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Business models for sustainable innovation – an empirical analysis of frugal products and services

Eugenia Rosca, Dr Marlen Arnold, Assistant Professor Dr. Julia C. Bendul



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• Authors name and affiliations.

Eugenia Rosca
Jacobs University
School of Mathematics and Logistics
Campus Ring 1
28759 Bremen, Germany
e.rosca@jacobs-university.de
Phone: +49 421 200-3077

Dr Marlen Arnold
University of Oldenburg
School of Educational and Social Science
Faculty 1, we.b
D-26111 Oldenburg
Germany
marlen.arnold@uni-oldenburg.de
Phone. +49(0)441-798-4469

Assistant Professor Dr. Julia C. Bendul
Jacobs University
School of Mathematics and Logistics
Campus Ring 1
28759 Bremen, Germany
j.bendul@jacobs-university.de
phone: +49 421 200 3194

• Corresponding author.

marlen.arnold@uni-oldenburg.de

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Abstract

Sustainable innovations are inventions providing an essential progress concerning social, economic and ecological concerns. The emergence of Base of the Pyramid markets and the growing importance of the developing economies as new sources of frugal innovations has attracted the interest of scholars and practitioners. Frugal innovation is an inclusive approach to innovation that maximizes value for customers, shareholders, and society – while significantly reducing the use of financial and natural resources in developing countries. Reverse innovations are frugal products and services successful in developing markets that make their way back to industrialized countries by creating new market segments. Therefore, both concepts are crucial for facing sustainability challenges in developing countries and may also lend insights to business models in industrialized countries. As the relationship between frugal and reverse innovation and sustainability remains largely unexplored in the literature, this study aims to fill in this gap and answer the research question: How can frugal and reverse innovation strengthen sustainable development, and how can business models in this context be systemized and described? Employing a multiple case study design, a total of 59 frugal products and services were investigated from a business models and sustainability strategy perspective from June 2014 until June 2015. The direction of innovation was distinguished between (a) from developing countries to developing countries, (b) from industrialized countries to developing countries, (c) from industrialized countries to industrialized countries, and (d) from developing countries to industrialized countries with the purpose to find differences between different directions of innovation and economies. Findings show that entrepreneurs and companies offering frugal and reverse products and services manage to combine the business model elements in an insightful manner and create economic, social and environmental value.

Highlights

- Frugal and reverse innovation have specific business models
- Sustainability is not inherent to frugal and reverse innovation
- Different sustainability archetypes relate with different directions of innovation
- Local manufacturing, local R&D, low costs and cooperation are key success factors
- Recycling, use of renewables, social and stewardship engagement are crucial

Keywords

Business models; Frugal innovation; Reverse innovation; Sustainability; Archetypes; Base of the pyramid

1 Introduction

Although the concept of sustainability and sustainable development are debated vividly in literature there are several main principles to highlight, including shaping human systems, economizing, producing and living in a way that the ability of the Earth's ecosystems to assimilate, buffer and regenerate is considered. Sustainability stresses the need for creating resilient systems regarding ecology, economy as well as society while respecting the limits of ecological capacity and viability (Arnold, 2015). Sustainability addresses the companies' activities to implement sustainable and social-ecological requirements across the whole value chain. "Once a product design has been set, its sustainability attributes are largely fixed" (Ny et al., 2008: 601), and strategies for future processes are mostly missing (Bratt et al., 2013) although there are some approaches involving several interdependent but distinct levels of sustainability in a strategic sense (Robèrt et al., 2002).

Sustainable innovations are inventions providing an essential progress concerning social, economic and ecological concerns (Arnold and Barth, 2012; Arnold and Hockerts, 2011). Having an ecological impact, respective innovations must realize improvements concerning eco-design and eco-efficiency, such as reducing energy, land, resource intensity, and emissions and waste, etc. per unit of production and/or during the use phase (Bocken et al., 2014). A social impact is clearly given when the quality of human life, the quality of health care and services as well as the individual wealth, etc. are improved. Thus, one of the key challenges is to ensure the success of a business model while simultaneously combining economic value with environmental and social benefits.

Frugal innovation encompasses (re)designing products, services and business models in order to reduce complexity and total lifecycle costs while providing high value and affordable solutions for Base of the Pyramid (BOP) customers in developing countries (Bhatti, 2012; Rao, 2013). There are numerous examples of frugal innovation outcomes such as cars, refrigerators, medical devices and healthcare services that cost between 50% and 97% less than regular corresponding products and services (Rao, 2013). A specific example includes the frugal cardiogram developed by General Electric, which is a simplified version of the normal cardiograms used in industrialized countries. General Electric's cardiogram removed all unnecessary components and reduced product and process complexity significantly by using substitute locally available materials, used printers from local bus terminals and off-the-self components (Sharma and Iyer, 2012). Frugal products and services provide market opportunities also for cost-conscious consumers in industrialized countries, and therefore by making their way back from developing to developed markets, frugal innovations can become reverse innovations (Immelt et al., 2009). Trimble (2012) emphasizes that reverse innovation is any innovation adopted first in developing markets and then in industrialized. However, this does not mean that innovators or companies are in developing countries, but the focus is rather on consumers.

Roland Berger Strategy Consultants (2013) estimate that frugal products and services are to double their global market share within the next five years. Concurrently, frugal and reverse innovations and related concepts are of growing importance in the management literature. Yet, e Cunha et al. (2014) in their systematic literature review found that the frugal innovation research stream is still in its infancy.

However, as companies have to develop capabilities on how to do more with less, the frugal innovation paradigm is crucial for facing future sustainability challenges (e Cunha et al., 2014).

Bhatti et al. (2013) emphasize that frugal innovation does not necessarily involve new technologies, but can also involve new business models. Simultaneously, the business model perspective has been proposed as a framework to better understand how sustainable innovations' business model architectures are built in order to enable sustainable outcomes (Boons and Lüdeke-Freund, 2013). Hence, this study employs a multiple case study design and investigates 59 empirical cases of frugal and reverse innovations in order to answer the research questions: *How can frugal and reverse innovation strengthen sustainable development, and how can business models in this context be systemized and described?*

The present article is structured as follows: first, the extant literature relevant to business models in the context of frugal and reverse innovation as well as sustainable development is reviewed. Second, the research methodology is presented and data analysis techniques are elucidated. Next, findings are derived from analysis and summarized. The paper concludes with a discussion of theoretical and managerial implications along with recommendations for further research.

2 State of the Art

2.1 Business models understanding

A business model describes how a firm creates value through the exploitation of business opportunities (Amit and Zott, 2010; Chesbrough, 2007). While often confused with the revenue model, the business model differs from the revenue model in the following way: a revenue model deals with value appropriation and a business model with value creation. There is no exclusive understanding of business models since various authors describe different elements business models should contain (Gassmann et al., 2014; Boons and Lüdeke-Freund, 2013; Amit and Zott, 2010; Casadesus-Masanell and Ricart, 2010; Osterwalder, 2004; Chesbrough and Rosenbloom, 2002).

Elements	Description	Frugal innovation	Reverse innovation	Key-words for search
<i>Target Customer</i>	...refers to the main group of customers a firm is focusing on.	Developing countries.	Developing countries, then developed countries.	Responsibility, stakeholder, relationships, group, consumer, customer, people, Bottom of the Pyramid, developing countries.
<i>Value Proposition</i>	...refers to the benefit offered by the product or service offered. It is viewed in terms of three aspects: economic, social and environmental value.	Affordability, good-enough products and services, basic functionality, access to knowledge and opportunities; improved health and standard of living; jobs creation, frugal use of resources; maximize value while reduce nonessential costs; Reduced total ownership cost (not only initial investment, but also low maintenance and repair), good quality able to cope with given infrastructural difficulties, robustness, user friendliness and economies of scale (Tiwari et al., 2014).	Differs; frugal, functional, good-enough-quality products and services; low-price, customer-centric; identify customer pain points, and develop products to solve customer problems.	Product, service, customer segments, relationships, dialog, balance, needs, economic, ecological, social, local development, affordable, jobs, income, standard of living.
<i>Revenue Model</i>	...describes in general terms how a company	High price sensitivity; high cost of operation, low margins and high-volume orientation.	Niche markets in the rich world with needs similar to the mass	Financial model, distribution, costs, costs

	makes money, what the main cost drivers and profit opportunities are. From a sustainability perspective, it is worthwhile observing the distribution across partners and stakeholders of economic benefits.	High costs related to training, awareness and education of customers and value chain actors; Provision of micro-finance services so that customers can afford to pay. Top 10 core competencies for frugal innovations: ruggedization, lightweight, mobile solutions, human centric design, simplification, new distribution models, adaptation, use of local resources, green technologies and affordability (SCU, 2013). Low price, compact design, no frills structure, limited use of resources, reuse of existing components, ease of use and cutting edge technology (Rao, 2013).	market in poor countries; marginalized markets in the developed world as they are mostly underserved or ignored; captures the value added in developing economies; high-volume orientation in the developing world (Govindarajan and Trimble, 2012).	structure, benefits, high volume, growth, scalability, revenue stream, ecological and social impacts.
<i>Value Chain</i>	...describes the specific activities used to create value and refers to the numerous aspects of relevance from a sustainability perspective, for instance the active engagement of suppliers in sustainable practices.	Specialization principles, pricing techniques, low capital intensity, workflow principle, high volume, talent leverage and values deeply held across the organization (Pralhad, 2005). Frugal engineering, local capacity building, involvement of BOP markets into the value chain as suppliers, distributors, producers and service providers, local suppliers, non-traditional supply chains, alliances with local non-conventional partners.	Two of the key innovation phases take place at least in a developing country; before launch knowledge is created, defined, and conveyed in new products and services (Von Zedtwitz et al. 215); Reinvent the product from the ground up; clean-slate innovation; Build new core competencies; Build new global growth platforms based in emerging markets (Govindarajan and Trimble, 2012)	Key activities, channels, partners, supply chain, suppliers, resources, technology, engagement, integration, balance, distribution, issue management, social and materials cycles, wastes.

