FI, confirming the insights by Rosca *et al.* (2017). While we have found very few instances in our literature review in which negative outcomes have been reported, it is true that in a good number of cases either economic or non-economic outcomes where the only ones reported. More of interest to this analysis, however, was under what conditions we might expect sustainable improvements, both economic and non-economic, to take place thanks to the development or adoption of FI.

Our findings indicate that the potential of FI to drive sustainable development outcomes is influenced by the type of actors developing the FI, defined in terms of their organizational form, their geographical origin or motivations. The majority of non-firm actors, both local or foreign, appear to have solving a social problem as their chief motivation for developing the FI; firms, particularly foreign ones, are rather primarily profit motivated, driven by an interest in an untapped market. While these findings do not come as a complete surprise and are in line with what has repeatedly been noted in management and development studies literature (e.g. Karnani, 2007; Nakata and Weidner, 2012), it is interesting that about one fifth of all frugal innovations show a hybrid motivation, being developed for addressing both social and economic goals. Moreover, our analysis also shows that securing only economic outcomes is more likely to occur with frugal innovations developed by foreign actors, while the likelihood of finding only non-economic outcomes is greater with local developers.

Another interesting finding emerging from our analysis regards the relevance for the innovation to be embedded in the local context. In the majority of the cases the frugal innovations have been developed by local actors – having unique knowledge of the local circumstances and needs. Overall, the prevalence of local actors is more marked within non-firm actors, whereas firms tend to be more balanced in their local and foreign representation. Furthermore, our study suggests that a connection exists between whether the developer is local or foreign, and its main motivation to introduce a FI. Profit-motivated frugal innovations are more likely to have been jointly developed by local and foreign actors, as opposed to socially oriented, which tend to be conducted by local developers.

Our results also show that collaboration plays a key role along the various stages of the FI cycle, from its development to adoption or diffusion, and would thus be relevant for its potential to drive sustainable development outcomes. Our analysis confirms that the majority of frugal innovations are not developed and implemented by one (type of) actor in isolation, in line with the literature suggesting the importance of an 'open innovation' and collaborative approach to the development of innovations having a social or environmental outcome (Austin and Seitanidi, 2012; Cainelli *et al.*, 2015; Ghisetti *et al.*, 2015). Quite the contrary, intensive collaboration between different kinds of actors in the innovation cycle appears to be a key characteristic of FI. We find that collaboration with other actors is significant, and particularly relevant at the development stage, but it is not significantly more likely to drive sustainable development (i.e. to achieve both economic and social or environmental results) when it regards the adoption stage. Although the prevalence of collaboration and polycentric innovation in FI has been referred before (Leliveld and Knorringa, 2018) it is still an issue that has not received the attention it deserves. Particularly, the role of cross-actor collaboration should be taken into consideration for understanding how and under which circumstances FI may contribute to sustainable development. Our findings suggest that a great majority of frugal innovations that report having economic and non-economic outcomes were developed with some form of collaboration taking place. Similarly, frugal innovations producing both economic and non-economic outcomes have most likely experienced a form of cross-partner collaboration during their adoption, with one actor identifiable as key driver and others supporting the process of adoption in multiple ways. More empirical evidence is needed, however, to critically study how the complementarities in resources/capabilities of these various types of actors might influence the sustainability of frugal innovations, taking stock of the potential conflicts arising, and assessing the role played by each actor in these collaborations and the costs and benefits of each, in line with the evidence emerging from studies focusing, for example, on environmental innovations (Melander, 2018; Niesten and Jolink, 2020; Watson *et al.*, 2018).

