



# **Supply Chain Management for Frugal Innovation Product**

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Thesis to obtain the Master of Science Degree in

## **Industrial Engineering and Management**

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## Abstract

While the global population is constantly increasing and natural resource steadily decreasing, greater pressure is placed on companies to tackle environmental and social issues. Frugal innovation is established as a profitable business strategy that satisfies the demand for essential needs, empowers local communities and preserves the natural ecosystem.

The use of SSCM practices can balance the conflicting objective of quality and affordability with more inclusive and environmental friendly activities. Existing investigation regarding SCM for frugal innovation is incomplete since it does not look at the entire product life-cycle and avoids dealing with upstream and downstream relationships.

This work has the objective of developing an integrated framework that supports corporations in managing frugal innovations and helps in identifying the correct supply chain strategies for the specific context of this type of products.

Based upon an extensive literature review, the knowledge on frugal innovation and sustainable supply chain management was systematized, in order to derive a collection of best practices to efficiently implement this type of products. Then by employing multiple case-studies and semi-structured interviews, the framework was validated and tested. The results proved the relevance of all the activities suggested in the framework and showed that most of them are actually being implemented in practice. Furthermore respondents acknowledged that increased efficiency and more environmental targets can be achieved by employing the model.

Key words: Frugal Innovation, Supply Chain Management, Framework, Sustainability

## Resumo

Enquanto a população mundial se encontra num aumento constante, os recursos naturais tornam-se cada vez mais escassos, existindo assim uma maior pressão para que as empresas criem medidas para enfrentar questões sociais e ambientais. *Frugal innovation* apresenta-se como uma estratégia de negocio lucrativa que satisfaz a procura de bens essenciais, beneficia as comunidades locais e preserva os ecossistemas.

O uso de praticas de cadeias de abastecimento sustentáveis (CAS), neste tipo de produtos, pode equilibrar os objetivos divergentes de qualidade e acessibilidade com atividades mais inclusivas e amigas do ambiente. A investigação existente relativamente a CAS aplicadas a frugal innovation são muito limitadas, não contemplando o ciclo de vida do produto holisticamente e não apresentam uma visão de interligação entre os vários níveis da cadeia de abastecimento.

Assim, este trabalho tem como objetivo o desenvolvimento de um framework integrado que oriente as empresas na gestão de produtos relativos à frugal innovations e ajude a identificar as melhores estrategias de cadeia de abastecimento para o contexto especifico deste tipo de produtos.

Baseado numa extensa revisão de literatura, o conhecimento em frugal innovation e SSCM foi sistematizado, com o objetivo de criar um conjunto de praticas recomendadas para implementar eficazmente este tipo de produtos. Com o uso de múltiplos casos de estudo e realização de entrevistas semi-estruturadas, o framework foi entao validado e testado. Os resultados obtidos provaram a importancia de todas as atividades sugeridas no framework e mostraram que grande parte delas estao de fato a serem implementadas. Mais se acrescenta que os entrevistados reconheceram que com a aplicação do framewrok poderão ser alcançados níveis mais altos de eficiência, numa prespectiva mais sustentável.

Palavras-chave: Frugal Innovation, Gestão da Cadeias de Abastecimento, Framework, Sustentabilidade

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## List of Abbreviations

3BL: Triple Bottom Line  
BoP: Bottom of the Pyramid  
CLSC: Closed-loop Supply Chain  
CRC: Central Recondition Centre  
CSR: Corporate Social Responsibility  
ECG: Electrocardiography  
ERP: Enterprise Resource Planning  
FISC: Framework for Frugal Innovation Supply Chain  
GDP: Gross Domestic Product  
GE: General Electric  
GSC: Green Supply Chain  
JIT: Just in Time  
LCA: Life-cycle Analysis  
MNC: Multinational Corporation  
NGO: Non-governmental Organization  
RCI: Resource Constrained Innovation  
RCPD: Resource Constrained Product Development  
RSC: Reverse Supply Chain  
SC: Supply Chain  
SCM: Supply Chain Management  
SME: Small and Medium Enterprise  
SSC: Sustainable Supply Chain  
SSCM: Sustainable Supply Chain Management  
TSC: Traditional Supply Chain  
WBSCD: World Business Council for Sustainable Development

# 1. Introduction

## 1.1. Contextualization

Two of the most fundamental disruptive trends that are changing the world economy and will strongly influence the future global development are the overall population increase and the reduction of scarce resources. In fact according to the United Nations 95% of the global population growth before 2030 will take place in emerging markets and already by 2020, consumption of product and services will double-digit in those countries (Roland Berger, 2014). For these reasons there is a growing concern in emerging markets economies' linked to sustainable resource consumption. The location of economic activity and the balance of power are shifting, as by 2030, 70% of real GDP growth and 70% of western firms profit will come from developing countries. If in the year 2000, 95% of the Fortune Global 500 were headquartered in developed economies, by 2025 half of the world's large companies are expected to come from emerging markets (McKinsey & Co., 2015). If western companies want to compete globally they need to target emerging markets, since they reveal great growth opportunities and untapped potential.

Furthermore the market characteristics will drastically change when by 2030, four out of five middle-class consumers will live outside Europe and the USA, and have a purchasing power 160% higher than in 2009 (Roland Berger, 2014). Greater pressure on natural resources will be a direct result from this middle class expansion with higher living standards. Adding up the growing demand, the overlapping global competition and the shift in customers' buying patterns to less wasteful products we see that a change in traditional business models is needed. Moved by the change in demographic, economic and social factors, companies can effectively exploit future opportunities through the development of frugal innovation strategies. Frugal innovations are simple product or services that meet customer requirements while minimizing costs and resources. They look at serving the emerging countries with disruptive affordable products, developed under stricter constraints to provide economic, environmental and social value.

If in the last years more firms decided to adopt frugal innovations, future growth is expected to gain even greater importance. Indeed companies that already have frugal products in their portfolio, affirm that they will double in importance in the next five years, accounting for 22% of the sales and generating 20% of overall profit (Roland Berger, 2014). An example that supports this expectations is the evolution of Dacia, part of the French group Renault that since its introduction on the market in 2004 became the fastest growing automotive brand in Europe and now accounts for over 40% of Renault global sales.

## 1.2 Problem Characterization

Frugal products were first developed in emerging markets, where a resource-scarce environment and a growing consumers' demand for lower price products forced entrepreneurs to innovate in alternative ways, but its impact is now global. Since their relevant characteristic is being quality products that balance both costs and performance objectives, they are valuable for developing countries as well. In fact western consumers' tendency is to become more price sensitive, due to lower incomes caused by

the financial crisis, and better conscious about products' ecological footprint, now that society values are shifting to more responsible consumption practices.

Even if frugal innovations appear as exceptionally valuable for users and highly profitable for companies, some firms are still sceptical. This hesitation, may result from the fact that those enterprises, which already have frugal products in their portfolio, often faces difficult challenges to make them work. Most companies perceive the great potential of these innovations to gain stronger competitive advantage, but a clear idea of how to enhance success factors is still missing.

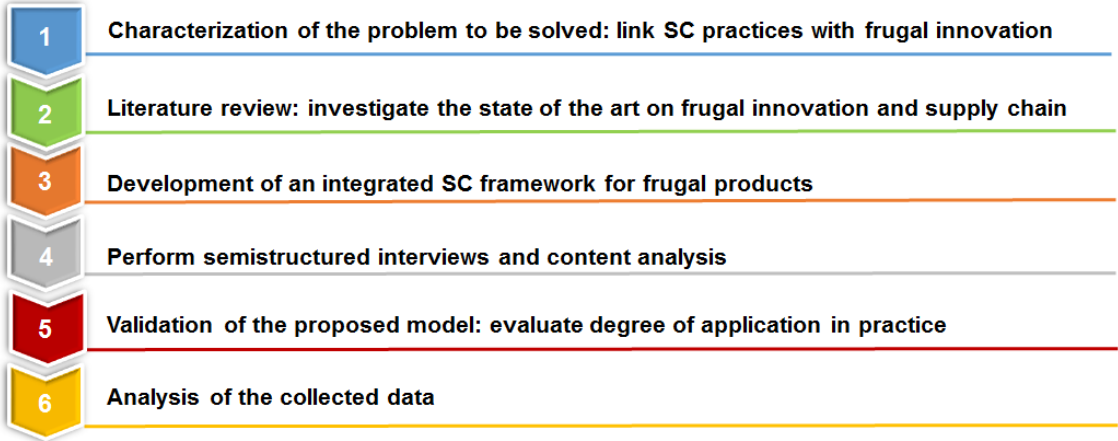
Supply chain management (SCM) practices could increase process efficiency, customer satisfaction and environmental sustainability of frugal products, but few research on this topic was already done. Further investigation on the link between SCM and frugal innovation is relevant and necessary, since the lack of a standardized framework needs to be filled. The literature does not cover the topics of frugal products and SCM together, since the first is mostly approached by an innovation management perspective and does not formally consider the SCM context. For these reasons the author believes that a structured model of supply chain strategies for frugal innovation products needs to be developed.