Table 1: Business model elements in the light of frugal and reverse innovation

The architecture of a business model comprises from three (Amit and Zott 2010) to nine dimensions (Osterwalder and Pigneur 2009) according to different perspectives. For example, Chesbrough and Rosenbloom (2002) perceive business models as mediators between the technical and economic domains of business environment, while Casadesus-Masanell and Ricart (2010) regard business models as choices such as assets, policy or governing choices made by the management teams and the associated consequences of these choices in terms of the impact they have on the firm's success. Boons and Lüdecke-Freund (2013) perform a systematic literature review in which they find three main streams in the business model literature, namely the technology focused stream that emphasizes the business model concepts for technology companies, the strategic management stream that views business models as tools for the improvement of a company's value chain and the strategy-oriented stream that enhances it with a market competition and efficiency focus. They suggest several normative requirements for the four business model components *target customer*, *value proposition*, *revenue model*, and *value chain* proposition, addressing sustainable innovations. In accordance with these four elements we combined several existing conceptualizations for business models for the purpose of this investigation (see table 1; Gassmann et al. 2014; Boons and Lüdecke-Freund, 2013; Osterwalder, 2004). Moreover, a recent stream of scholars suggests that the concept of sustainable innovation needs a systematic framework for examination and that business model framework could serve as one (Boons and Lüdecke-Freund, 2013). Thus, we combine business model elements with

sustainability and frugal innovation. In our case it is of interest whether there are some differences recognizable in terms of sustainability.

2.2 Innovation terms in the light of frugal and reverse innovation

Already in 1995, Luken and Freij (1995) analyzed market opportunities for developed countries and cleaner industrial production in developing countries. Roland Berger Strategy Consultants (2013) argue that western companies have a very competitive position in the high-end market both in developed and developing countries, but a weak and almost non-existent position in the low and bottom markets in developed and developing countries. They also show that precisely these market segments are the ones which will encounter strong growth in the near future. Therefore, western companies should better position themselves in order to realize benefits. There are several concepts and definitions describing innovation concerning impact, market opportunities, point of origin, target markets, sustainability impact, etc. (see table 2). Thus, the comparison of definitions makes clear that there are similar approaches, and different terms combine different items of classification. Therefore, frugal and reverse innovation will be introduced in more detail below.

Term	Definition	Sources
Blowback innovation	Innovative solutions developed and adopted first in emerging markets	Brown and Hagel 2005
Bottom of Pyramid Innovation	Products and services which address under-served or un-served markets at the low end of the economic system	Prahalad (2005)
Catalytic Innovation	Innovative practices based primarily on social change and creation of social wealth for poor consumers through 'scalable, sustainable, system-changing solutions'. Catalytic innovations are low-cost, simple solutions which are useful for people traditionally ignored by the social sectors, considered 'good-enough' by users, meet significant underserved need. Examples of catalytic innovation are frequent in health care, education and economic development.	Christensen et al. 2006
Cost Innovation	The use of cost advantage of developing economies in order to develop innovativeness at much lower cost	Williamson 2010
Disruptive Innovation	Processes of replacing older technologies with technologies that change the course of development. Disruptive innovation are products or services which offer superior customer value at low cost.	Christensen 1997
Frugal Engineering	A clean-sheet approach to product development that aims to maximize value for customers while minimizing non-essential costs. Frugal engineering refers to product developed practices.	Sehgal et al. 2010, Radjou et al. 2012
Frugal Innovation	<i>Frugal innovations are not re-engineered solutions but products or services developed for very specific applications in resource-constrained environments. They are based on new product architectures that are often quite disruptive; for example, by making a stationary product portable, a frugal innovation may reach an entirely new customer group.</i>	<i>The Economist 2010, Zeschky et al. 2014</i>
Gandhian innovation	Innovation developed for the Indian market, corresponding to the two Gandhi assumptions: affordability and sustainable development	Prahalad & Mashelkar 2010
Good-Enough Innovation	Innovation associated with functionality and features designed in a way that they meet specific needs of customers with limited environmental resources	Hang et al. 2010; Zeschky et al. 2014
Grassroots Innovation	Bottom-up development approach which includes social integrity and social civilians as inventors by connecting people through social and technical networks in order to develop ecologically and socially acceptable products and services.	Brem & Wolfram 2014
Inclusive Innovation	Innovations for inclusive growth are developed to create and enhance opportunities to improve the well-being of those at the BOP. The development and implementation of new ideas which aspire to create opportunities that enhance social and economic wellbeing for disenfranchised members of society.	George et al. 2012
Indigenous Innovation	A process of making use of technologies transferred from the advanced economies to develop superior technologies at home	Lazonick 2004, Lu 2000
Jugaad innovation	Innovation based on ingenious solutions, consisting of overcoming limitations (e.g. the lack of funds) and finding effective, often improvised solutions with limited resources	Radjou et al. 2012
Resource Constrained Innovation	Innovations which use minima resources and are affordable to end-customers.	Ray & Ray 2011; Sharma & Iyer 2012;
Reverse Innovation	<i>The development of ideas in emerging markets and then the export of this knowledge and innovation to developed economies</i>	<i>Govindarajan & Ramamurti 2011, Trimble 2012, Immelt, et al. 2009</i>

Trickle-up Innovation	Innovations developed for the bottom of the pyramid that subsequently trickle up to the developed world	Prahalad 2005
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Table 2: Concepts and understandings of innovation in the light of frugal and reverse innovation

Brem and Wolfram (2014) suggest that frugal innovation integrates the specific needs of BOP markets as a starting point and works backwards to develop solutions, which often end up very different from existing solutions in developed markets. As such, frugal innovations do not only involve new technologies, but also innovative ways of altering traditional value creation and capture mechanisms through value chain elements reconfiguration, business models reshaping, re-engineered products and services, inclusion of poor into the economic markets and extreme focus on affordability constraints. Initially, Christensen (1997) used the term disruptive technology, then extended the concept to disruptive innovation in order to emphasize the need for new business models (Christensen and Raynor, 2003). Similarly, Bhatti et al. (2013) also emphasize that frugal innovation does not necessarily involve new technologies, but it does involve new business models. Another approach related to theoretical foundations of frugal innovation is proposed by Bhatti (2012). He defines the theoretical roots of frugal innovation at the intersection between social innovation, business innovation and institutional innovation. As such, business innovation explores the resource constraints, institutional innovations support the institutional voids debate and social innovations reveal aspects of dealing with affordability constraints. Anderson and Markides (2012) suggest that frugal innovation needs to meet numerous socio-economic, institutional and environmental requirements of developing countries and the specific criteria of affordability, acceptability, availability and awareness. Furthermore, the authors point out that developing frugal products implies the creation of a new 'who', 'what' and 'how'. Similarly, George et al. (2012) argue that process and business models are at least equally important – if not even more important than product innovations in emerging countries. Tiwari et al. (2014) define the value proposition of frugal products and services as reduced total ownership cost (not only initial investment, but also low maintenance and repair), robustness, user friendliness and economies of scale. There is consensus in the literature that frugal innovation's core focus is low cost (Brem and Wolfram 2014). However, there are different opinions regarding the way that is achieved. Some authors suggest that in order to achieve significantly lower costs while maintaining high quality, frugal innovation focus on core features and eliminate unessential ones (Moore 2011). Others suggest the use of a technique called reverse engineering, which starts with an existing competitor's product and works backwards to define the development and manufacturing process (Samuelson and Scotchmer 2002).