All in all, we contribute to the FI literature by reaffirming the need for greater empirical attention to where and when sustainability-enhancing outcomes of FI are more likely to occur. Our results show that nearly one third of cases in current FI literature do not provide an explicit reference to the outcomes of the innovation, let alone make an attempt to actually measure these outcomes. It is also important to note that those that do report, are often based on self-reporting by research participants and tend to describe economic and/or social outcomes, with lesser consideration of environmental aspects. A more careful empirical and evidence-based approach to the measurement of the sustainability outcomes of FI will be beneficial for a better understanding of the societal relevance of FI. Finally, to strengthen the credibility of FI and arrive at more nuanced and evidence-based claims on its sustainability outcomes, it will be crucial to move beyond self-reporting and to add independent third-party evaluations, especially on the outcomes on poorer households. A useful next step would be to build upon the Monitoring and Evaluation protocol by the Donor Committee for Enterprise Development (DCED), which measures systemic change in private sector development programmes. The DCED standard uses three criteria: sustainability of the intervention or innovation, its scalability, and its resilience (Kessler, 2021). On top of that, Posthumus *et al.* (2020) add a so-called 'helicopter lens' to assess responses or changes in the broader system as a consequence of the implementation of innovations. Moreover, Vellema *et al.* (2022) offer additional tools to qualitatively explore, through action research, the terms of inclusion of actors in their respective value chains, and the terms of access for consumers of the innovation that looks at factors like affordability, availability and appropriateness, making this a highly relevant framework for changes that result from frugal innovations.

By implementing a content analysis approach, we contribute to the FI literature by systematically coding each paper regarding the features of the innovation, the innovators,

and the outcomes achieved. By adopting a more objective way of taking stock of current FI literature, we offered a first attempt to quantify the extent to which frugal innovations actually lead to improved economic, environmental and social sustainability outcomes. We also contribute to the FI literature by reaffirming the need for greater attention to where and when sustainability-enhancing outcomes of FI are more likely to occur. We hope our analysis will push the debate forward and motivate a next generation of FI research to provide evidence-based findings on its sustainability outcomes that can assist managerial teams and policy makers in determining which types of FI to support, depending on what outcomes they would like to see. We identify three main areas for follow up studies to understand under which circumstances FI is more likely to contribute to sustainable development, considering all its dimensions. First, a clear exploration of the distinctions (in motives and innovation processes) existing between types of frugal innovators, and the corresponding effect that said differences can have in terms of economic, social and environmental outcomes of their innovations. Second, given the importance that collaborations have for FI, research is needed to better understand the various patterns of (cross-actor) collaborations and polycentric innovation. In particular, a focus on agency is necessary to explore if and how local firm and non-firm actors are actually benefiting from their participation in these networks of collaboration. Also further empirical research can integrate the analysis of collaboration along the various stages of the FI cycle vis-vis sustainability outcomes, to better understand how and under which circumstances FI may contribute to sustainable development. Third, as extant knowledge about FI outcomes is scarce, evidence-based research is needed with a stronger focus on objective measurements of the outcomes of FI.

Notes

1. Own elaboration, based on Community Innovation Survey (CIS) data referring to the period 2014–2016. CIS is a comprehensive survey on the innovative activities of EU firms, which is widely adopted in Innovation studies. Information on green innovation have been collected for 14 European countries (Bulgaria, the Czech Republic, Germany, Estonia, Greece, Spain, Croatia, Cyprus, Latvia, Lithuania, Portugal, Romania, Slovakia, and Norway), for a total of almost 40,000 firms representative of the underlying universe. For more information see, for example (Cainelli *et al.*, 2015; Ghisetti *et al.*, 2015),
2. Part of the subjectivity in the analysis is related with the coding of the variables where intensity is involved (e.g. in terms of collaboration for development or implementation, or on the features of innovations). In those cases, expertise of the scholar has been essential to code such elements, based on the descriptions provided in the text.
3. Please note that we do not have all the information for all cases; for each analysis we are indeed reporting the number of valid cases used for calculation.
4. Figures are visually summarizing the relationship between the three variables considered. Contingencies analysis have also been performed, considering for all the couples of variables but are not reported. Statistical significance has been calculate using the Chi2 test.
5. Please note that for this analysis we have focused just on the analysis of the cases in which all the outcomes reported are positive – excluding the small number of cases in which mixed results were reported. For reasons of numerosity of observations, we could not report this analysis disentangling among all the possible cases (e.g. only environmental, only social, . . .).