### 1.3 Master Dissertation Objective

The aim of this work is to propose a comprehensive framework for the efficient management of frugal innovation products, through the analysis of supply chain strategies. The master dissertation will be structured to reach the following intermediate objectives. (1) Problem Identification: analysis of product consumption shifts and market trends, investigation of frugal products in emerging and developing countries and understanding of SCM practices applicable to frugal innovations. (2) State of the Art: study the current situation of frugal innovations, Sustainable Supply Chain Management, and systematization of the knowledge acquired. (3) Development and validation of the Framework for Frugal Innovation Supply Chains (FISC): creation of the model, and testing through a quantitative and a qualitative analysis of the results obtained from empirical research.

### 1.4 Master Dissertation Methodology

The methodology employed for the master dissertation is composed by the six phases presented in *Figure 1*.



*Figure 1 - Project Methodology*

The **first** section includes the contextualization and the characterization of the problem to be investigated. It introduces the main drivers that led to the growth of frugal products and shows how they can answer to increasing global pressures. Furthermore it underlines how the inclusion of individual companies into integrated supply chains can improve the performance of all business partners.

The **second** step is constituted of the comprehensive literature review concerning frugal innovation and supply chain management. All relevant publications dealing with frugal products or related terms, e.g. jugaad, RCI, social innovation, BoP innovation and inclusive innovation, are analysed. The collected information are organized and sorted, in order to acquire a solid theoretical knowledge and facilitate future work. SCM and the evolution of supply chain structures are investigated. The concept of sustainability is introduced and linked to supply chain practices, i.e. SSCM.

In the **third** phase an original framework is developed. The goal is to structure the best practices of frugal innovation in the supply chain processes, in order to improve efficiency and sustainability. For all the SC phases various actions, which are specific to frugal products, are presented to demonstrate how they meet different business, social and environmental objectives. Furthermore the link between frugal practices and other managerial theories is studied.

The **fourth** stage includes the collection of data about possible gaps between the created FISC and the practical reality. The information are gathered through semi-structured interviews and case-studies. Relevant companies and research institutes are selected to realize face-to-face or computer interviews. Furthermore the firms which are being interviewed will constitute the sample for the multiple case-study analysis.

The **fifth** part of the work consists of the validation of the model. The data previously collected should permit to verify how company's supply chain decisions enhance frugal products. The degree of formalization of SC strategies for frugal innovations in practice is compared to the previously proposed framework.

The **sixth** phase summarizes the results of the research and includes the findings which can be derived from the entire work. The conclusion show how supply chain strategies can be specifically tailored for frugal products and reveal how companies are in practice implementing these activities. Moreover further research directions are suggested.

## 1.5 Master Dissertation Structure

The master dissertation is constituted of six chapters.

The **first** chapter is an introduction to the work, which includes a contextualization of the problem analysed and sets the objectives of the study. The reasons for the investigation are explained and then a problem characterization is performed, in order to describe the different elements that constitute the research.

The **second** chapter begins with a comprehensive literature review on frugal innovations that aims at gathering exhausting information on this topic. A description of these products is given, through a characterization of their essential features. The analysis of existing examples is performed to research the actual market integration and its future development. The attributes of similar concepts, as Jugaad or RCI, are studied to link and combine complementary theories. The success factors and the obstacles to their implementation are presented. Furthermore the author discuss the relationship between frugal products and enhancement of sustainability practices. Then the state of the art of Supply Chain Management is investigated. A broad study on SCM is executed to describe its concepts and outline characteristics of currently developed models. The sustainability aspect of SCM is analysed, in order to finally investigate SSCM and GSC. In the end the effects of frugal innovation products in supply chains are analysed, in order to evaluate the research performed so far on the topic.

The **fourth** chapter includes a detailed description of the process employed to develop the FISC. The structure of the framework is analysed through a characterization of its constituting elements. Then an explanation of the scope and use of the FISC is given. Finally the glossary of all the terms contained in the model is presented.

The **fifth** chapter consist of the validation and testing of the FISC. In particular 6 companies were used as basis for a multiple case-study analysis and 12 semi-structured interviews were performed. The data gathered through the first research methodology enabled the collection of measurable outcomes, which were employed to verify the relevance of the practices contained in the FISC. Then the second investigation procedure was used to reinforce the validation process and confirm the validity of the result obtained in the quantitative analysis. Finally is presented a compact version of the FISC and is explained how the two tools can be used in a complementary manner.

The **sixth** chapter summarizes the major conclusions that can be derived from the work and suggests directions for future research.

## 2. State of the Art

This chapter starts by examining the actual knowledge on frugal innovation (Section 2.1). In particular the definitions, the characteristics, the drivers, the hurdles and best practices of this type of products are presented. Furthermore the concept of frugal innovation is compared with similar theories and some practical examples are analysed. Then in Section 2.2 the state-of-the-art about research on supply chain management is summarized. The origin and the evolution of SCM is presented through the description of green and sustainable supply chains. Lastly the chapter finishes deriving some conclusions about the information collected along the literature review (Section 2.3).

### 2.1 Frugal Innovation Products

#### 2.1.1 Definition

Since its first use in an article of the Economist (Woolridge 2010), the term frugal innovation gained increasingly importance in the academic and entrepreneurial community. Consequently a steady evolution of the concept followed. One of the first definitions describes frugal innovation as the ability to “do more with less for more people” (Prahalad and Mashker, 2010, p.2). The notion embraces three key ideas: deliver more value, efficiently reduce costs and target a greater number of customers (Mahmood, 2013), but it still leaves the label unclear.

As reported by Brem and Wolfram (2014, p.14) “some authors assign frugal innovation to the product perspective (Gupta 2011; Hartigan 2011; Kingsnorth et al. 2011) and others to the process perspective (Woodward 2011), while still others declare that frugal innovation comprises products, processes, and business models (Moore 2011; Prahalad 2006)”. According to Bhatti, Khilji, & Basu (2013) frugal innovation is understood as a process and an outcome at the same time, which means that the term can be applied to the set of activities needed to create the product, but also to the output itself. Frugal innovations can involve manufacturing and service delivery processes as well as products and services (Bhatti et al, 2013; Bound and Thornton 2012). As Bhatti & Ventresca (2013, p.3) conclude “frugal innovation is a label that captures a range of heterogeneous activities which cut across different sectors” and therefore complementary definitions were given according to the specific application.

While some researches’ definitions focus on good enough (Hang, 2010), low cost products (Ramamurti,2012), others underline the importance of frugal innovation “fulfilling or even exceeding certain pre-defined criteria of acceptable quality standard” (Tiwari and Herstatt, 2014, p.3). Frugal products have the potential to be disruptive (Hang, 2010) by creating value for underserved markets (Bahtti, 2012). For Radju and Prabhu (2015, p.497) frugal innovations are “well-designed, good-quality products that are developed cost-effectively and sold at affordable prices to deliver best customer value”. Ernst and Young (2011a) agree that for the output to be cheap and reach a vast low income customer base, an economical use of resources is necessary.

Frugal innovation is a new business model that reaches unserved, price-sensitive consumers (den Ouden, 2012). Conceived in developing countries to deliver innovative, low-cost and high-quality products, its business model is exportable even to the developed world (George et al, 2012).

Basu et al. (2013) describe frugal innovation as a design innovation process to solve sustainability challenges in BoP markets, through the development of appropriate, adaptable, affordable, and accessible services and products.

Believing that previous definitions do not capture the true nature of frugal innovation, Bhatti & Ventresca (2013, p.3) describe it as “means and ends to do more with less for more people”. They argue that the frugal innovation concept is not new and it has been used in the past to face resource scarcity and affordability constraints (historical perspective). Nonetheless today’s contextual environment makes frugal innovation more relevant, due to larger population and increased institutional voids (current perspective). Therefore frugal innovation is both the method and the aim to face these rising challenges.

According to Radjou and Prabhu (2015, p.1) frugal innovations is “the ability to create significantly more business and social value while minimising the use of diminishing resources such as energy, capital and time”. *Table 1* summarizes the different definitions given by researches.