Immelt et al. (2009) define reverse innovations as innovations that make their way from developing countries to developed markets. Zeschky et al. (2014) develop a topology for frugal innovation and suggest that any frugal innovation developed in and for developing markets that makes its way back to developed markets is a reverse innovation. Govindarajan and Rammamurti (2011) argue that there are a large number of companies from developing countries that enter industrialized markets with products developed in their country of origins. Brem and Wolfram (2014) define reverse innovation as

the development of new products and services in and for emerging markets that are then equally introduced to industrialized markets if demand is identified. Von Zedtwitz et al. (2015) argue that most definitions of reverse innovation are market-based and incomplete because they exclude loci of idea generation and development. Thus, a clear framework and topology of reverse innovation is missing in the literature. They propose a comprehensive global innovation model that extends the market-based model by adding two dimensions: development and ideation-based reverse innovation (see also table 2). As there are different classifications for defining frugal and reverse innovation, we work with the following definition: in our sample, frugal innovation describes a process that reduces the complexity and cost of goods or services – either during production or the utilization phase or both. In accordance with Zeschky et al. (2014), reverse innovation is when a successful frugal product or service opens up a new market segment in industrialized countries and therefore follows a reverse innovation path from developing to developed markets.

2.3 Sustainability challenges

In their in-depth investigation of frugal innovation and related terminologies, Brem and Wolfram (2014) find most conceptualizations do not inherently consider sustainability aspects, while some terminologies directly imply ecological or social sustainability impacts. First, the literature has mainly connected frugal innovation to the terms inclusive growth and inclusive innovation because of the principle of organizations engaging in social innovation activities in order to drive social and economic development in disfranchised communities (George et al. 2012). Subsequently, the concept of inclusive business models is helpful for successful commercialization of frugal products and services at the BOP (Halme et al. 2012). Porter and Kramer (2011) propose the concept of shared value in order to emphasize the need for new innovation approaches to be employed by organizations. Second, several authors argue that the underlying philosophy of frugal innovation, doing more with less, has ecological aspects as direct attributes (Brem and Wolfram, 2014).

Innovations in developing countries do not tend to involve technological breakthroughs, which drive innovation in developed countries (Zeschky et al., 2014; Soni and Krishnan, 2014; Brem and Wolfram, 2014). They rather involve novel and innovative combinations of existing knowledge and technologies in order to solve local problems (Govindarajan and Ramamurti, 2011). In developing markets, customer needs are unique and different from developed markets. Since products of the developed world have high cost bases, even when prices are reduced significantly they do not allow for competitive prices and reasonable profits in developing countries (Sehgal et al., 2010; Sehgal et al., 2011). Another way of seeing frugal innovation is through the lens of the paradox “doing more with less,” because by employing frugal innovation capabilities firms are able to produce more economic output and social impact while considerably reducing the cost of procurement, production and distribution. “Business model innovations for sustainability are defined as: innovations that create significant positive and/or significantly reduced negative impacts for the environment and/or society,

through changes in the way the organization and its value-network create, deliver value and capture value (i.e. create economic value) or change their value propositions” (Bocken et al., 2014 pp 44).

As the relationship between sustainability and frugal or reverse innovation is not inherent, several papers analyze how frugal and reverse innovations drive sustainable development (Brem and Ivens, 2013; Bhatti, 2012; Basu et al., 2013; Christensen et al., 2006). Bocken et al. (2014) apply a set of sustainable business model archetypes. The authors performed an extensive secondary data survey and found eight main archetypes for sustainable business models, including: maximize material and energy efficiency (A1), create value from waste (A2), substitute with renewable and natural processes (A3), deliver functionality rather than ownership (A4), adopt a stewardship role (A5), encourage sufficiency (A6), repurpose for society/environment (A7), and develop scale up solutions (A8).

Yet, there is no empirical investigation of frugal products and services and their potential for sustainability. Therefore, this paper aims to fill in this gap and examine multiple empirical cases of frugal and reverse innovation and investigate their sustainable innovation potentials. In our analysis we focus on economically successful business models or innovations launched in BOP markets, and the focus lies on the main factors of economic success and the potential ecological and social outcomes.

3 Methodology

Research Strategy

This study employs an exploratory multiple case study approach in order to investigate 59 cases of frugal and reverse products and services. The methodological foundations are rooted in the grounded theory approach, in which data is systematically gathered and analyzed in order to generate theory (Strauss and Corbin, 1998). The grounded theory approach is suitable for this study because it is an exploratory approach best suited for when no explicit testable hypotheses exist yet and the research is only in its infancy. As mentioned before, frugal and reverse innovation literature streams have not reached a maturity stage yet and thus, the most suitable approaches for investigation are of exploratory nature. In order to obtain the rich insights on business models and how they create sustainable innovation, a multiple-case embedded case study design was adopted (Yin 2013). The employment of a sample of 59 cases provides a good basis for analytical generalizations (Eisenhardt 1989). In order to show the effectiveness of the database, we used criteria of external validity for case study research design as recommended by Gibbert et al. (2008) and Eisenhardt (1989). As such, they suggest that in the case of theoretical sampling, efforts are focused on theoretically useful concepts and cases are selected ‘in order to fill theoretical categories and provide examples of polar types’ (Eisenhardt, 1989, pg. 537). The case study approach is suitable for research questions involving ‘why’ and ‘how’ that aim to identify key variables and the associated relationships, thus, the main focus of this study is: How can frugal innovation strengthen sustainable development, and how can business models in this context be systemized and described?

Data collection, analysis and interpretation were done from June 2014 until June 2015. In the first step, we identified academic articles on frugal and reverse innovation by using the search keywords as presented in table 1 in common scientific databases. All found papers were scanned for analysis of frugal innovations. A good overview of products and services is provided by Pitta et al. (2008), Rao (2013) and Zeschky et al. (2014). A product or service was introduced in our database if it was mentioned in at least two frugal and reverse innovation academic articles, making sure that the sample contains only very popular and studied frugal and reverse innovation. Making sure that a selected frugal innovation or service was identified independently twice, so we did not need to make clear anymore that these innovations and services can be really classified as frugal. Thus, a large database of products and services often mentioned in the frugal and reverse innovation literature was created. For each case, different sources of information have been employed in order to ensure data triangulation (Yin, 2013). The data was mainly collected through publicly available documents because documents can be understood and analyzed in the same way as interviews - namely as text (Silverman, 2001). Main academic search engines (such as Google Scholar, EBSCO, Sage and Science Direct) were used to retrieve academic literature based on frugal and reverse innovation case studies. The keywords for the search were derived from an extensive literature review on frugal and reverse innovation (see table 2 for an overview). The Google search engine proved to be very helpful in identifying reports of NGOs and development organizations as well as consulting companies. During the data collection phase, a database with a protocol was created with the main information, the corresponding sources, coding schemes and data analysis in order to comply with external validity and reliability aspects (Gibbert et al. 2008). Sources of data collection include:

1. Academic literature in the form of scientific case studies or teaching cases on frugal, reverse and resource constrained products and services in journals and books (e.g. Prahalad, 2005; Ray and Ray, 2011; Zeschky et al. 2011; Govindarajan and Ramamurti 2011; Agarwal and Brem, 2012; Bhatti et al. 2013; Rao, 2013; Tiwari et al. 2014)
2. Magazines, newsletters, interviews with executives, university reports, company websites, product manuals, videos (e.g. Nature, The Economist, Huffington Post, Forbes, Health International, Harvard Business Review, Harvard Business School Cases, Mitticool.in, gehealthcare.in, bamboobike.org, Siemens.com, airtel.in, araving.org, ace.tatamotors.com, IMD on Lessons from Saurer in 2009, MIT on Affordable Speech Synthesizers, KPMG reports, Roland Berger Strategy Consultants Reports)
3. Reports of foundations, development organizations and NGOs (e.g. GIZ, USAID, Nesta UK, World Bank, World Health Organization, DFID, Serco Institute)
4. Interviews or emails – in order to amend missing information. Several interviews with experts from NGOs, startups in developing countries as well as company representatives from multinational companies (MNC) were conducted by the authors. Some interviews were conducted on the phone, while in some cases information was asked via email from the company representatives. The interview questions followed the same themes as the data collection procedure. Especially challenging was finding reliable data regarding the dimensions of value chain and profitability.

In a second step, we analyzed all cases according to the business model items (as shown in table 1) and selected those products and services that have already been introduced to the market and thus entail a functioning business model for certain time.