References

Agarwal, N., Grottke, M., Mishra, S. and Brem, A. (2017), "A systematic literature review of constraint-based innovations: state of the art and future perspectives", *IEEE Transactions on Engineering Management*, Vol. 64 No. 1, pp. 3-15, doi: 10.1109/TEM.2016.2620562.

Albert, M. (2019), "Sustainable frugal innovation - the connection between frugal innovation and sustainability", *Journal of Cleaner Production*, Vol. 237, p. 117747, Elsevier Ltd.

Angeli, F. and Jaiswal, A.K. (2016), "Business model innovation for inclusive health care delivery at the bottom of the pyramid", *Organization and Environment*, Vol. 29 No. 4, pp. 486-507, doi: 10.1177/1086026616647174.

Angot, J. and Plé, L. (2015), "Serving poor people in rich countries: the bottom-of-the-pyramid business model solution", *Journal of Business Strategy*, Vol. 36 No. 2, pp. 3-15.

Annala, L., Sarin, A. and Green, J.L. (2018), "Co-production of frugal innovation: case of low cost reverse osmosis water filters in India", *Journal of Cleaner Production*, Vol. 171 Supplement, pp. S110-S118, doi: 10.1016/j.jclepro.2016.07.065.

Arnold, M.G. (2018), "Sustainability value creation in frugal contexts to foster Sustainable Development Goals", *Business Strategy & Development*, Vol. 1 No. 4, pp. 265-275.

Austin, J.E. and Seitanidi, M.M. (2012), "Collaborative value creation. A review of partnering between nonprofits and businesses. Part 2: partnership processes and outcomes", in *Nonprofit and Voluntary Sector Quarterly*, SAGE Publications Sage CA, Los Angeles, CA, Vol. 41 No. 6, pp. 929-968.

Baker, T. and Nelson, R.E. (2005), "Creating something from nothing: resource construction through entrepreneurial bricolage", *Administrative Science Quarterly*, Vol. 50 No. 3, pp. 329-366.

Basu, R.R., Banerjee, P.M. and Sweeny, E.G. (2013), "Frugal innovation core competencies to address global sustainability introduction: a call for global sustainability", *Journal of Management for Global Sustainability*, Vol. 2, pp. 63-82.

Battilana, J. and Dorado, S. (2010), "Building sustainable hybrid organizations: the case of commercial microfinance organizations", *Academy of Management Journal*, Vol. 53 No. 6, pp. 1419-1440.

Battilana, J. and Lee, M. (2014), "Advancing research on hybrid organizing – insights from the study of social enterprises", *The Academy of Management Annals*, Vol. 8 No. 1, pp. 397-441.

Berdegué, J. (2005), *Pro-Poor Innovation Systems*, IFAD Background Paper, Rome.

Bhaduri, S. and Talat, N. (2020), "RRI beyond its comfort zone: initiating a dialogue with frugal innovation by 'the vulnerable", *Science, Technology and Society*, Vol. 2020, pp. 1-18.

Bhattacharyya, O., Wu, D., Mossman, K., Hayden, L., Gill, P., Cheng, Y.L., Daar, A., Soman, D., Synowiec, C., Taylor, A., Wong, J., Von Zedtwitz, M., Zlotkin, S., Mitchell, W. and McGahan, A. (2017), "Criteria to assess potential reverse innovations: opportunities for shared learning between high- and low-income countries", *Globalization and Health*, Vol. 13 No. 1, pp. 1-8, doi: 10.1186/s12992-016-0225-1.

Biggi, G. and Giuliani, E. (2021), "The noxious consequences of innovation: what do we know?", *Industry and Innovation*, Vol. 28 No. 1, pp. 19-41, Routledge.

Bortza, G. and Thomas, H. (2017), "Biotechnologies for inclusive development: scaling up, knowledge intensity and empowerment (the case of the probiotic yoghurt 'yogurito' in argentina)", *Innovation and Development*, Vol. 7 No. 1, pp. 37-61, doi: 10.1080/2157930X.2017.1281206.

Brem, A. (2017), "Frugal innovation-past, present, and future", *IEEE Engineering Management Review*, Vol. 45 No. 3, pp. 37-41.