*Table 1 - Definition of frugal innovation*

Author	Definition
Woolridge (2010)	Redesigning products and processes to cut out unnecessary costs
Prahlad & Mashker (2010)	Do more with less for more people
Zeschky et al. (2010)	Good-enough, affordable products that meet the needs of resource-constrained consumers
Ernst and Young (2011)	Economical use of resources to provide products affordable by those on a lower income
Gupta (2011)	New management philosophy, which integrates specific needs of the BoP markets as a starting point and works backward to develop appropriate solutions that may be significantly different from existing solutions designed to address needs of upmarket segments
George et al. (2012)	Innovative, low-cost and high-quality products and business models originating in developing countries and exportable to other developing countries or even the developed world
Bhatti (2012)	Redefine business models, reconfigure value chains and redesign products to use resources in different ways and create more inclusive markets by serving users with affordability constraints, often in a scalable and sustainable manner
Soni (2013)	The act of producing low-cost, good-enough products for the underserved markets
Basu et al. (2013)	Design innovation process to solve sustainability challenges in BoP markets, through the development of appropriate, adaptable, affordable, and accessible services and products.
Bhatti & Ventresca (2013)	A means and ends to do more with less for more people
Tiwari and Herstatt (2014)	New or significantly improved products (both goods and services), processes, or marketing and organizational methods that seek to minimize the use of material and financial resources in the complete value chain (development, manufacturing, distribution, consumption, and disposal) with the objective of significantly reducing the total cost of ownership and/or usage while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards
Brem and Wolfram (2014)	A derived management approach, based on jugaad, which focuses on the development, production, and product management of resource-saving products and services for people at the BoP by achieving a sufficient level of taxonomy and avoiding needless costs
Radjou and Prabhu (2015)	Well-designed, good-quality products that are developed cost-effectively and sold at affordable prices to deliver best customer value. The ability to create significantly more business and social value while minimising the use of diminishing resources such as energy, capital and time

Taking into consideration the various aspects of previous descriptions, the following original definition, aggregating the state of the art definitions is proposed and will be followed.

*Frugal innovations are products, services, processes and business models that target underserved customers of low-mid market segments with high-quality solutions at affordable prices. They are developed in a sustainable and cost-effective manner that minimise the use of resources, materials and capital in the entire value chain, while enhancing social value.*

### 2.1.2 Characteristics of frugal innovation

Many authors have formally listed the characteristics (Hamacher, 2014), the core competences (Basu et al., 2013) and the attributes of frugal innovation (Radjou and Prabhu, 2015). According to Roland Berger (2014) the acronym FRUGAL can be used to explain its main features.

#### **Functional**

Frugal products are functional in the sense that are designed to be practical and useful. Focusing on core needs, the product's functionalities serve customers in the simplest and shorter way (Engel and Sebaux, 2014). As Basu et al. (2013, p.16) state: they "address the essence of the problem" and do not include unnecessary extras. People who strongly benefit from frugal solutions are consumers with budget constraints: low and mid-end customers from both emerging and developed countries.

#### **Robust**

The product has to be robust, to avoid planned obsolescence and be easily fixable. Basu et al. (2013) define the quality as ruggedization, which means being designed for harsh physical environments. In fact frugal innovations "have to cope with various infrastructural shortcomings, such as abrupt power-cuts, dust and extreme temperatures" (Tiwari et al., 2014, p.3). Product's life should be extended as much as possible through a proper made design that encourages the use of lasting materials and maintenance-friendly components. For emerging-market consumers key qualities are durability and reliability in adverse conditions. They place a high priority on the longevity of the product and its reparability, which should match local skills. Modular products designed of widely available components that can be easily replaced are preferable (Petrick and Juntiwassarakij, 2011).

#### **User-friendly**

Frugal innovations are simple, easy-to-use and fault-resistant. Thanks to its human centric design, customers can intuitively utilize the product without prior knowledge. Little or no training is required for the user to work with it. To respond to western consumers' apprehension of over-engineered products (Slade, 2007), frugal innovations capture the essential functional requirements with a minimalist lean-featured offering (Petrick and Juntiwassarakij, 2011). To lucratively target the low-middle market frugal innovations must focus on core functionalities that are highly valued by its customers.



### **Growing**

Frugal products “aim at serving volume-driven markets with comparatively thin margins” (Tiwari and Herstatt, 2013, p.5). They target mass markets and use economies of scale to push back costs (Sharma and Iyer 2012). Since frugal products are market-driven innovations, whose primary purpose is to tap unfulfilled demand, they face high customer’s growth rate (Tiwari and Herstatt, 2013). In fact frugal innovations aim at turning into clients all the non-consumers, who constitute the greatest part of the emerging market.

### **Affordable**

Frugal innovation’s products are affordable in two ways: cheap price, low costs of operation and maintenance along all the product life cycle. According to Roland Berger (2015) utilizing local resources for R&D, procurement and production is the best way to achieve affordability. Frugal innovations can lower the price point by anywhere between 50% to 97% (Rao, 2013). This result can be obtained only with a frugal approach that “rather than simply cutting existing costs, seeks to avoid needless costs in the first place” (Sehgal et al., 2010, p.21). Many authors agree that when seeking a frugal solution, characterized by a low cost of ownership, affordability must be considered in the entire value chain activities (Bhatti, 2012; Tiwari and Herstatt, 2013). The purpose is to reduce not just the selling price but also the overall cost of operation (Tiwari and Herstatt, 2012).

### **Local**

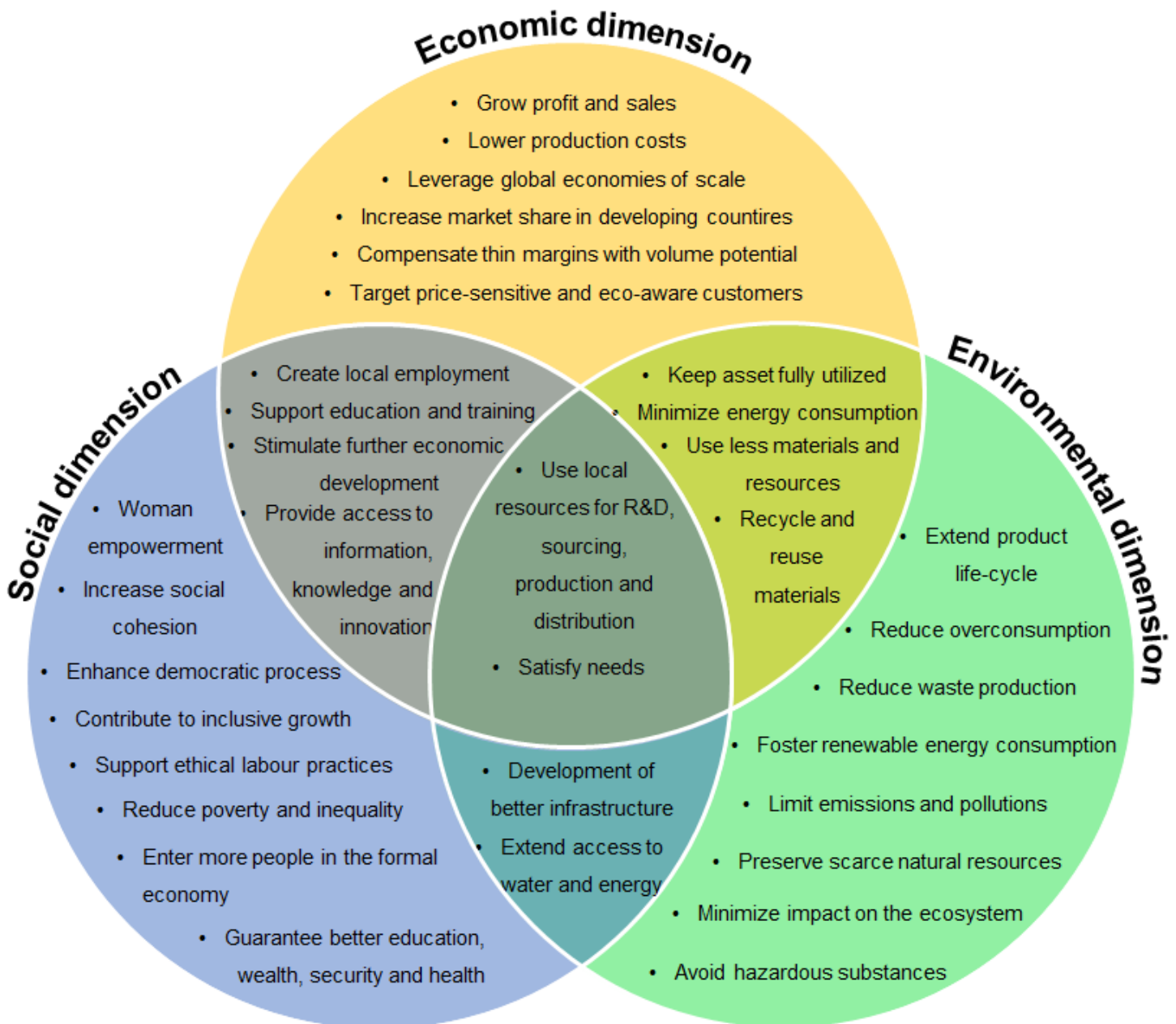
Frugal solutions leverage local resources, as sourcing inputs, to reduce costs and risks. Rather than importing employees, equipment and materials, local innovation and manufacturing centres are created close to customers (Engel & Sabaux, 2014). Accessing local technological capabilities creates open global innovation networks that can be used to lower development costs and risks (Tiwari and Herstatt, 2012). Furthermore their output is locally customized to match distinct aspirations while catering to their specific environmental and socio-cultural requirements (Tiwari and Herstatt, 2014). Frugal innovations promote a decentralized production strategy, where many micro factories, located close to the point of consumption, can produce customized goods using locally sourced parts (Radjou and Prabhu, 2015).