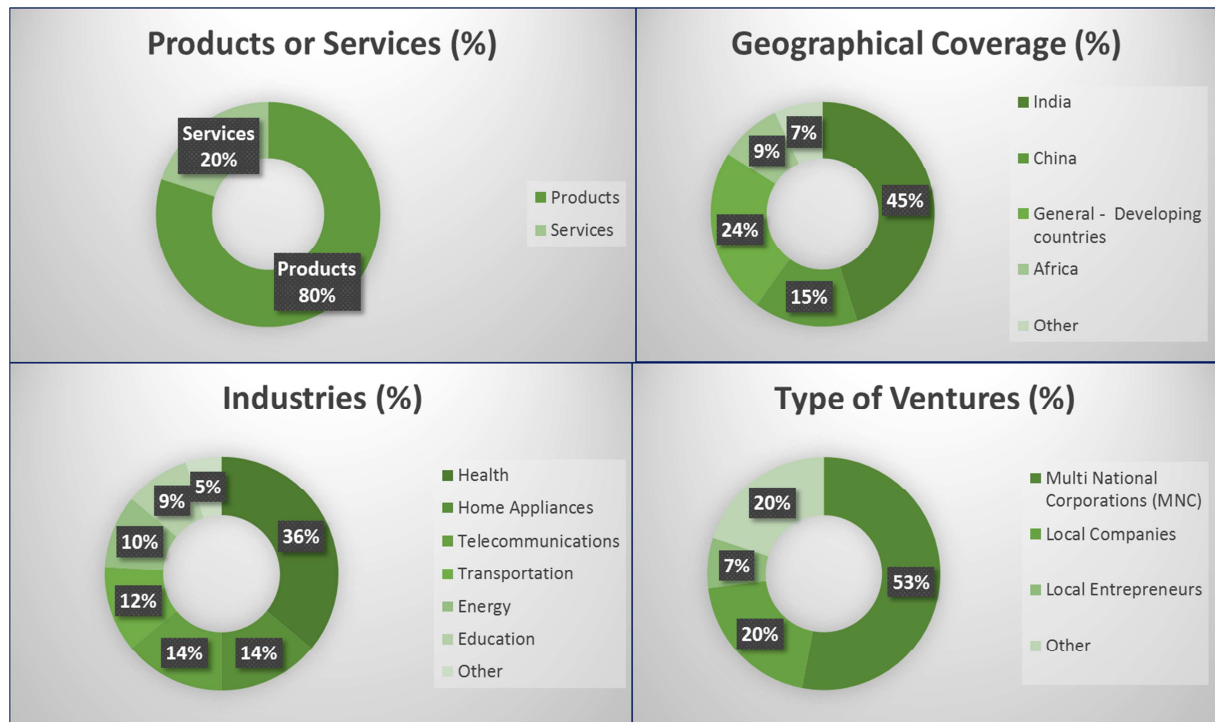


Figure 1: Overview of cases selected for the analysis

The data collection and analysis processes are rather iterative for case study approaches (Eisenhardt, 1989). Although difficult to codify, the data analysis used a list of codes derived from the sample literature (see table 1). The research and the results were structured using the business model and sustainability frameworks presented in this paper's literature review and the current challenges the investigated ventures face at the moment. Business models were analyzed on the basis of *target customer*, *value proposition* (environmental, social in addition to economic value), *revenue model* (appropriate distribution of economic costs and benefits), and *value chain* (inclusion of BOP markets in the value chain as suppliers, distributors, service providers and producers).

The final database consists of 59 cases, all of them products and services found in the frugal and reverse innovation academic literature. All have already been launched on the market and achieved market success to a certain extent in terms of sales, profitability and development objectives. The sample entails a cross-industry and cross-country design in order to allow for heterogeneity and to evaluate best practices across different contextual factors (Yin, 2013). Frugal innovations examples range from product innovations (e.g. cars and medical equipment) to service innovations (e.g. transport services and surgeries) and from different geographical areas (e.g. Asia and Africa) and industries (e.g. food, transport, education). Figure 1 gives an overview of the ratio of services and products, geographical coverage, industries, and types of ventures analyzed in this research. Although not representative, the industry types found in the database confirm the findings of Pitta et al. (2008), who found that most frugal products and services comprise essential sectors such as healthcare,

energy, food, housing, transport and water and information and communication technologies. As such, they classify frugal innovations in four categories of needs according to which we classify our database: 1) basic needs for survival (16 cases), 2) essential services for safety and security (30 cases), 3) connectivity needs for social interaction (6 cases) and 4) finer things in life for self-esteem and self-actualization (7 cases). As such, our 59 cases are distributed across the four categories and provide opportunity for cross-comparison.

Used classifications

To analyze business models in regards to sustainability, several classifications were used besides the type of innovation (product versus process) and the direction of innovation was distinguished between:

- from developing countries to developing countries – 27 cases including 18 products and nine services (two of which are often cited as reverse innovations),
- from industrialized countries to developing countries – 27 cases including 24 products and one service (eight of which are often cited as reverse innovations),
- from developing countries to industrialized countries (reverse) – three cases all products developed by multi-national and local companies located in developing countries that made their way to market success in industrialized countries and
- from industrialized countries to worldwide customers – two products successfully developed and marketed by Siemens and Ikea.

All products and services in the database are classified accordingly in (Figure 2).

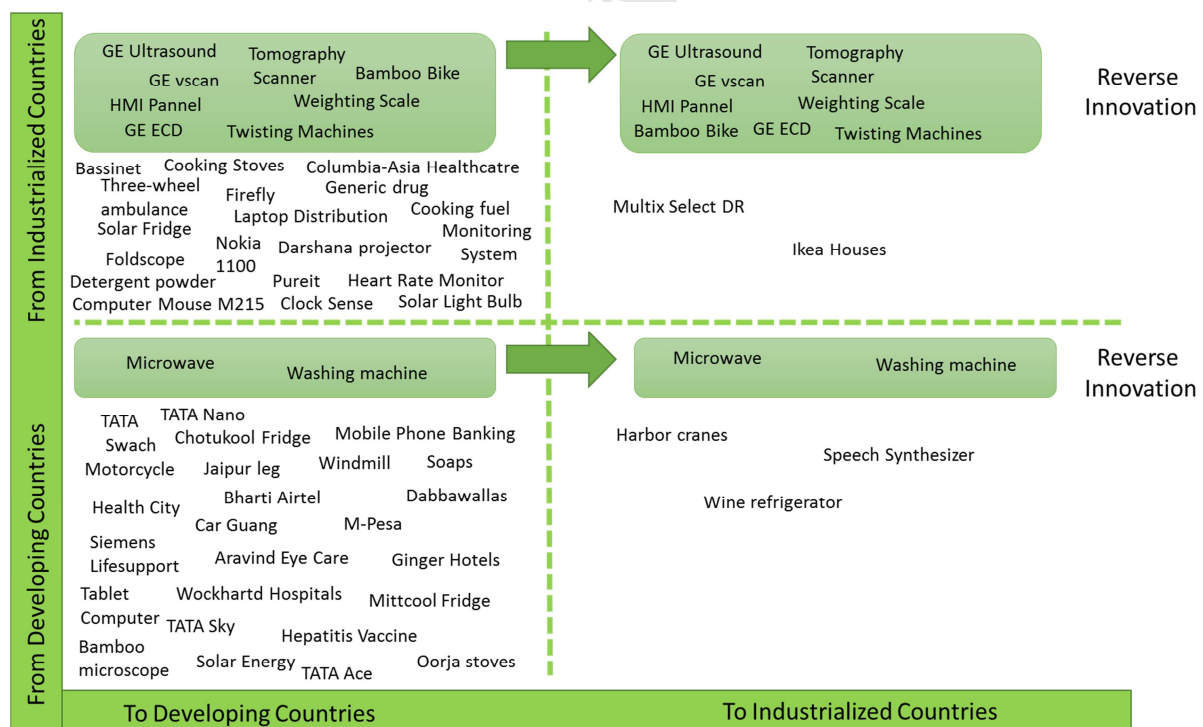


Figure 2: Classification of cases according to the direction of innovation

Firstly, all products and services developed in or for developing countries that achieved market success there and found their way back to achieve market success in industrialized countries were

classified as reverse innovations. For instance, Vscan, a portable ultrasound system developed by General Electric mainly for the Indian market and today sold in both developing and industrialized countries. Second, sustainability was analyzed on the basis of sustainable innovation and therefore with regard to its economic, social and environmental impacts. Third, as part of the data analysis, the sustainable business model archetypes proposed by Bocken et al. (2014) were applied. The analysis of the cases according to the business models, sustainability impact and the sustainable business models archetypes was done independently by each of the three authors in order to ensure results reliability and triangulation. Analyzing the inter-observer consistency or inter-rater reliability, the respective coefficients were calculated using SPSS. Cohen's kappa was used for the archetypes, whereas sustainability was measured by Cronbach's alpha. Moreover, contingency analysis was conducted in order to find relations between the single categories.

Limitations

The study focuses on collecting data of 59 frugal and reverse innovations mainly through secondary sources and then analyzing the data through the lens of theoretical frameworks derived from literature. Thus, other important cases might have been missed. The investigated business models target different income levels of BOP customers. Possibly more specific insights could be gained from having a consistent target group. Although well described in literature, several cases were lacking data concerning our classification. Although triangulation was used for data collection, there were still difficulties in obtaining data that satisfied all classification items. Thus, our classification and evaluation are based on the available data. Our sample only shows a current momentum, since there is always the problem of studying sustainable innovation in a single period due to sustainability's long term orientation. In order to have more solid results, the analysis should be amended by more cases and case evaluators, especially to generate resilient statistical data, and performed as a longitudinal study in the future to ensure sustainable progress.