Brem, A. and Ivens, B. (2013), "Do frugal and reverse innovation foster sustainability? Introduction of a conceptual framework", *Journal of Technology Management for Growing Economies*, Vol. 4 No. 2, pp. 31-50.

Brem, A. and Wolfram, P. (2014), "Research and development from the bottom up - introduction of terminologies for new product development in emerging markets", *Journal of Innovation and Entrepreneurship*, Vol. 3 No. 1, pp. 1-22.

Cainelli, G., De Marchi, V. and Grandinetti, R. (2015), "Does the development of environmental innovation require different resources? Evidence from Spanish manufacturing firms", *Journal of Cleaner Production*, Vol. 94, pp. 211-220, Elsevier.

Casado Cañeque, F. and Hart, S.L. (Eds) (2015), *Base of the Pyramid 3.0*, 1st ed., Greenleaf Publishing, Sheffield.

Chambers, R. and Conway, G.R. (1992), "Sustainable rural livelihoods: practical concepts for the 21st century", *IDS Discussion Paper*, Vol. 296.

Chataway, J., Hanlin, R. and Kaplinsky, R. (2014), "Inclusive innovation: an architecture for policy development", *Innovation and Development*, Vol. 4 No. 1, pp. 33-54.

Chesbrough, H.W. (2006), "The era of open innovation", *Managing Innovation and Change*, Vol. 127 No. 3, pp. 34-41.

Cillo, V., Petruzzelli, A.M., Ardito, L. and Del Giudice, M. (2019), "Understanding sustainable innovation: a systematic literature review", *Corporate Social Responsibility and Environmental Management*, Vol. 26 No. 5, pp. 1012-1025.

Coad, A., Nightingale, P., Stilgoe, J. and Vezzani, A. (2021), "Editorial: the dark side of innovation", *Industry and Innovation*, Vol. 28 No. 1, pp. 102-112, Routledge.

Cross, J. and Murray, D. (2018), "The afterlives of solar power: waste and repair off the grid in Kenya", *Energy Research & Social Science*, Vol. 44, pp. 100-109, Elsevier Ltd.

Cunha, M.P.E., Rego, A., Oliveira, P., Rosado, P. and Habib, N. (2014), "Product innovation in resource-poor environments: three research streams", *Journal of Product Innovation Management*, Vol. 31 No. 2, pp. 202-210, doi: 10.1111/jpim.12090.

Darbi, W.P.K., Hall, C.M. and Knott, P. (2018), "The informal sector: a review and agenda for management research", *International Journal of Management Reviews*, Vol. 20 No. 2, pp. 301-324.

De Marchi, V. (2012), "Environmental innovation and R&D cooperation: empirical evidence from Spanish manufacturing firms", *Research Policy, North-Holland*, Vol. 41 No. 3, pp. 614-623.

Denyer, D. and Tranfield, D. (2009), "Producing a systematic review", *The SAGE Handbook of Organizational Research Methods*, pp. 671-689.

Dressler, A. and Bucher, J. (2018), "Introducing a sustainability evaluation framework based on the sustainable development goals applied to four cases of South African frugal innovation", *Business Strategy & Development*, Vol. 1 No. 4, pp. 276-285.

Economist, T. (2009), "Health care in India: lessons from a frugal innovator", *The Economist*.

Economist (2010), "First break all the rules: the charms of frugal innovation. Special report on innovation in emerging markets", *The Economist*, April.

Elkington, J. (1997), *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*, Capstone Publishing, Oxford.

Ertug, G., Gruber, M., Nyberg, A. and Steensma, H.K. (2018), "From the editors a brief primer on data visualization opportunities in management research", *Academy of Management Journal*, Vol. 61 No. 5, pp. 1613-1625.

Firoz, T., Makanga, P.T., Nathan, H.L., Payne, B. and Magee, L.A. (2017), "Reverse innovation in maternal health", *Obstetric Medicine*, Vol. 10 No. 3, pp. 113-119, doi: 10.1177/1753495X17700515.