### **Timely-to-market**

Siemens developed the term SMART to describe their frugal strategy: Simple, Maintenance-friendly, Affordable, Reliable and Timely-to-market. Velocity and flexibility are considered important characteristics to face off competition from emerging markets. Being “the strategy dynamics of frugal innovations market-pull oriented rather than technology-push oriented” it is vital to accelerate the development and the introduction of products in the market (Engel & Sabaux, 2014, p.7). As Roland Berger (2015, p.8) affirms “speed takes precedence over perfection; products become established if they get to market early, if their quality is ‘good enough’ and if they accurately target relevant customer needs”.

## Sustainable

Basu et al. (2013) believe that frugal models improve social, environmental and economic sustainability due to their engagement with better production and consumption practices. Therefore frugal innovations are sustainable solutions that address immediate needs and integrate a long-term outlook while prioritizing all business stakeholders: the end consumers, the environment and future generations (Basu et al., 2013). Frugal positive outcomes are explored on three different sustainability dimensions and graphically represented in *Figure 2*.



*Figure 2 - Sustainability and frugal innovation*

### Economic Dimension

According to Roland Berger (2015) frugal products are often firm's cash-cow, which possess the highest growth in sales and profit. Their inclusion into product portfolios enhances competitive advantage since both price-sensitive and eco-aware customers are targeted.

Frugal approaches compensate thin contribution margins with their volume-potential, indeed through global economies of scale they are able to generate sufficient profits (Tiwari and Herstatt, 2014). Leveraging the business opportunities that fast growing emerging markets represent, frugal innovations increase market share to generate revenues (Agarwal and Brem, 2012). Furthermore they create local employment opportunities that stimulate further investments in economic activities (Rosca, 2015). Through the use of capital and micro-financing options, more customers can be reached and benefit from frugal products (Radjou et al., 2012).

### Environmental Dimension

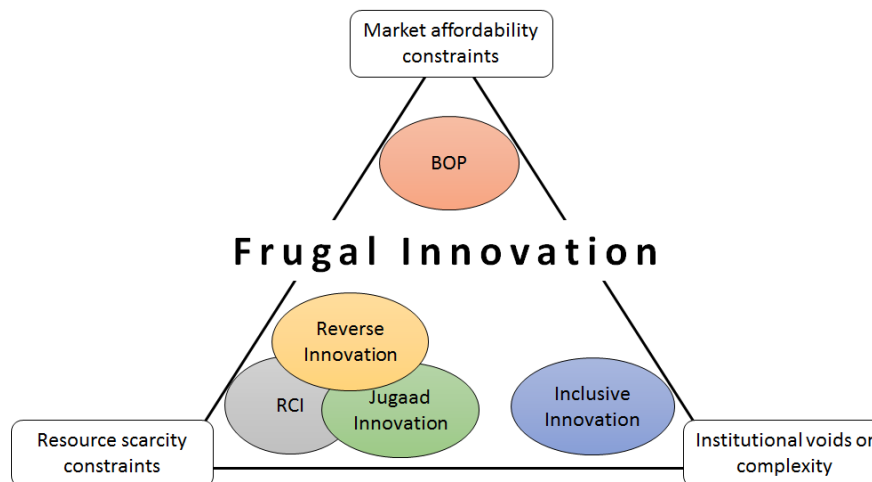
Since frugal innovations are scarcity-driven and have to face harsh resource-constrained condition, they are conceived to reduce raw materials and energy consumption (Pansera and Sarkar, 2016). Built upon green technologies, frugal products are designed to minimize environmental impacts and prioritize the consumption of renewable energy. Furthermore the emphasis on preserving local materials and focus on basic features, lowers the use of resources in the product development (Sharma and Iyer, 2012). Frugal techniques boost modular products whose components can be easily repaired and replaced. Therefore the effective life of the product can be extended and the waste produced decreases (Sharma and Iyer, 2012). New methods of design, production and distribution are implemented to create a circular-economy in which material are reused (Radjou and Prabhu, 2015). Eco-design principles, e.g. cradle-to-cradle, closed-loop and biomimetic, are adopted to create products whose materials are abundant, do not harm the environment and can be 100% recycled (Radjou and Prabhu, 2015). Made of environmental-friendly materials and biodegradable packaging frugal innovations reduces nature degradation (Rosca, 2015). They promote collaborative consumption practices and sharing economy that enables assets to be fully utilized and optimizes resource usage (Radjou and Prabhu, 2015).

### Social Dimension

“Frugal innovations enhance democratic processes by making affordable solutions available to large populations who had no prior access to them” (Kahle et al., 2013, p.11). The approach provides access to innovation while creating new sources of growth and cost-saving opportunities (Hart & Christensen, 2002). By meeting underserved basic needs, more people have the opportunity to enter the formal economy and improve their standard of living (Prahalad, 2012; Sheth, 2011). The inclusions of BoP (Bottom of the Pyramid) citizens into the value chain provides increased social cohesion (Acosta et al., 2011). In fact people become engaged stakeholder, who are at the same time consumers and manufacturers. Thanks to a stable income generation citizens are enabled to increase their economic and social independence (Kahle et al., 2013). Furthermore greater capital investments in emerging countries allows the development of better infrastructure and extends access to water and energy. As Kahle et al. (2013, p.12) summarize “frugal innovation is thus able to contribute to inclusive growth, reduce inequality and increase participation and empowerment, all of which result in better education, wealth, security, health, and economic development”.

### 2.1.3 Comparison with similar concepts

To address the recent evolution of innovation in emerging countries, many theories have been developed in the past years: 'Bottom of the Pyramid (BoP)', 'Jugaad', 'Reverse Innovation', 'Inclusive Innovation' and 'Resource-Constrained Innovation (RCI)' (Govindarajan & Ramamurti 2011; Radjou, et al., 2012; Ray & Ray, 2010; Prahalad, 2006; Nijhof et al., 2002). Having explored the progress of frugal innovation definitions and its characteristics, it is possible to compare the concept with these terms often associated with it. Two conceptual diagrams from Tiwari & Herstatt (2014) and Bhatti & Ventresca (2013) are adapted to demonstrate how various innovation theories are correlated since they share common constraints. *Figure 3* exhibits a triangle, whose vertexes are constituted by the three constraints which tackle developing countries: market affordability, resource scarcity and institutional voids. The concepts are positioned in the figure to reveal the degree by which they seek to overcome the specific constraint. This level is expressed according to their proximity to the vertex. Furthermore the diagram shows how frugal innovations incorporate the fundamental attributes of these terms. As Tiwari and Herstatt. (2014, p.13) state, "frugal innovations can fully encompass the key characteristics of these individual related terms" and therefore "act as an integrating mechanism to bring these various concepts under one umbrella".



*Figure 3 - Conceptual model - Adapted for Tiwari & Herstatt (2014) and Bhatti & Ventresca (2013)*

#### **BoP Innovations**

Bottom of the Pyramid innovations are products and services targeting the 4 billion customers living with less than 2 \$ a day. Prahalad (2006) affirms that multi-nationals companies (MNCs) can innovate and create win-win scenarios with local partnerships to both eradicate poverty and generate profitable businesses. BoP theory and frugal innovation are similar for three main characteristics. First they underline the importance of the poor being target groups and co-developers (Karnani, 2006), as well as business partners and innovators (Hart and Simanis, 2008, Zeschky et al. 2011; Woodward 2011). Second the products are designed to overcome diverse market challenges, e.g. low and irregular income, limited education, inadequate infrastructure and fragmented distribution (Khale et al, 2013). Third both market-approaches enhance sustainable development by creating positive social impacts, e.g. poverty alleviation, and enhancing local communities' economy (Basu et al., 2013). However frugal innovations are considered more sustainable than Bop products, because the former stress ecological

efforts (Gupta and Wang 2009; Howard 2011), while the latter are not necessarily concerned with reducing resources consumption and do not tackle directly environmental issues.

Despite these similarities, many authors believe that frugal innovation is a more comprehensive concept (Tiwari and Herstatt, 2012; Hamacher, 2014; Bhatti & Ventresca, 2013). Frugal products have a target market that is not necessarily limited to the very bottom of the pyramid tier (Tiwari and Herstatt, 2014), but includes both low and mid- market segments. In fact they are able to satisfy the needs of the BoP customers and upmarket demand (Immelt et al., 2009; Lifland, 2010; Gupta, 2011). While BoP oriented approaches are essentially cost-driven, frugal solutions address all those customers that, “by compulsion or choice, seek products whose overall cost of ownership is placed significantly below standard products” (Tiwari and Herstatt, 2012, p.6).