4 Findings

4.1 Business models patterns

The structured analysis based on the approach presented by Bocken et al. (2014) reveals several interesting insights into the relevant elements and cause-and-effect relationships in the field of sustainable innovation. As most products and services from the sample refer to basic needs of the BOP markets, the value proposition inherent to most cases is related to higher standards of living. First, the standard of living is increased through the provision of basic services at lower costs, and second, the savings BOP consumers can retain and use for other activities. An important finding is that most of the developed products are based on given social problems, and the product or service ideas aimed to provide solutions to those problems. For example the non-electric fridge Mitticool addresses the need for constant food cooling without electricity because of repeated power shortages in India. In regard to the value capture mechanisms, all analyzed business models were characterized by comparably low business margins. Some ventures clearly specify that they are financially successful because of the

large number of transactions and customers, such as M-Pesa and Bharti. The low margins also foster low cost structures for the underlying supply chain and distribution systems and well as require a large volume of operations in order to be economically viable.

The value chain activities include local materials, local suppliers, local production as well as local distribution systems. Local distribution was organized through local shops, local shopkeepers, local entrepreneurs, local NGOs and specifically the involvement of women. This aspect needs to be highlighted since traditionally women do not comprise the majority of entrepreneurs, company founders or the workforce in both developing and industrialized countries. Local distribution is reflected by mostly very basic revenue models for the sales of products and services. For other businesses the reduction of materials and resources was one guiding design criterion for the offered products and services. However, whereas the upstream supply chain is typically characterized by low cost-orientation, rather high costs emerge for education and training of employees as well as for customers. In the case of Aravind, employees need specific trainings to perform eye surgeries (Prahalad, 2005), while in the case of the water purifier Swach, offered by TATA Chemicals, large investment was needed for education and marketing materials

Marketing aspects also became visible during the analysis; obviously, changing the name and adapting it to local languages has an important impact on the attractiveness and appeal of products and services to local customers. For instance, the banking service M-PESA was adapted for the Swahili language: the M stands for the commonly used word mobile, whereas “pesa” is Swahili for less money. The same principle could be observed for water purifier Swach, where TATA does not need to provide any further explanation since the term “swach” means clean in Hindi.

Moreover, we identified that it is necessary to understand the roles of MNCs as well as NGOs for the understanding of business models in the context of frugal innovation and sustainability. In this sample, many frugal products and services are developed by the subsidiaries of MNCs in developing countries (e.g. GE, Philips and Unilever). In addition, several innovations have been developed by local companies and then taken over by MNC, as is seen in the case of Safaricom, which was bought by Vodafone. We identified several cases in which NGOs were involved. NGOs are integrated at different levels of the value chain, such as in R&D funding, awareness and marketing as well as distribution, as in the examples of Pureit.

Cooperation through alliances and partnerships appears to be the solution for dealing with low profit margins and institutional barriers in developing countries. In several cases, prices were still too high for all people at the very bottom of the pyramid. Cooperation has been established with NGOs, local institutions or governments in order to provide microcredit or insurance services. For instance, Toyola cooking stoves (Ghana) cooperates with microcredit institutions, or Narayana Hospitals (India) cooperates with the Indian government to create a special insurance plan for the poor people. Overall, the business models of frugal innovations contain predominantly similar value propositions, local value chain activities, cooperation through partnerships and alliances with non-conventional players and local development R&D capabilities.

4.2 Business model patterns and sustainable development

As the main research question of the study was how frugal and reverse innovation enable sustainable development, the analysis aimed to understand how the business models architectures create sustainable outcomes. The sustainability framework analysis along with the inter-observer consistency coefficient revealed that sustainability is not inherent to frugal and reverse products and services. Based on our sample, on average, every fifth product or service is not related to sustainability or is not based on a sustainable business model or archetype, e.g. Galanz microwave, ZPMC harbor cranes or twisting machines. Table 3 provide an overview of the main findings by specifying the sustainability impact for each sustainability type, and table 4 highlights the respective sustainable business model archetypes and the direction of innovation (4). Beside economic value, the majority of the cases create either social value, ecological value or both. For instance, several business models for medical devices show economic and social impact since these products create substantial income for the companies and also improve health at the BOP by providing new or low cost services, such as the Tomography Scanner, the Patient Monitoring System or the Ultrasound Machine. In accordance with table 5, one dimension of sustainability or double bottom line are found primarily in the directions industrialized to industrialized and developing to industrialized.

Sustainability dimension	Average cases (number/percentage)	Sustainability impact
Economic	12/ 20	Lower production cost per unit, higher productivity, employment, increased agricultural output
Ecological	9/ 15	Reduced use of materials, production resources, energy, water, emissions; substitution with local materials and processes; waste as a resource.
Social	0/ 0	Free up women and child labor, health care services for people in remote villages, education materials for remote schools and universities
Economic and social	17/ 29	Women employment opportunities, access to information and knowledge networks, education and training, access to new or low cost health services
Economic and ecological	2/ 3	Lower production costs per unit, less use of materials and resources, less emissions
Social and ecological	5/ 9	Use of locally produced, clean energy at affordable prices enables increased agricultural output
Economic, social and ecological	14/ 24	Collaborative and inclusive value chains; creation of markets for agricultural waste; increased workforce productivity through education, training and knowledge; provision of basic services to increase standard of living.

Table 3: Overview of findings in terms of sustainability impact

Reverse innovation can only be identified in two of eight archetypes cases (A1, A5). A deeper analysis of the specific business models shows that for reverse innovation the economic impact seems to be critical as in the cases of the Wine Refrigerator and TATA Sky. These products have been developed in developing countries, however a deeper look shows that their target customer is rather middle class than the BOP customers. Thus, these products and services are also promising for lower-income customer segments in industrialized countries. Additionally, health-related products and services are brought from developed to industrialized countries, such as the VScan and the Tomography Scanner. These reverse innovations are often optimized in terms of size, weight and robustness. Hence, they open up new market segments in industrialized markets. Also in industrialized countries, these medical devices are not affordable for every medical practice. Thus, two aspects are central for

making medical devices advantageous for reverse innovation: 1), the mobility of devices that opens up new application fields such as home visits and 2) the affordability for smaller institutions as well.

Environmental Aspects

From the environmental perspective, the analysis shows that in several cases there is a reduction of used material and production resources needed for the product (including packaging) or service and thus, reduced emissions. This also includes the reduced consumption of energy and water. One specific approach to reduce resource consumption is to make use of waste and renewable materials for value creation. For instance, TATA Swach utilizes rice husk, the Bamboo microscope and bike are made of fast growing bamboo and the Solar Bulb is made of waste plastic bottles. This concept is closely related to the idea of focusing on the use of local resources. For example, Mitticool fridge and Solar Bulb replace materials and processes with local and natural processes. A few examples follow the concept of encouraging functionality rather than ownership as well. In the case of Oorja stoves people can borrow, and therefore share, a product instead of buying it.

Sustainability business model archetype	Average cases (number/percentage)	Direction of innovation	Some examples
A1 Maximize material and energy efficiency	4/7	Developing to Developing, Industrialized to Developing, Industrialized to Industrialized, Developing to Industrialized (reverse)	Car (TATA Nano), Washing Machine, Microwave, TATA Ace, Computer Mouse M215, vscan, Ikea Houses
A2 Create value from waste	2/4	Industrialized to Developing	Darshana - Lunch Box Projector, Cooking Fuel, Solar light bulb, Bamboo Bike
A3 Substitute with renewable and natural processes	6/11	Developing to Developing, Industrialized to Developing	Bamboo Windmill, Solar Chill Fridge, Bamboo Bike, Oorja stoves
A4 Deliver functionality rather than ownership	1/2	Developing to Developing	M-Pesa
A5 Adopt a stewardship model	16/27	Developing to Developing, Industrialized to Developing, Industrialized to Industrialized, Developing to Industrialized (reverse)	Monitoring and Lifesupport - Diagnosis and Imaging, Pureit, Tomography Scanner, Water Purifier Swach
A6 Encourage sufficiency	4/7	Developing to Developing	Tablet Computer (Aakash), Chotu Kool Refrigerator, Bharti Airtel
A7 Repurpose for society/environment	11/18	Developing to Developing, Industrialized to Developing	Aravid Eye Care, Bamboo Microscope, Foldscope
A8 develop scale up solutions	2/3	Developing to Developing, Industrialized to Developing	Solar Light Bulb, DabbaWalas of Mumbai

Table 4: Overview of findings concerning sustainable business models archetypes

Social Aspects

Social aspects range from work creation, or involving local people to make essential products and services available to people at the BOP, to education and general improvement of living standards. Products and services that cost less money become not only accessible to poor people (such as soap or detergent powder), but they can also spend leftover money on education, food and other goods or services. Similar considerations can be made for hospitals buying cheaper medical devices (such as VScan and the Tomography Scanner). In this respect, one central aspect is that poor people get access to health care by cheaper services or by new medical devices that are often portable and simplified in hospitals and for flying doctors. Some of the analyzed business models involve women as central actors. The employment of women improves social status and empowers women in general. However, the creation of jobs through local development, production and distribution is important for the general

life status and may serve as a trigger for the establishment of entrepreneurial business ideas in future. One interesting example in this context is the TATA Nano: TATA employs entrepreneurs in remote locations and teaches them to assemble and sell cars (Ray and Ray, 2011). TATA ensures word-of-mouth marketing and reaches remote locations while creating jobs. This effect is even fostered by involving the entrepreneurs into the collaborative design of products.