Gebauer, H., Saul, C., Halidmann, M. and Kramer, S. (2017), "When one business model is not enough for a social business", *Strategic Direction*, Vol. 33 No. 1, pp. 10-12, doi: 10.1108/SD-06-2016-0096.

Ghisetti, C., Marzucchi, A. and Montresor, S. (2015), "The open eco-innovation mode. An empirical investigation of eleven European countries", *Research Policy*, Vol. 44, pp. 1080-1093.

Goyal, S., Sergi, B.S. and Kapoor, A. (2017), "Emerging role of for-profit social enterprises at the base of the pyramid: the case of Selco", *Journal of Management Development*, Vol. 36 No. 1, pp. 97-108, doi: 10.1108/JMD-05-2015-0070.

Gupta, A.K. (2013), "Tapping the entrepreneurial potential of grassroots innovation", *Stanford Social Innovation Review*, Vol. II No. 3, pp. A18-A20, doi: 10.48558/YHQJ-GJ06.

Gutiérrez, R. and Vernis, A. (2016), "Innovations to serve low-income citizens: when corporations leave their comfort zones", *Long Range Planning*, Vol. 49 No. 3, pp. 283-297, Elsevier Ltd.

Halme, M., Rintamäki, J., Steen Knudsen, J., Lankoski, L. and Kuisma, M. (2020), "When is there a sustainability case for CSR? Pathways to environmental and social performance improvements", *Business & Society*, Vol. 59 No. 6, pp. 1181-1227.

Hansen, U.E., Nygaard, I. and Dal Maso, M. (2021), "The dark side of the sun: solar e-waste and environmental upgrading in the off-grid solar PV value chain", *Industry and Innovation*, Vol. 28 No. 1, pp. 58-78.

Hart, S.L. and Christensen, C.M. (2002), "The great leap: driving innovation from the base of the pyramid", *MIT Sloan Management Review*, Vol. 44 No. 1, pp. 51-56.

Hassani, Y., Ionescu, R.C. and Mansour, J. (2019), "Contribution of frugal innovation to sustainable development", *Quality - Access to Success*, Vol. 20 No. S2, pp. 302-306.

Hörisch, J., Johnson, M.P. and Schaltegger, S. (2015), "Implementation of sustainability management and company size: a knowledge-based view", *Business Strategy and the Environment*, Vol. 24 No. 8, pp. 765-779.

Heuër, A. (2017), "Women-to-women entrepreneurial energy networks: a pathway to green energy uptake at the base of pyramid", *Sustainable Energy Technologies and Assessments*, Vol. 22, pp. 116-123, doi: 10.1016/j.seta.2017.02.020.

Hockerts, K. and Wüstenhagen, R. (2010), "Greening Goliaths versus emerging Davids - theorizing about the role of incumbents and new entrants in sustainable entrepreneurship", *Journal of Business Venturing*, Vol. 25 No. 5, pp. 481-492.

Hossain, M. (2016), "Grassroots Innovation : a systematic review of two decades of research", *Journal of Cleaner Production*, Vol. 137 No. 20, pp. 973-981.

Hossain, M. (2017), "Mapping the frugal innovation phenomenon", *Technology in Society*, Vol. 51, pp. 199-208, Elsevier Ltd.

Hossain, M. (2018a), "Frugal innovation: a review and research agenda", *Journal of Cleaner Production*, Vol. 182, pp. 926-936, Elsevier Ltd.

Hossain, M. (2018b), "Grassroots innovation: The state of the art and future perspectives", *Technology in Society*, Vol. 55 No. June, pp. 63-69.

Hossain, M., Simula, H. and Halme, M. (2016), "Can frugal go global? Diffusion patterns of frugal innovations", *Technology in Society*, Vol. 46, pp. 132-139, Elsevier Ltd.

Hunter, J. and Schmidt, F. (2004), Methods of meta-analysis: correcting error and bias in research findings.

Hyvärinen, A., Keskinen, M. and Varis, O. (2016), "Potential and pitfalls of frugal innovation in the water sector: insights from Tanzania to global value chains", *Sustainability (Switzerland)*, Vol. 8 No. 9, 888, doi: 10.3390/su8090888.