### **Jugaad Innovation**

Radjou et al. (2012, p.1) describe jugaad innovation as “an innovative fix; an improvised solution born from ingenuity and cleverness”. It is a creative mind-set to deal with scarce resources (Prahalad and Mashelkar, 2010) and overcome constraints (Kumar and Puranam, 2012). Jugaad solutions are simple products designed for people at the BoP (Saraf, 2009) that therefore deliver high benefits at low cost. Various authors criticise jugaad for its unstructured approach (Hamacher, 2014), limited process reproducibility (Brem and Wolfram, 2014), but also lack of taxonomy and discipline (Lacy, 2011). While for frugal products a more methodized and analytical model is used, jugaad concept “does not capture the means by which innovation is to be achieved” (Hamacher, 2014, p.93). Furthermore frugal innovation “does not mean improvised solution” (Tiwari and Herstatt, 2013, p.5) and moves beyond jugaad limited application to BoP underserved markets, since it “is concerned with global scale” (Bhatti and Ventresca, 2013, p.17). Some researchers therefore conclude that frugal innovation is the management approach based on jugaad culture of creative improvisation (Bound and Thornton, 2012; Brem and Wolfram, 2014).

### **Reverse Innovation**

Reverse innovation is an innovation that is first developed and sold in emerging countries, to be then modified and introduced in western economies (Govindarajan & Ramamurti, 2011; Basu et al., 2013; Brem and Wolfram, 2014). It possesses two main characteristics: first the product flow is bottom-up and East-to-West (Bhatti, 2011), second the offering has to be scaled up to be profitably marketed in developed economies (Govindarajan, 2009). Frugal innovation differs from reverse innovation since it focus on a market segment rather than a geographical region, accepts that product flow is bidirectional, and targets from the beginning both developing and developed countries.

As Zeschky et al. (2014) affirm, reverse innovation is more a market innovation, whereas frugal innovation is rather a product and process innovation. Due to the challenges of turning an innovation into uphill, only few firms successfully implemented reverse innovation (Govindarajan, 2012), and mainly only as a defensive strategy (Immelt et al. 2009). According to Govindarajan and Trimble (2012) reverse innovation can be understood more as a high level strategy that describes what should be done rather than how it is done. As Bhatti and Ventresca (2013, p.17) conclude: while “reverse innovation does not cover how to do the innovation or what it should look like – frugal innovation covers this gap”.

## Inclusive innovation

George et al. (2012, p.663) define inclusive innovation as "the development and implementation of new ideas, which aspire to create opportunities that enhance social and economic well-being for disenfranchised members of society". Inclusive innovations "deal with improving the welfare of individuals and community through employment, consumption or participation" (OECD, 2008, p.21). Five qualities are assigned to inclusive innovations: pushing social change, fulfilling badly served needs, offering low-cost good-enough solutions, exploring unusual resources and being ignored by present competitors (Christensen et al. 2006).

Nonetheless as Hamacher (2014, p.93) affirms "just like jugaad and reverse innovation, inclusive innovation does not refer to the means by which this is to be achieved". Furthermore the concept strongly focuses on the inclusion of business social responsibilities in strategy and operations management (Nijhof, Fisscher, & Looise, 2002), but leaves unclear an implementation mechanism. While both frugal and inclusive innovation include marginalized populations in formal economies (Iizuka, 2013), the latter is believed to be separate from profit interests (Pol and Ville, 2009).

## Resource-Constrained Innovation (RCI)

RCPD is "the process of developing new products that use minimal resources and are affordable to a broader market" (Sharma and Iyer, 2012, p.2). RCI leverages process efficiency to reduce total costs and lower the selling prices (Reddy, 2011). Sharma and Gopalkrishnan (2012) identify three methods to attempt RCPD: new product design, new process design and leveraging scale economies.

Compared to frugal innovations, RCI lacks in directly addressing social problems and focuses on the operational dimension, rather than on the strategic level. However two features are similar. First RCI as well as frugal innovation, "absorb, adapt and build upon the technologies imported from abroad, rather than produce completely novel technologies" (Kumar, 2008, p.251). Second RCPD customizes processes and business models according to the environment of local customers, in order to provide products embedded in the cultural context (Pansera & Owen, 2015).

To systematize the comparison along various dimensions between different theories addressing emerging markets, the following table, *Table 2*, was developed.

*Table 2 - Comparison between innovation theories*

Dimension	Bop innovation	Jugaad innovation	Reverse innovation	Inclusive innovation	RC innovation
Target market	Low income customers	Emerging markets	First East then West market	Underserved customers	Global market
Type of innovation	Product	Problem oriented	Market	Problem oriented	Process
Objective	Target the poor	Solve urgent problems	Enlarge market base	Social wealth	Protect resources
Sustainability	Social and economic	Economic	Economic	Social	Environmental and economic
Main characteristic	Cost-driven	Improved simple solution	Upscale products	System changing solution	Adapt existing technologies
Approach	Unstructured	Unstructured	Structured	Unstructured	Structured
Organizational level	Strategy	Culture	Strategy	Culture	Operations

## 2.1.4 Drivers and Hurdles

### Drivers

Different macro-economic changes that occurred in the last years made western companies look at frugal innovations as an essential long-term business strategy. Demographic, technological and value transformations increased the demand for frugal products in both emerging and mature markets (Tiwari and Herstatt, 2014).

- Many authors believe that the combination of **increasing consumers belonging to the middle class** and the rising purchasing power of emerging customers are the major engine of both economic growth and resource scarcity (Roland Berger, 2014). OECD believes that a reverse movement in society may occur:

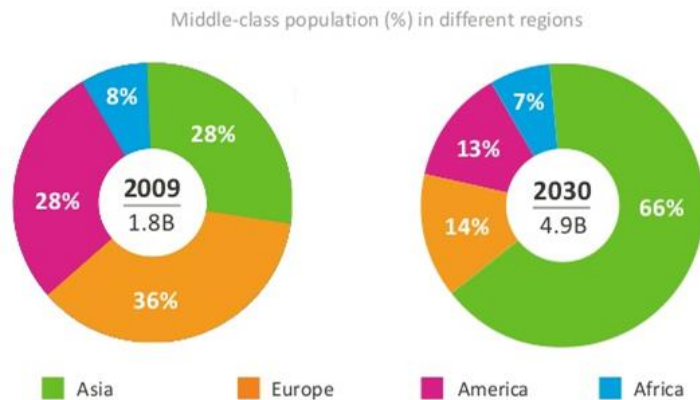


Figure 4 - Middle class growth - Source MediaTek Inc. (2014)

- western customers will regress from high to mid-end market segments, while consumers from emerging countries will raise from low to mid-end segments. The new market segment which stems from this phenomenon, typically referred to as 'middle market' (Govindarajan 2012), is the "next global battleground" (Zeschky et al., 2014, p.2), since it shows the highest growth rate (Roland Berger, 2014).
- This largely increasing customer base will strongly **pressure on natural resources**. "The demand for even higher quality products will rise and the availability of resources to satisfy that demand will remained constrained" (Radjou and Prabhu, 2015, p.201). The limited availability of resources will force companies to be more efficient in how they use raw materials (Roland Berger, 2014) and to meet the growing demand in a sustainable way (Mc Kinsey & Co, 2014).
  - The lack of supplies, the excessive product consumption and the increasing waste made people become more aware about **sustainability issues**. "Buying patterns are shifting to less wasteful products" (Engel, 2014, p.3). Customers are becoming both 'value and values conscious': they care about the price as well as about ecological and social issues when buying commodities (Radjou and Prabhu, 2015). As reported by Edelman 2014 trust barometer 80% of EU citizens affirm that a product environmental impact is a critical element in their purchasing decision.
  - Beside the sustainability challenge, people are expecting companies to use their ability to innovate doing good for society and **addressing social inclusion** (Edelman 2016 Trust Barometer). Sufficiency-driven business models that "emphasise the role of the consumer in making responsible choices" (Bocken and Short, 2015, p.5), are gaining greater importance. More companies are "moderating demand through education and consumer engagement, making products that last and avoiding built-in obsolescence" (Bocken and Short, 2015, p.5). A wider number of people support



enterprises whose “revenues and benefits are fairly distributed across all stakeholders throughout the supply chain” (Bocken and Short, 2015, p.5). Both clients and enterprises are seeking the same objective: focusing on satisfying ‘needs’ rather than promoting wants (Bocken and Short, 2015).

- Due to lower incomes consumers are increasingly benefiting from “**sharing economy**” commodities, where rather than buying a product, it is temporary rented becoming a service. New technologies are facilitating the change from ownership of an individual object to a “collaborative consumption” of the asset (Rachel Botsman, 2010). Peer-to-peer economic models based on frugality respond to environmentally responsible consumers and, reducing the cost of use, allow more people to benefit from these services.
- Furthermore governments are framing the market evolution with **new regulations** that require businesses to be more resource efficient, to reduce social inequality and to promote inclusive growth (Radjou and Prabhu, 2015). An increasing societal pressure for companies to adopt triple bottom line approaches (Porter and Kramer, 2011; Ahlstrom, 2010) encourages the development of official indicators. Measures to lower countries environmental impacts are a major challenge that most organizations are including as a priority within their business models.
- The 2008 global financial crisis made western consumer **look for simpler offering** that deliver the greatest value (Flatters and Willmat, 2009). Customers and governments became more cost conscious, seeking more value for less money. Clients in developed countries seem to undergo what Mahmood (2013) defined as innovation revolution, where people demand 80% benefit for 20% cost. Booz & co (2012) defines these consumers “permanently value-sensitive”: it means that their frugal habits adopted during the recession will not change in better times. As Engel (2014, p.3) affirms “people are willing to spend less money and adapt their consumption patterns toward low frills offers”.
- To **face increasing global competition** multinational firms have to be ‘global all-rounders’ (Zeschky et al., 2014). On one side more and more emerging market multinationals have become global players and started challenging western multinationals with low-cost, high-quality products. On the other side young start-ups are creating disruptive solutions that respond faster and better to customer needs (Radjou and Prabhu, 2015). Creating effective collaboration networks with different innovators, institutions or even competitors has become a widespread business strategy.