Information access is also critical for educational aspects: for example the Foldscope microscope and the touchscreen tablet computer, Aakash, provide educational materials for schools and universities that developing countries otherwise would not have access to. Along with essential products and services, people also get access to information and communication technology with the help of products like M-Pesa for banking transactions and Tata Sky for international TV. M-Pesa, for example, allows people to fulfil the prerequisites for a credit and therefore for establishing own business. Successful frugal products and services do a lot more than just selling products to BOP markets: they create social impact by raising awareness and education through complementary activities, e.g. M-PESA with renewables energy and Aravind with Eye Care Camps in remote villages.

Economic Aspects

Along with the aspects of business models elaborated upon in the previous sections, economic aspects of sustainability have been analyzed. Analyzed business models have significant impacts on employment and the economy. For example, new markets for agricultural waste were created, where farmers can make extra money by selling it (for example Oorja stoves). In general, the businesses create employment opportunities for local people. Similar to education, training and access to knowledge this has a spillover effect on the economy - people are more productive and better prepared to work. The integration of local entrepreneurs and women into the value chain such as in the cases of TATA Nano and Chotukool can free women and children from hard labor in agriculture. Especially interesting is how Aravind and Narayana take high school women from remote villages and train them to perform basic tasks in the hospital and employ them (Pralhad, 2005). Many of the cases analyzed focus on remote locations, where this effect has an even higher impact. The positive effect on general health, which was elaborated upon in the previous section on social impact will reduce mortality and fetal death rate. From an economic sustainability perspective, this will impact productivity and the cost of the health system positively in the long run.

Statistical analysis

The Cohen's kappa is 0.898. According to Bryman (2008), a coefficient above 0.75 is considered very good. Cronbach's alpha is 0.909, and this indicates a high inter-observer consistency. Moreover, using contingency analysis, the following relations were identified, see table 5.

Category pairs	Phi	Cramer's V	Contingency Coefficient	Approx. Significance	Pearson Chi-Square (Value/df/Asymp. Sig. (2-sided))
<i>Sustainability - Archetype</i>	1.398	.625	.813	.000	115.333/40/.000
Sustainability – Type of innovation	.383	.383	.358	.123	8.667/5/.123
<i>Sustainability – Direction of innovation</i>	.824	.476	.636	.000	40.076/15/.000
Archetypes – Type of innovation	.364	.364	.342	.453	7.806/8/.453
Archetypes – Direction of innovation	.553	.320	.484	.800	18.070/24/.800
<i>Direction of innovation –</i>	.497	.497	.445	.002	14587/3/.002

Only in the case of the direction ‘developing to developing,’ products and services are almost equally represented. Products are dominant in all the three other directions of innovation in our sample.

5 Discussion

All in all, the four chosen dimensions of business models seem to be appropriate in order to understand similarities and differences between the business models of the 59 cases.

Business model reflections and theoretical implications

The analysis sheds light on the opportunities and challenges of the frugal and reverse innovation-related business model. From an economic perspective, frugal product development efforts are only justified by the large volumes of customers available in developing markets, as the cost structures are very low and must be kept low in order to account for the affordability constraints in developing countries (London and Hart, 2011). Mostly, there is a high volume needed for financial success, and not all companies managed to achieve this high volume; the challenge of scalability remains similar to the findings of other scholars (London and Hart, 2011). However, some revenue models, such as the model of Aravind (a business offering eye surgeries to customers in India), can serve as promising role models for other ventures by having customer group-dependent prices. The described model found in several cases from our sample corresponds to what the literature calls ‘a whole pyramid orientation’ (Jenkins et al. 2010). By exploiting different solvency levels of customers, the companies are able to cross-subsidize the offered services and therefore offer nearly zero-priced services for BOP customers. Moreover, there is room for more innovation especially in terms of revenue models, e.g. some companies manage to serve the BOP by also providing services and products to middle class consumers. In this manner, they reduce the risk and uncertainty and they compensate for the low margins of the BOP (Jenkins et al. 2010). Collaborations and partnerships are other keys for maintaining market success (Gold et al., 2013). This is similar to what Jenkins et al. (2010) found in their 14 case study sample of frugal business models. Furthermore, other scholars acknowledge the importance of partnerships and alliances with non-conventional partners such as NGOs (Dahan et al. 2010). Developing partnerships and collaborations with NGOs and other local institutions in developing markets enables the creation of new business models and inclusive value chains, therefore developing local competencies (Gold et al., 2013; Perez-Aleman and Sandilands, 2008).

According to Porter’s (1985) generic strategies, the majority of business models focus on low costs. In the cases of reverse innovation, costs are the main driver as well, but from an industrialized market perspective the products show more characteristics of a differentiation strategy. It might be no matter of chance that these companies, offering reverse products and being multinationals, have a reasonable amount of data for entering the target markets. From a theoretical-methodological perspective, this study confirms the usefulness of employing the business model perspective for the study of sustainable development and innovation as suggested by Boons et al. (2013). The architecture of the business

model elements in the cases of frugal products and services reveals how sustainable outcomes are created through innovative value creation and capture mechanisms.

In this sense, our research confirms the findings Brem and Wolfram (2014), stressing that frugal innovation integrates the specific needs of BOP markets. However, our sample does not fully confirm their second conclusion that innovations work backwards to develop solutions. We found that frugal innovations have a high variety in terms of products, services and business models since they can reintegrate value chains, reengineer products and services to account for affordability constraints and local socio-cultural differences, reconfigure resources and reinvent business models. Especially, reverse innovations are close to western standards and meet customer values that are not addressed by western companies. Thus, frugal innovation is more related to processes reducing complexity, the cost and the production or allocation of goods or services. In addition, frugal and reverse innovations are more a matter of definition or classification than related to specific items. Frugal and reverse innovations do not have an inherent sustainability impact. So, reverse innovations do not necessarily target poor people in industrialized countries, but can also target the middle class with luxury goods (wine refrigerator) or young people trying to be stylish (bamboo bike).

Sustainability implications

The findings suggest that a sustainability impact differs for different directions of innovation in different dimensions. First, frugal innovation has a significant social impact by offering basic services in the food, health, information and communication technology, water and transportation sectors for large markets in developing countries. By offering these services at very low prices and good-enough quality, the health and well-being of the BOP population segment is improved. Second, frugal innovation drives poverty reduction by opening new markets, entrepreneurial opportunities and access to global knowledge. Entrepreneurs and MNCs offering frugal and reverse products and services manage to combine the business model elements in an insightful manner that can create economic, social and environmental value. Third, the ecological impact which refers to the use of less material for both production and maintenance and the support of local materials use is rather a spill-over effect. Fourth, the sustainability effect of reverse innovation in developed countries relates mostly to the ecological impact. It includes examples of offering better products and services with less use of resources and less unnecessary features. Most of the sustainability innovations have a clear social impact like community involvement and development or human rights in the sense of ISO 26000 (close to A5 and A7). The economic and ecological impact is not always given clearly. Ecological impact is mostly focused on single aspects of sustainability as restricting the uses of hazardous substances or the use of renewables.

According to Zeschky et al. (2014), Soni and Krishnan (2014) as well as Brem and Wolfram (2014) innovations in developing countries tend not to involve technological breakthrough which drive innovation in developed countries. However, frugal innovations highlight the social dimension of sustainability and have a high impact on society, especially in health or education. Several cases offer new service combinations and unique value chains that are indeed novel combinations of knowledge

and technologies (Godvindarajan and Ramamurti, 2011) and provide crucial solutions for developed industries. To this effect, industrialized industries should analyze frugal innovation and their business models more deeply for solving their own problems.

From a sustainability perspective, it is important to highlight the importance of local manufacturing (Gold et al., 2013). Local suppliers, local development and R&D, local production, local employees and local distribution channels, as have been found in our sample, correspond to what London (2011) calls ‘social embeddedness,’ which is needed in order to be successful at the BOP. Local R&D decreases with the growing size of businesses; however, local production contributes as a success factor in developing countries. In ecological terms, many innovations and business models provide recycling instead of sourcing. Many companies use recycled materials as raw materials to reduce procurement costs and increase acceptance at the same time. Some companies are very engaged and provide numerous social impacts for the BOP. These are also the companies who are most successful in the BOP market, like M-Pesa, Bharti, Aravind and Narayana. These companies even help to establish infrastructure in developing countries through their projects, e.g. Bharti telecommunication, Narayana - Health insurance. In that sense they are also connected with the sustainable development goals aimed at increasing the standard of living of the poor in terms of health, food, etc. Especially, the sustainable business models fulfill these goals by proving self-sustained financial solutions and locally maintained and stress the importance of sustainable business models for BOP market. However, by offering affordable products – in the sense of frugal and reverse innovation – more people will be able and buy them, and this increased consumption may result in even more environmental damage in the long run. As the archetypes A4 and A6 are not very often in the sample, the development of frugal and reverse innovation should be redirected towards more sufficiency, too.