Janssen, F., Fayolle, A. and Wuilaume, A. (2018), "Researching bricolage in social entrepreneurship", *Entrepreneurship and Regional Development*, Vol. 30 Nos 3-4, pp. 450-470, Routledge.

Kaplinsky, R. (2011a), "Schumacher meets schumpeter: appropriate technology below the radar", *Research Policy*, Vol. 40 No. 2, pp. 193-203, Elsevier B.V.

Kaplinsky, R. (2011b), "Innovation knowledge development", *Research Policy*, Vol. 40 No. 2, pp. 193-203.

Karjalainen, J. and Heinonen, S. (2018), "Using deliberative foresight to envision a neo-carbon energy innovation ecosystem–a case study of Kenya", *African Journal of Science, Technology, Innovation and Development*, Vol. 10 No. 5, pp. 625-641, Taylor & Francis.

Karnani, A. (2007), "The mirage of marketing to the bottom of the pyramid: how the private sector can help alleviate poverty", *California Management Review*, Vol. 49 No. 4, pp. 90-111.

Kessler, A. (2021), *Assessing Systemic Change: Implementation Guidelines for the DCED Standard*, Donor Committee for Enterprise Development.

Khan, K.S., Kunz, R., Kleijnen, J. and Antes, G. (2003), "Five steps to conducting a systematic review", *Journal of the Royal Society of Medicine*, Vol. 96 No. 3, pp. 118-121.

Knorringa, P. and Bhaduri, S. (2018), CFIA working paper series No. 6 frugal innovation in EU research and innovation policy, No. 6.

Knorringa, P., Peša, I., Leliveld, A. and Van Beers, C. (2016), "Frugal innovation and development: aides or adversaries?", *European Journal of Development Research*, Vol. 28 No. 2, pp. 143-153.

Kolk, A., Rivera-Santos, M. and Rufín, C. (2014), "Reviewing a decade of research on the 'base/bottom of the pyramid' (BOP) concept", *Business and Society*, Vol. 53 No. 3, pp. 338-377.

Landrum, N.E. (2011), "Unintended consequences of business with 4 billion: lessons learned from first generation BOP strategies", *Ethical Models and Applications of Globalization: Cultural, Socio-Political and Economic Perspectives*, Vol. January, pp. 42-54, doi: 10.4018/978-1-61350-332-4.ch003.

Laursen, K. and Salter, A. (2006), "Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms", *Strategic Management Journal*, Vol. 27 No. 2, pp. 131-150.

Le Bas, C. (2016), "Frugal innovation, sustainable innovation, reverse innovation: why do they look alike? Why are they different?", *Journal of Innovation Economics & Management*, Vol. 21 No. 3, pp. 9-26.

Leliveld, A. and Knorringa, P. (2018), "Frugal innovation and development research", *The European Journal of Development Research*, Vol. 30 No. 1, pp. 1-16.

Levänen, J. and Lindeman, S. (2016), "Frugal innovations in circular economy : exploring possibilities and challenges in emerging markets", *The International Society for Ecological Economics 2016 Conference. Transforming the Economy: Sustaining Food, Water, Energy and Justice*, June.

Levänen, J., Hossain, M., Lyytinen, T., Hyvärinen, A., Numminen, S. and Halme, M. (2016), "Implications of frugal innovations on sustainable development: evaluating water and energy innovations", *Sustainability (Switzerland)*, Vol. 8 No. 1, pp. 1-17.

Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gøtzsche, P.C., Ioannidis, J.P.A., Clarke, M., Devereaux, P.J., Kleijnen, J. and Moher, D. (2009), "The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration", *Journal of Clinical Epidemiology*, Vol. 62 No. 10, pp. e1-e34.

Melander, L. (2018), "Customer and supplier collaboration in green product innovation: external and internal capabilities", *Business Strategy and the Environment*, Vol. 27 No. 6, pp. 677-693.