Figure 5 - Drivers to frugal innovation

Figure 5 summarizes all the different drivers to frugal innovations and the link between them.



## Hurdles

Many companies are still suspicious about frugal innovation success since they often face arduous challenges. Roland Berger (2015, p.15) survey shows that only less than half firms are “satisfied with the sale success of their frugal product”. The hurdles occur in all conception, production and marketing stages of the product development cycle.

- One major issue faced by Western corporation during the **conception** phase is to understand hidden needs of price sensitive consumers. Using developed country perspectives and norms hinder the adaptation to local cultures and therefore fail to match the unique requirements of emerging societies (Soydan, 2012). To get a deeper understanding of specific customer needs, companies should strain collaboration with local teams. Partnerships however have to face increased complexity and frictions due to contrasting cultures, misalignment of quality requirements and different know-how (Roland Berger, 2015). Another obstacle consists in the ability to successfully balance quality with low cost (Soydan, 2012). Creating a product with an affordable price is a necessary but insufficient condition for its success, which rather depends on the overall value proposition. While offering the cheapest product is not likely to succeed, companies should design frugal solutions with quality level comparable to entry-level alternatives (Tiwari and Herstatt, 2014). Finally the application of traditional R&D, which is rigid, costly and time consuming, negatively affects the development process. The strict use of established models leads to long development cycles that cannot compete with faster and more flexible local competitors (Roland Berger, 2015).
- The first challenge identified in the **production** process is “failing to rigorously follow the design-to-cost principle” (Roland Berger, 2015, p.3). Delivering a product that offers the core functions of a high-end alternative at much lower costs is a hard task. Secondly if the manufacturing is performed in emerging markets, the availability of skilled human capital, reliable local partners and proficient suppliers need to be overcome in order to guarantee the compliancy of predetermined quality standards (Soydan, 2012).
- Regarding **marketing** activities, a key hurdle for large corporations with a product portfolio targeting different market segments consists in the adoption of the right selling strategy. This includes difficulties in the sales channel, in the after sale service and in the branding. Western companies are not familiar with local market condition and therefore use traditional channels, which are often inappropriate for frugal products (Roland Berger, 2015). Moreover enterprises are often concerned about the effect of frugal innovations on the brand image and fear that they might compete against firm’s existing products. However as Zeschky et al. (2011, p.7) affirms “the potential for massive low-end profits may well outweigh losses in higher-end product lines”. Finally corporations have to create solutions that are able to overcome poor infrastructure, weak distribution network, inefficient transportation and low IP protection (Soydan, 2012).

*Figure 6* summarizes the hurdles faced by companies to implement frugal innovation

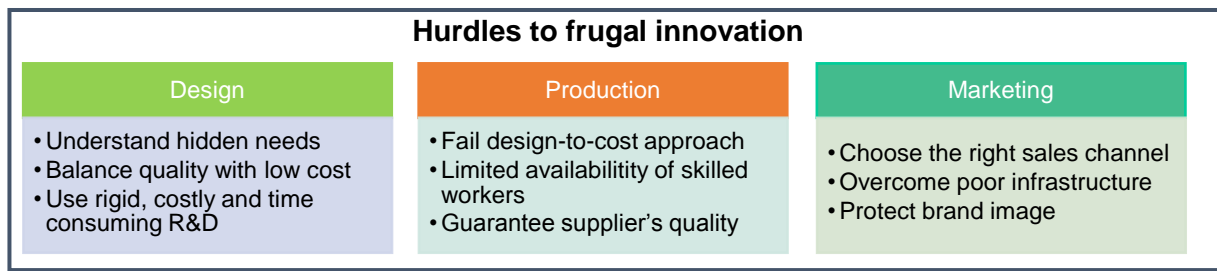


Figure 6 - Hurdles to frugal innovation

### 2.1.5 Best Practices

Core elements of the frugal innovation process are based on the following best practices. They represent effective strategies adopted by companies, which successfully have profited from the implementation of frugal business models.

#### Innovative distribution and sale models

The implementation of a frugal approach includes the creation of new distribution and selling models (Engel & Sabaux, 2014). Non-conventional channels must be developed when traditional logistic services cannot overcome the poor infrastructures and expensive transportation costs of areas with limited access (Basu et al., 2013). To deal with last-mile challenges, i.e. fulfil orders in far-flung locations, companies make use of local networks, e.g. corner shops for product distribution and community personnel for service sale (Radjou and Prabhu, 2015). In order to respond to price-sensitive consumers, innovative financing and micro-credit services are specifically developed. Original pricing models, e.g. subscriptions or lease-and-buy-back options, are used to reduce initial capital investment and make the service accessible to low income customers (Roland Berger, 2015).

#### Knowledge of the local context

The development of a frugal product hinges critically on understanding the essential needs of resource-constrained consumers (Roland Berger, 2015, p.11). A high level of embeddedness in the local context is required, in order to build awareness of cultural preference and infrastructural or institutional shortcomings (Zeschky et al., 2011; Tiwari and Herstatt, 2012). To generate successful ideas companies should involve a broad range of stakeholder, e.g. lead users in the target markets or prosumers, and develop market-focused, agile R&D model (Engel & Sabaux, 2014; Radjou and Prabhu, 2015).

#### External collaboration

Collaboration with external partners is crucial to obtain cost reduction and knowledge access (Tiwari and Herstatt, 2012). Local organizational structures and resources can improve distribution to dispersed customer base and therefore considerably reduce the cost of ownership for the consumer (Tiwari and Herstatt, 2012). Furthermore they enhance the brand image and facilitate promoting new products among the population (Tiwari and Herstatt, 2012). Then partnerships with start-ups and research institutes accelerate the speed of innovation by giving quick access to technical know-how that reduces risks and increases quality (Soni, 2013; Engel & Sabaux, 2014). As suggested by Tiwari and Herstatt (2012) making best use of 'open innovation' on global scale advances a firm's technology. Finally dispersed R&D, located in core emerging markets, improves the innovation network by capitalizing on local talent (Zeschky et al., 2011; Engel & Sabaux, 2014).

### **Clean slate approach**

Frugal products only roll up the market if they are rethought from the ground up (Roland Berger, 2015) and need to be addressed with a 'clean slate' approach (Govindarajan and Trimble, 2012; Tiwari and Herstatt, 2012). As many authors agree selling stripped-down versions of western products or simply removing features are unsuccessful strategies (Sehgal et al., 2010; Tiwari and Herstatt, 2012). Frugal innovations should be re-developed from scratch for the local consumers (Agarwal and Brem, 2012; Soni, 2013) with an open mind-set oriented to radical cost goals (Eyring et al., 2012). To meet extreme price-performance objectives several design-to-cost instruments are employed, such as value analysis, target costing, quality function deployment and conjoint analysis (Roland Berger, 2015).

### **New business model**

According to Soni (2013) the product innovation need to be supported by a business model innovation, in order to fit the disruptive character of frugal innovations (den Ouden, 2012; Bhatti, 2012). A successful frugal business model is a strategy that targets price-sensitive underserved consumers with highly valuable products at affordable prices (den Ouden, 2012; Zeschky et al., 2011). The frugal business model is designed to: 1) overcome both resource scarcity and institutional voids, 2) win transportation and distribution bottlenecks, 3) promote the customer's purchase, and 3) lower the price points drastically (Soni, 2013; Bhatti and Ventresca, 2013).

### **Technology fusion and analogies**

Adopting a 'clean slate' approach does not prevent firms from using available technologies or transferring solutions from one industry domain to the other (Tiwari et al., 2014). On the contrary firms combine 'technology fusion' and 'product analogies' to create effective solution that reduce development cost and increase product affordability (Tiwari and Herstatt, 2014). Frugal innovations leverage existing products through adaptation skills (Basu et al., 2013) and rather than 're-inventing the wheel', " look for analogies in other fields, including low cost solutions" (Tiwari and Herstatt, 2012, p.8). Existing technology are re-designed to be applied in new product architecture (Zeschky et al., 2014). Frugal innovations are 'new' in the sense that are constituted of "a novel combination of elements from existing knowledge bases that have not previously been connected" (Tiwari and Herstatt, 2012, p.8).