Interesting enough, the archetypes A1 and A5 are the only ones in which both reverse innovation occurs and frugal innovations within industrialized countries take place at the same time. It seems that some archetypes are more likely in industrialized countries than others. Therefore, further investigation is necessary.

Set of suppositions

Based on our findings and the discussion above we provide some presumptions for further research. These preliminary presumptions are the results of this exploratory research and are subject to the limitations of the methodological approach employed. Thus, the set of presumptions needs to be further evaluated and validated in empirical studies employing mainly primary and longitudinal data. Our main presumption is that frugal innovation and sustainable business models have to be handled and systemized separately. However, there are some supporting conditions for the emergence of sustainable frugal innovation:

- The more collaborative and inclusive value chains are the higher the probability of a sustainable business model is.
- The better education, training and knowledge are the higher the probability of a sustainable business model is.

- The provision of basic services that increase the standard of living is more a moderating variable.
- The sustainability of a business model at the BOP in developing countries is highly dependent on the local competences, resources and capabilities used.
- The more frugal innovations become reverse innovations the higher the probability of sustainability impact is.
- Generic strategies depend on the direction of the respective frugal innovation.
- The involvement of local NGOs enhances the success of a business model.
- Reverse innovations that are launched by MNCs are more successful than other types of companies operating in developing industries.
- There are only some windows of opportunity concerning the archetype success of reverse innovation in industrialized countries; some archetypes are more likely than others.

6 Conclusion and Implications

The analyzed business models show that limiting products and services to basic functionalities and items allows the provision of better value for lower cost and lower prices. Thus, a higher number of BOP customers can be achieved. High distribution costs have to be considered by MNCs looking to reach remote areas, because they will increase the total costs and subsequent consumer prices. Moreover, marketing and awareness are aggravated due to the so far missing information accessibility. For example Siemens faced difficulties in the adoption of new technologies by BOP customers, because the customers stick to traditional approaches, even in the health care environment. Small margins require large scale operations. For instance, M-Pesa and Bharti are only successful because they have achieved a large scale level. However, these high quantities are difficult to achieve. In some cases, the short lifecycle of technologies such as mobile phones makes this even more difficult. In many countries missing legal frameworks and regulations put companies at risk of knowledge and intellectual property loss. In particular, knowledge-intensive businesses, such as M-Pesa, have to come up with individual solutions to protect data exchange and their intellectual property. The combination of global solutions with local ones in order to reach high scales while respecting local values and norms is one of the success factors for reaching high volumes in remote areas (Gold et al., 2013). In total, concerning business models of frugal and reverse innovation we can highlight the following findings:

- Target customers vary from BOP to middle-class consumers.
- The value proposition focuses mainly on satisfying basic needs, thus offering basic functionalities.
- The main revenue model is based on low costs and relatively low business margins.
- The value chain is characterized by cooperation, partnerships and NGO involvement, which appears to foster business model success.

- The sustainable business models successfully operated at the BOP build upon local resources and capabilities. Thus the development of local competencies is a success factor.

Highlighting the question ‘How can frugal innovation strengthen sustainable development?’ several findings can be stressed:

- Frugal and reverse innovations do not have an inherent sustainability impact. Only every fourth business model addresses all three areas of sustainability.
- Different sustainability archetypes relate with different directions of innovation.
- The occurrence of reverse innovation is very limited concerning the variety of sustainability business models.
- The importance or meaning of local manufacturing / local R&D decreases as the size of the business grows; however, local production turns out as a success factor in developing countries.
- Recycling is performed instead of sourcing. Many companies use recycling materials as raw materials for reducing procurement costs and increasing acceptance at the same time.

We strongly encourage the separation of frugal and reverse innovation from sustainability or sustainable business model discussions. There are good cases offering sustainable progress, but it is not inherent. As there are several concepts concerning frugal and reverse innovation, we recommend defining it regarding (1) the level of manufacturing compared to the steady state in the respective economic area, (2) where the main processes and part of innovation development is set (Govindarajan and Trimble, 2012), and (3) the direction of innovation, viz. where the main distribution is based.

Further research has to investigate whether there is more insight by comparing urban versus rural areas, which is also related to local versus decentralized production and procurement. In the light of business models, the focus should also be set on the target group more deeply and analyze differences between business models for poor and middle class consumers. Conducting an in-class study could also provide more insights as well as a deeper analysis concerning the classification of innovations in terms of mobility, health, food, living comfort, energy and communication.

References

- Agarwal, N., Brem, A., 2012. Frugal and reverse innovation: Literature overview and case study insights from a german MNC in India and China. *Engineering, Technology and Innovation (ICE)*, 2012 18th International ICE Conference on, 1-11.
- Anderson, J., Markides, C., 2012. Strategic innovation at the base of the pyramid. *Image*.
- Amitt, R., Zott, C., 2010. Business Model Design: An Activity System Perspective. *Long Range Plan.* 43(2), 216-226.
- Arnold, M., 2015. Fostering sustainability by linking co-creation and relationship management concepts. *J. of Clean. Production*. Available online 1 April 2015. doi:10.1016/j.jclepro.2015.03.059
- Arnold, M., Barth, V.: Open innovation in urban energy systems, *Energy Efficiency*. 5(3), 351–364, DOI 10.1007/s12053-011-9142-6.
- Arnold, M., Hockerts, K., 2011: The Greening Dutchman: Philips’ Process of Green Flagging to Drive Sustainable Innovations, *Bus. Strategy and the Environ.* 20(6), 394–59. Article first published online 2010: 21 OCT 2010, DOI: 10.1002/bse

- Bhatti, Y.A., 2012. What is Frugal, What is Innovation? Towards a Theory of Frugal Innovation (February 1, 2012). Available at SSRN: <http://ssrn.com/abstract=2005910> or <http://dx.doi.org/10.2139/ssrn.2005910>.
- Bhatti, Y. A., Khilji, S. E., Basu, R., 2013. Frugal innovation. Globalization, Change and Learning in South Asia. Oxford, UK: Chandos Publishing.
- Basu, R. R., Banerjee, P. M., Sweeny, E. G., 2013. Frugal innovation: Core competencies to address global sustainability. *J. of Manag. for Glob. Sustainability*. 1(2), 63-82.
- Björkdahl, J., Holmén, M., 2013. Editorial: Business model innovation—the challenges ahead. *International J. of Product Development*, 18(3/4), 213-225.
- Bocken, N. M. P., Short, S. W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. *J. of Clean. Production*. 65, 42-56.
- Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. *J. of Clean. Production*. 45, 9-19.
- Boons, F., Montalvo, C., Quist, J., Wagner, M., 2013. Sustainable innovation, business models and economic performance: an overview. *J. of Clean. Production*. 45, 1-8.
- Bratt, C., Hallstedt, S., Robèrt, K.H., Broman, G., Oldmark, J., 2013. Assessment of criteria development for public procurement from a strategic sustainability perspective. *J. of Clean. Production*. 52, 309-316.
- Brem, A., Ivens, B. S., 2013. Do frugal and reverse innovation foster sustainability? Introduction of a conceptual framework. *J. of Technology Manag. for Grow. Economies*. 4.
- Brem, A., Wolfram, P., 2014. Research and development from the bottom up-introduction of terminologies for new product development in emerging markets. *J. of Innovation and Entrepreneurship*. 3(1), 9.
- Brown, J. S., Hegel, J., 2005. Innovation blowback: Disruptive management practices from Asia. *The McKinsey Quarterly*. 35-45.
- Bryman, A., 2008. *Social Research Methods*. Oxford University Press, Oxford.
- Casadesus-Masanell, R., Ricart, J. E., 2010. From strategy to business models and to tactics. *Long Range Plan*. 43, 195-215.
- Chesbrough, H., 2007. Business model innovation: it's not just about technology anymore. *Strategy & Leadersh*. 35(6), 12-17.
- Chesbrough, H., Rosenbloom, R.S., 2002. The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*. 11(3), 529-555.
- Christensen, C. M., 1997. *The Innovator's Dilemma: The Revolutionary Book that Will Change the Way You Do Business* (Collins Business Essentials).
- Christensen, C. M., Bower, J. L., 1996. Customer power, strategic investment, and the failure of leading firms. *Strategic Manag. J.* 17(3), 197-218.
- Christensen, C. M., Raynor, M. E., 2003. Why hard-nosed executives should care about management theory. *Harv. Bus. Rev.* 81(9), 66-75.
- Christensen, C. M., Baumann, H., Ruggles, R., Sadtler, T. M., 2006. Disruptive innovation for social change. *Harv. Bus. Rev.* 84(12), 94.
- Cunha, M. P., Rego, A., Clegg, S., Neves, P., Oliveira, P., 2014. 2 unpacking the concept of organizational ingenuity: Learning from scarcity. *Handbook of Organizational and Entrepreneurial Ingenuity*, 34.
- Dahan, N. M., Doh, J. P., Oetzel, J., Yaziji, M., 2010. Corporate-NGO collaboration: co-creating new business models for developing markets. *Long Range Plan*. 43(2), 326-342
- Eisenhardt, K. M., 1989. Building theories from case study research. *Academy of Manag. Rev.* 14(4), 532-550.
- Frankenberger, K., Weiblen, T., Csik, M., Gassmann, O., 2013. The 4I-framework of business model innovation: A structured view on process phases and challenges. *International J. of Product Development*. 18(3), 249-273.
- Gassmann, O., Frankenberger, K., Csik, M., 2014. *The Business Model Navigator – 55 Models that will revolutionise your business*. Pearson, Harlow.
- George, G., McGahan, A. M., Prabhu, J., 2012. Innovation for inclusive growth: towards a theoretical framework and a research agenda. *J. of Manag. Stud.* 49(4), 661-683.
- Gibbert, M., Ruigrok, W., Wicki, B., 2008. What passes as a rigorous case study? *Strategic Manag. J.* 29(13), 1465-1474.