Molina-Maturano, J., Speelman, S. and De Steur, H. (2020), "Constraint-based innovations in agriculture and sustainable development: a scoping review", *Journal of Cleaner Production*, Vol. 246, p. 119001, Elsevier Ltd.

Nakata, C. and Weidner, K. (2012), "Enhancing new product adoption at the base of the pyramid: a contextualized model", *Journal of Product Innovation Management*, Vol. 29 No. 1, pp. 21-32.

Niesten, E. and Jolink, A. (2020), "Motivations for environmental alliances: generating and internalizing environmental and knowledge value", *International Journal of Management Reviews*, Blackwell Publishing, ijmr.12228, Vol. 22 No. 4, pp. 356-377.

Niesten, E., Jolink, A., Lopes de Sousa Jabbour, A.B., Chappin, M. and Lozano, R. (2017), "Sustainable collaboration: the impact of governance and institutions on sustainable performance", *Journal of Cleaner Production*, Vol. 155, pp. 1-6, Elsevier Ltd.

Pansera, M. and Martinez, F. (2017), "Innovation for development and poverty reduction: an integrative literature review", *Journal of Management Development*, Vol. 36 No. 1, pp. 2-13.

Pansera, M. and Sarkar, S. (2016), "Crafting sustainable development solutions: frugal innovations of grassroots entrepreneurs", *Sustainability*, Vol. 8 No. 51, pp. 1-25.

Pisoni, A., Michelini, L. and Martignoni, G. (2018), "Frugal approach to innovation: state of the art and future perspectives", *Journal of Cleaner Production*, Vol. 171, pp. 107-126, Elsevier Ltd.

Posthumus, H., Shah, R., Miehlbradt, A. and Kessler, A. (2020), *A Pragmatic Approach to Assessing System Change, Boekel: Hans Posthumus Consultancy*, Springfield Centre, Miehlbradt Consulting, and Donor Committee for Enterprise Development.

Prabhu, J. and Jain, S. (2015), "Innovation and entrepreneurship in India: understanding Jugaad", *Asia Pacific Journal of Management*, Vol. 32, pp. 843-868, doi: 10.1007/s10490-015-9445-9.

Prahalad, C.K. (2004), *The Fortune at the Bottom of the Pyramid*, Wharton School Pub, Upper Saddle River, NJ.

Prahalad, C.K. (2012), "Bottom of the pyramid as a source of breakthrough innovations", *Journal of Product Innovation Management*, Vol. 29 No. 1, pp. 6-12.

Prahalad, C.K. and Hart, S.L. (2002), "The fortune at the bottom of the pyramid", *Strategy+business*, Vol. 26, pp. 1-13, first quarter.

Radjou, N. and Prabhu, J. (2015), *Frugal Innovation: How to Do More with Less*, The Economist Profile Books, London.

Radjou, N., Prabhu, J. and Ahuja, S. (2012), *Jugaad Innovation: Think Frugal, Be Flexible, Generate Breakthrough Growth*, Jossey-Bass, San Francisco, CA.

Rao, B.C. (2013), "How disruptive is frugal?", *Technology in Society*, Vol. 35 No. 1, pp. 65-73, Elsevier Ltd.

Ray, P.K. and Ray, S. (2010), "Resource-constrained innovation for emerging economies: the case of the Indian telecommunications industry", *IEEE Transactions on Engineering Management*, Vol. 57 No. 1, pp. 144-156.

Reficco, E. and Gutiérrez, R. (2016), "Organizational ambidexterity and the elusive quest for successful implementation of BoP ventures", *Organization and Environment*, Vol. 29 No. 4, pp. 461-485.

Rosca, E., Arnold, M. and Bendul, J.C. (2017), "Business models for sustainable innovation – an empirical analysis of frugal products and services", *Journal of Cleaner Production*, Vol. 162, pp. S133-S145, Elsevier.

Rosca, E., Reedy, J. and Bendul, J.C. (2018), "Does frugal innovation enable sustainable development? A systematic literature review", *European Journal of Development Research*, Vol. 30 No. 1, pp. 136-157, Palgrave Macmillan UK.