### **Dual brand strategy**

"A distinct branding strategy is imperative" for frugal innovation (Roland Berger, 2015, p.11). In fact it is a fundamental approach to avoid jeopardizing established brands with label dilution and cannibalization. Companies must differentiate their product offering for distinctive target markets, but also clearly communicate the origin of the frugal product, e.g. 'powered by' (Roland Berger, 2015). The dual brand strategy is flexible and allows to address previously neglected customers with specifically tailored products. Even if initial investments are higher and the time to achieve brand awareness is longer, the proximity to growing market segments enhance competitive advantage. In addition economies of scope can be employed to increase affordability of frugal products, by sharing asset between brands.

## Customer-driven modularity

Frugal innovations are developed as modular products that can be customized for the needs of different customer segments (Sharma and Iyer, 2012). Built on a low-cost base platform they exploit economies of scale and component standardization. Upon this basic product customers are free to choose special 'add-on' features and upgrades depending on specific needs and financial resources (Tiwari and Herstatt, 2013). The production and the logistic processes need to be flexible to allow modularity and postponement for mass customization at lower cost (Radjou and Prabhu, 2015).

To sum up the best practice of frugal innovation, *Table 3* outlines both the approaches and their benefits for companies.

*Table 3 - Best practices of frugal innovation*

Best practice	Benefits
Innovative distribution and sale models	Overcome poor infrastructure and last mile-challenges Reach low income consumers
Knowledge of the local context	Understand essential needs and cultural preferences
External collaboration	Cut costs and access local know-how
Clean slate approach	Meet extreme price objectives with minimalist solutions
New business model	Support the product innovation with new operational practices
Technology fusion and analogies	Reduce development costs and increase affordability
Dual brand strategy	Avoid brand cannibalization and leverage economies of scope
Customer-driven modularity	Respond to the needs of different customer segments

### 2.1.6 Frugal Innovation in practice

In both emerging and developed markets there are numerous frugal innovations examples, which have been developed either by multinational companies (MNC) or by small and medium-sized enterprises (SME) (Rao, 2013; Basu et al., 2013; Radju, 2012; Angot and Plé, 2015). Between the most relevant could be mentioned Embrace's portable infant warmer that delivers the functionality of a western incubator at only one per cent of the price, Mitticool clay fridge, which keeps food fresh for up to five days without the need of electricity, or also the high-quality cataract surgery performed free for poor people by the Aravind Eye Care Hospital. These solutions were all created by local entrepreneurs to tackle urgent problem that their community was facing, such as high infant mortality, inconstant electricity supply or expensive surgery.

To analyse better the link between the frugal theoretical approach and its practical implication, five in depth examples of successful innovations are described.

**MAC 400 by General Electric** (Wooldridge, 2012; Petrick and Juntiwasaraki, 2011; Rao, 2013; Angot and Plé, 2015; Tiwari et al., 2014)

MAC 400 is a General Electric's electrocardiogram (ECG) device that is specifically designed to fulfil demand for cheap transportable medical equipment. The product is reduced to the essence, focusing on core functionalities and modularizing extra features for up-scaled possibilities. MAC 400 was designed to match India's specific context and needs, but it also responded to the necessities of

individual practitioners in developed nations who could not afford more expensive machines. So that nowadays half of the product turnover is generated in Western Europe. GE was able not only to generate profits, but also to enable people, who before had no access to an ECG, to be healed.

The success of MAC 400 was possible only through GE's shift from a centralized to a decentralized organizational structure, which empowered and increased autonomy of local business units in India.

GE product developers searched for proved technologies within and outside the firm to reach strong cost reduction and extensively used analogies to increase process efficiency, e.g. MAC 400 is compatible with available mobile phone batteries.

The machine is an important example since it possesses most frugal innovation characteristics.

- a) Low cost: sells for 800\$ (vs 2000\$ of a traditional ECG) and performs a test for 1\$ (vs 5-20\$)
- b) Quality: uses the same microchip and algorithm present in GE's premium ECG devices
- c) Portable: weighs only 1.3 kg, runs on battery that lasts over a week and can be recharged in 3 hours
- d) Robust: dust resistant printer normally used for bus tickets
- e) Simple: fewer button and easy to use software
- f) Sustainable: saves lives and equips more doctors (social value), generated 20M\$ revenues and has been exported worldwide (economic value)

#### **Dacia Logan by Renault** (Radjou and Prabhu, 2015; Roland Berger, 2015; Ernst, 2015)

In 1999 Renault, a French automotive group, acquired a Romanian local car company called Dacia, to create a low-cost car destined for emerging markets. In 2004 the Logan was launched in the market: priced at 5000 € it is a robust, simple and affordable car that leverages the frugal innovation approach. The car is built on the B0 platform, already used for other Renault models, and integrates existing technologies with new technical solutions. It boasts a simpler architecture that needs 50% fewer parts than a high-end Renault vehicle and minimizes the number of expensive electronic components. For example rear-view mirrors are designed symmetrical to be used on either sides of the car, the windscreens are flatter to avoid defects and the dashboard is made of a single injection-moulded piece. These characteristics reduce the use of raw materials and avoid costly manufacturing tools. Therefore both production and maintenance of Logan vehicles are cheaper and easier, increasing benefits for the manufacturer and the client.

To meet the specific requirements of emerging market customers, Renault created a cross cultural team made of French designers and Romanian engineers to profit from workers' knowledge about resource constraints and their cost sensitivity. Specifications addresses the particular developing country's needs: the chassis height is increased to deal with ill-maintained roads, the engine is designed to handle lower quality fuels and the battery can survive extreme weather conditions. Moreover 50% of Logan purchasing is made from suppliers in the surrounding zone to reduce procurement costs.

When the Logan became a big success in developed markets, Renault decided to capitalize on growing demand by developing an entirely new entry-level product line: the Dacia brand. All Dacia models are based on one platform and can be produced on the same assembly line. A decentralized production strategy is adopted to manufacture close to the customers in local facilities.

Dacia vehicles are eco-friendly, since 95% of their components are recyclable and low-consuming engines are adopted to reduce CO2 emissions.

Renault adopted a dual brand strategy to avoid cannibalization in markets where the group was already present. For the western market, more safety features and more appealing exterior characteristics are introduced. Furthermore in addition to the basic model, Dacia products can be scaled up with additional equipment and customized optional. Renault applied many frugal innovation best practices to deliver a low-cost quality car that targets middle class consumers. The success of this strategy is reflected in the growing importance of the Dacia brand within the group, three out of five best-selling models are from Dacia, and its constantly increasing sale rate.

**M-Pesa** (Wooldridge, 2012; The Economist, 2013; Zeschky et al., 2014; Radjou and Prabhu, 2015)

M-Pesa is a mobile-phone based payment service that was introduced in 2007 by Vodafone and Safaricom to target the Kenyan market. Here most of the population does not have access to financial services and cannot afford a traditional bank account, but 90% of the people have a mobile phone. M-Pesa allows users to withdraw at small corner shops and transfer money with an ordinary mobile device. Leveraging the GSM technology and a small per-transaction fee, it offers financial services affordable for millions of people previously unbanked. Unlike a traditional bank that distinguishes between profitable and unprofitable clients, M-Pesa serves any Safaricom user who pays for an account. Thanks to its simplicity and low transaction cost, M-Pesa became one of the world's most successful mobile payment services. Nowadays 95% of Kenyan adults use it and half of the country's GDP flows through it every year. Furthermore it is believed that rural household adopting M-Pesa increased their incomes from 5 to 30%, allowing poor people to invest in education, health and productivity. In addition, the increased number of people with access to finance and availability of reliable mobile-payment platforms, generated a large group of start-ups, whose business model is based on M-Pesa. Some examples include M-Kopa, M-Farm and M-Pedigree.

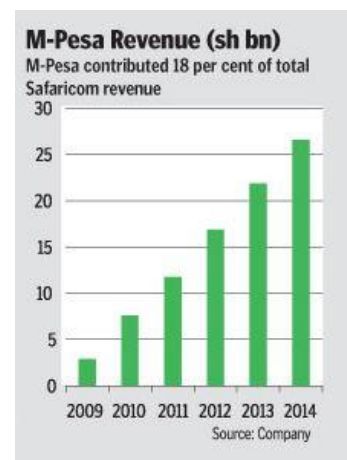


Figure 7 - M-Pesa growth - Source Vodafone

**M-KOPA** (www.m-kopa.com; Bloomberg Businessweek, 2015; GSMA, 2013)

M-KOPA Solar is a company based in Nairobi that provides rent-to-own solar energy products to rural homes. Founded in 2012, it makes solar products affordable to low-income households by providing a "pay-per-use" instalment plan. Customers acquire the solar system for a small up-front deposit of 35\$ and then purchase daily usage for 0.5\$. After one year of micro payments customers own the product and can upgrade to more power.

It represent a perfect off-grid solution that meets rural customer needs where infrastructure is poor and electricity supply inconstant. M-KOPA targets the 80% of Kenya's population who does not have access to electricity and provides a cheaper alternative to the traditional kerosene lighting.