- Gold, S., Hahn, R., Seuring, S., 2013. Sustainable supply chain management in “Base of the Pyramid” food projects—A path to triple bottom line approaches for multinationals?. *International Bus. Rev.* 22, 784–799
- Govindarajan, V., Ramamurti, R., 2011. Reverse innovation, emerging markets, and global strategy. *Glob. Strategy J.* 1(3-4), 191-205.
- Govindarajan, V., Trimble, C., 2012. Reverse innovation: A global growth strategy that could preempt disruption at home. *Strategy & Leadersh.* 40(5), 5-11.
- Hang, C., Chen, J., Subramian, A. M., 2010. Developing disruptive products for emerging economies: Lessons from Asian cases. *Res.-Technology Manag.* 53(4), 21-26.
- Halme, M., Lindeman, S., Linna, P., 2012. Innovation for inclusive business: Intrapreneurial bricolage in multinational corporations. *J. of Manag. Stud.* 49(4), 743-784.
- Hart, S. L., Christensen, C. M., 2002. The great leap. *Sloan Manag. Rev.* 44(1), 51-56.
- Immelt, J. R., Govindarajan, V., Trimble, C., 2009. How GE is disrupting itself. *Harv. Bus. Rev.* 87(10), 56-65.
- Jenkins, B., Ishikawa, E., Geaneotes, A., Paul, J., 2010. Scaling up inclusive business: advancing the knowledge agenda. Washington, DC: International Finance Corporation and the CSR Initiative at the Harvard Kennedy School.
- Lazonick, W., 2004. Indigenous innovation and economic development: Lessons from china's leap into the information age. *Industry and Innovation.* 11(4), 273-297.
- Lu, Q., 2000. China's leap into the information age: Innovation and organization in the computer industry Oxford University Press, Inc.
- London, T., 2011. Building Better Ventures with the Base of the Pyramid: A Roadmap. In T. London, T., Hart, S. L., 2011. Next generation business strategies for the base of the pyramid: new approaches for building mutual value. (T. London & S. L. Hart, Eds.) (1st ed.). Upper Saddle River, NJ: Pearson Education Inc.
- Luken, R.A., Freij, A.-C., 1995. Cleaner industrial production in developing countries: market opportunities for developed countries, *J. of Clean. Production.* 3(1-2), 71-78.
- Magretta, J., 2002. Why business models matter. *Har. Bus. Rev.* 80(5), 86-92.
- Moore, K. (2011). The emergent way: How to achieve meaningful growth in an era of flat growth. *Ivey Bus. J.* November/December
- Ny, H., Hallstedt, S., Robèrt, K.-H., Broman, G., 2008. Introducing Templates for Sustainable Product Development - A Case Study of Televisions at the Matsushita Electric Group. *J. of Industrial Ecology.* 12(4), 600–623.
- Osterwalder, A., 2004. The Business Model Ontology: A proposition in a design science approach. http://www.hec.unil.ch/aosterwa/PhD/Osterwalder_PhD_BM_Ontology.pdf
- Osterwalder, A., Pigneur, Y., 2009. Business Model Generation. In: A Handbook for Visionaries, Game Changers, and Challengers. Modderman Drukwerk, Amsterdam.
- Perez-Aleman, P., Sandilands, M., 2008. Building value at the top and bottom of the global supply chain: MNC-NGO partnerships and sustainability. *Calif. Manag. Rev.* 51(1), 24-49.
- Pitta, D., Subrahmanyam, S., & Tomas Gomez-Arias, J. (2008). Integrated approach to understanding consumer behavior at bottom of pyramid. *Journal of Consumer Marketing,* 25(7), 402-412.
- Prahalad, C. K., 2005. The fortune at the bottom of the pyramid, eradicating poverty through profits. Upper Saddle River, NJ: Wharton School Publishing.
- Prahalad, C. K., Mashelkar, R. A., 2010. Innovation's holy grail. *Harv. Bus. Rev.* 88(7-8), 132-141.
- Porter, Michael E., 1985. *Competitive Advantage.* Free Press.
- Porter, M. E., Kramer, M. R., 2011. Creating shared value. *Harv. Bus. Rev.* 89(1/2), 62-77.
- Radjou, N., Prabhu, J., Ahuja, S., 2012. Jugaad innovation: Think frugal, be flexible, generate breakthrough growth. John Wiley & Sons.
- Rao, B. C., 2013. How disruptive is frugal? *Technology in Society.* 35(1), 65-73.
- Ray, S., Ray, P. K. (2011). Product innovation for the people's car in an emerging economy. *Technovation.* 31(5), 216-227.
- Robèrt, K.-H., Schmidt-Bleek, B., Aloisi de Larderel, J., Basile, G., Jansen, J. L., Kuehr, R., Price Thomas, P., Suzuki, M., Hawken, P., Wackernagel, M., 2002. Strategic sustainable development - selection, design and synergies of applied tools. *J. of Clean. Production.* 10(3), 197-214.
- Roland Berger Strategy Consultants (2013), COO insights: Frugal innovation - Einfach, einfacher, am besten.

- Samuelson, P., Scotchmer, S., 2002. The law and economics of reverse engineering. *Yale Law J.* 1575-1663.
- SCU. (2015). Frugal innovation lab. Retrieved from <http://www.scu.edu/fyi/blog.cfm?c=16119>
- Sehgal, V., Dehoff, K., Panneer, G., 2010. The importance of frugal engineering. *Strategy Bus.* 59, 1-5.
- Sehgal, V., Dehoff, K., Panneer, G., 2011. Back to basics. *Market Leader Articles*, January 2011
- Silverman, D., 2001. *Interpreting qualitative data: Methods for analyzing talk, text and interaction.* London: Sage.
- Sharma, A., Iyer, G. R., 2012. Resource-constrained product development: Implications for green marketing and green supply chains. *Industrial Marketing Manag.* 41(4), 599-608.
- Soni, P., T. Krishnan, R., 2014. Frugal innovation: Aligning theory, practice, and public policy. *J. of Indian Bus. Res.* 6(1), 29-47.
- Strauss, A., Corbin, J. M., 1998. *Basics of qualitative research: techniques and procedures for developing grounded theory.* Thousand Oaks: Sage.
- The Economist., 2010. The world turned upside down. Retrieved from <http://www.economist.com/node/15879369>
- Tiwari, R., Kalogerakis, K., Herstatt, C., 2014. Frugal Innovation and Analogies: Some Propositions for Product Development in Emerging Economies, Working paper, TUHH.
- Trimble, C., 2012. Reverse innovation and the emerging-market growth imperative. *Ivey Bus. J.* 76(2), 19-21.
- Williamson, P. J., 2010. Cost innovation: Preparing for a 'value-for-money' revolution. *Long Range Plan.* 43(2), 343-353.
- Von Zedtwitz, M., Corsi, S., Sjøberg, P. V., Frega, R., 2015. A typology of reverse innovation. *J. of Product Innovation Manag.* 32(1), 12-28.
- Yin, R. K., 2013. *Case study research: Design and methods.* Sage publications.
- Zeschky, M. B., Winterhalter, S., Gassmann, O., 2014. From cost to frugal and reverse innovation: Mapping the field and implications for global competitiveness. *Res.-Technology Manag.* 57(4), 20-27.
- Zeschky, M., Widenmayer, B., Gassmann, O., 2011. Frugal innovation in emerging markets. *Res.-Technology Manag.* 54(4), 38-45.
- Zott, C., Amit, R., 2010. Business model design: an activity system perspective. *Long Range Plan.* 43, 216 - 226.