Santos, L.L., Borini, F.M., Oliveira, M.D.M. Jr, Rossetto, D.E. and Bernardes, R.C. (2020), "Bricolage as capability for frugal innovation in emerging markets in times of crisis", *EJIM*, Vol. 25 No. 2, pp. 413-432.

Sarkar, S. (2018), "Grassroots entrepreneurs and social change at the bottom of the pyramid: the role of bricolage", *Entrepreneurship and Regional Development, Routledge*, Vol. 30 Nos 3-4, pp. 421-449.

Schumacher, E.F. (1973), *Small Is Beautiful: A Study of Economics As If People Mattered*, Harper, New York.

Seuring, S. and Gold, S. (2012), "Conducting content-analysis based literature reviews in supply chain management", *Supply Chain Management*, Vol. 17 No. 5, pp. 544-555, doi: 10.1108/13598541211258609.

Shibin, K.T., Dubey, R., Gunasekaran, A., Luo, Z., Papadopoulos, T. and Roubaud, D. (2018), "Frugal innovation for supply chain sustainability in SMEs: multi-method research design", *Production Planning and Control, Taylor & Francis*, Vol. 29 No. 11, pp. 908-927.

Singh, R., Gupta, V. and Mondal, A. (2012), "Jugaad-from 'making do' and 'quick fix' to an innovative, sustainable and low-cost survival Strategy at the bottom of the pyramid", *International Journal of Rural Management*, Vol. 8 Nos 1-2, pp. 87-105.

Soni, P. and Krishnan, R.T. (2014), "Frugal innovation: aligning theory, practice, and public policy", *Journal of Indian Business Research*, Vol. 6 No. 1, pp. 29-47, doi: 10.1108/JIBR-03-2013-0025.

Stanley, T.D., Doucouliagos, C. and Jarrell, S.B. (2008), "Meta-regression analysis as the socio-economics of economics research", *Journal of Socio-Economics*, Vol. 37 No. 1, pp. 276-292.

Tiwari, R. and Herstatt, C. (2012), "Frugal innovation: a global networks' perspective", *Die Unternehmung*, Vol. 66 No. 3, pp. 245-274, doi: 10.5771/0042-059x-2012-3-245.

United Nations (2015), *Transforming our World: The 2030 Agenda for Sustainable Development*, A/RES/70/1, General Assembly, United Nations.

Vellema, S., Schouten, G. and Faling, M. (2022), *Monitoring Systemic Change in Inclusive Agribusiness*, IDS Bulletin, forthcoming.

Watson, R., Wilson, H.N., Smart, P. and Macdonald, E.K. (2018), "Harnessing difference: a capability-based framework for stakeholder engagement in environmental innovation", *Journal of Product Innovation Management*, Vol. 35 No. 2, pp. 254-279, doi: 10.1111/jpim.12394.

Weyrauch, T. and Herstatt, C. (2016), "What is frugal innovation? Three defining criteria", *Journal of Frugal Innovation*, Vol. 2 No. 1, pp. 1-17.

World Commission on Environment and Development (1987), *Our Common Future*, Annex to document A/42/427, United Nations.

Xu, Y., Li, J., Tan, Q., Peters, A.L. and Yang, C. (2018), "Global status of recycling waste solar panels: a review", *Waste Management*, Vol. 75, pp. 450-458, Elsevier Ltd.

Zanello, G., Fu, X., Mohnen, P. and Ventresca, M. (2016), "The creation and diffusion of innovation in developing countries: a systematic literature review", *Journal of Economic Surveys*, Vol. 30 No. 5, pp. 884-912, doi: 10.1111/joes.12126.

Zeschky, M., Widenmayer, B. and Gassmann, O. (2011), "Frugal innovation in emerging markets", *Research-Technology Management*, Vol. 54 No. 4, pp. 38-45.

Zeschky, M., WinterhalterProf, S. and Gassmann, O. (2014), "From cost to frugal and reverse innovation: mapping the field and implications for global competitiveness", *Research Technology Management*, Vol. 57 No. 4, pp. 20-27.

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