M-KOPA uses M-Pesa mobile phone technology as a backbone financial structure. Clients realize the payments with the mobile money system, but they also receive alerts and reminders on their phones.

Furthermore the company partnered with Safaricom to achieve branding, marketing and distribution advantages.

M-KOPA is selling 500 units per day and in four years has already connected over 300,000 homes to affordable solar power. Positive impact that M-KOPA has made include 170M\$ customer savings, 37.5M hours of fume-free lighting per month, 260K tonnes of CO2 reduced and 1650 employments created in Africa. By making “high quality energy affordable to everyone” M-KOPA perfectly reflects the frugal innovation business model.

**M-Farm** (New Agriculturist, 2013; Capgemini, 2011; [www.mfarm.co.ke](http://www.mfarm.co.ke))

M-Farm is a mobile application that informs, connects and empowers local farmers. Most low-volume Kenyan farmers faced asymmetric information: they would sell their products for lower prices and purchase inputs at higher costs. M-Farm solves this problem by offering three distinct services: real time price of crops in different markets, collective selling to bulk small-scale production and group buying to negotiate discounted input prices. The service is accessible through the internet, the app and a mobile phone as well. Farmers receive SMS containing pricing information and send messages promoting what they have to sell, cutting out middlemen.

M-Farm lowers supply costs and offers better margins for farmers, who are usually able to double their sales. Furthermore the established network can be used to exchange valuable information between producers, such as changes in international regulations. Nonetheless the company is a profitable organization that earns money by taking a transaction fee for every deal made in the platform. M-Farm handles all money transactions with M-Pesa and therefore allows even unbanked farmers to benefit from the service. To further improve and expand the firm, many partnerships have been established with organisations such as iHub, Mlab East Africa and Samsung. Nowadays the application is used by over 7000 farmers.

**mPedigree** (Zedlmayer, 2011; The Guardian, 2012; MIT Technology Review, 2014)

mPedigree is a phone-based system that secures products against faking, counterfeiting and diversion. It uses ICT software application to inform consumers about the origin and safety of their drug. In fact fake pharmaceutical are a massive problem in the developing world, where they account for 30% of all medicine on sale and kill up to 2000 people daily. Initially developed for medications only, nowadays it aims at ensuring the quality of all life-impacting products.

mPedigree allows buyers to send a free text message with the product code to a universal number and quickly receive a response to authenticate the purchase. Fast, secure, and easily accessible it protect customers in regions with low literacy and low technical capacity. In addition it enables distributors and other middlemen to check that the supply chain has not been compromised.

mPedigree matches the technology platform to the regional infrastructure, using a cloud-based data system while leveraging the high penetration of mobile phones. The firm now works with 20 telecom companies, has appeared on 6.5M medicine packs and is adopted as the national standard in three different countries. According to McKinsey study it reaches up to 50 percent of current usage with significant economic and social impact.

To sum up how the practical examples previously presented contain most qualities of frugal innovation products and implemented many of their best practices, the diagram of *Figure 8* was developed.

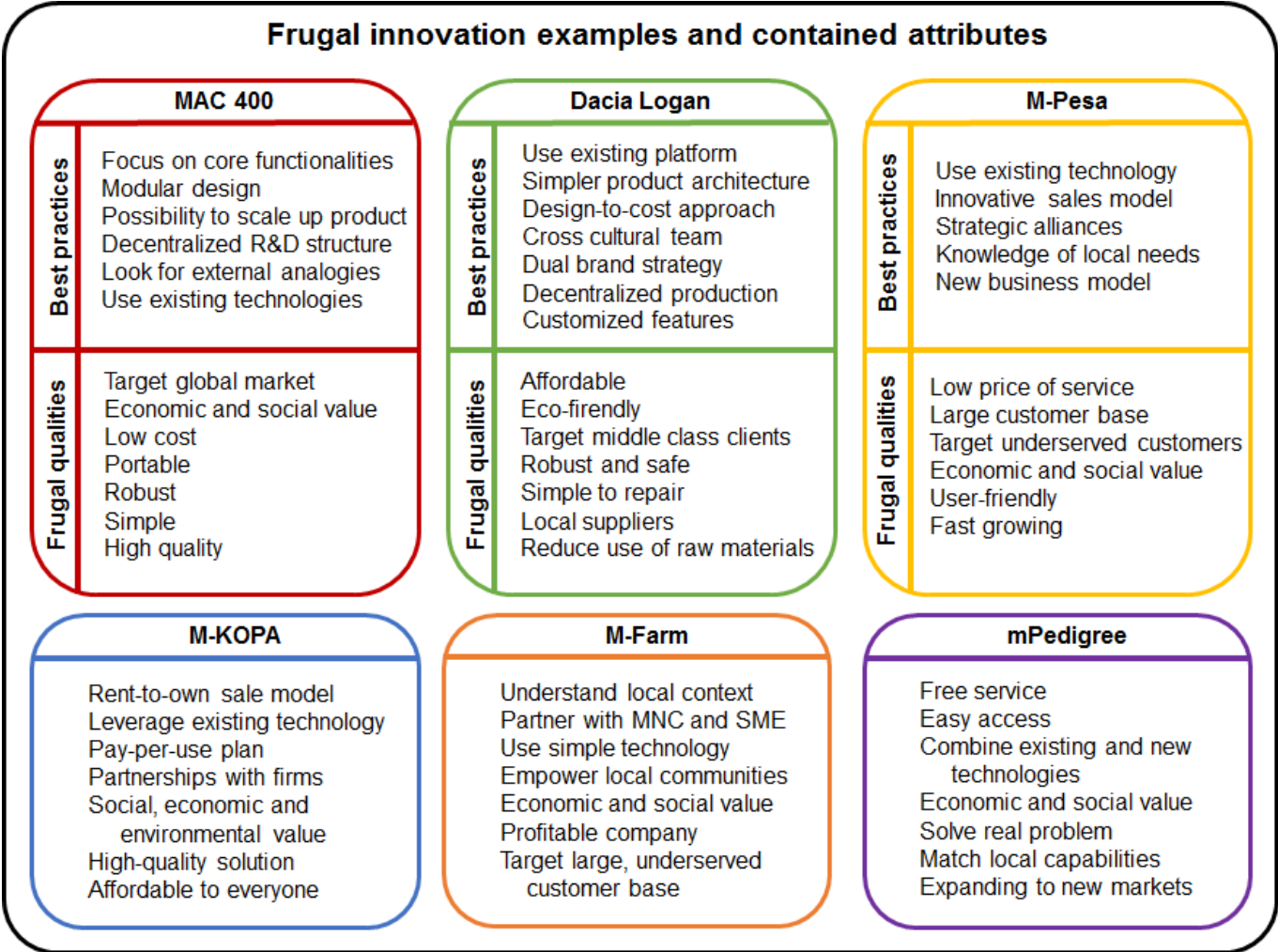


Figure 8 - Frugal innovation examples and contained attributes

### 2.1.7 Theoretical Models

Only few researchers attempted to conceptualize the frugal innovation process. While some models lack of empirical foundation and others do not capture the frugal approach holistically, they generally do not deliver practical insights about the management of frugal product.

**Bhatti (2012)** describes how the different perspectives of Technology innovation, Institutional innovation and Social innovation individually occur in emerging market. Each of these concepts stems to provide a solution for respectively resources, institutional and affordability constraints. Bhatti affirms that frugal innovation lies at the intersection of all three and is therefore a mix of social, business and institutional innovation. Furthermore he underlines the importance of frugal innovation being a knowledge-bridging mechanism across the different innovation theories, which is able to overcome the boundaries of resource, affordability and institutional constraints.

**Soni (2013)** studies the conceptual grounding of the frugal innovation phenomenon investigating three main topics: drivers, market conditions and success factors of emerging countries innovations. Firstly he identifies six antecedents that led to the frugal innovation development: a) Stagnating markets in the



western world, b) Global economic slowdown, c) Market potential of emerging economies, d) Availability of local talent in emerging economies, e) Movement towards green and sustainability, f) Diminishing returns to structured approach to conducting R&D. Secondly the author describes the unique characteristics that emerging markets possess to trigger frugal innovation growth: on the demand-side fierce competition and customer's affordability constraint, make them perfect lead-markets to pioneer frugal innovation; on the supply-side underdeveloped institutions encourage firms to find new ways to create value. Finally Soni offers five key recommendations for firms to address frugal innovation systematically: a) Identify lead markets, b) Create new price- performance ratio, c) Devise new business model, d) Foster external collaboration, and e) Adopt unconventional measurement metrics.

**Bhatti and Ventresca (2013)** propose a value chain framework to study how frugal innovation faces both resource scarcity and institutional voids. On one hand upstream suppliers face lack of inputs, such as capital, skill and labour, and have to deal with institutional complexities, e.g. absence of rules, contracts and legitimacy. On the other hand downstream customers with affordability constraints encounter lack of supply-chain and distribution infrastructure. The authors believe that being resources scarce at all points of the value chain, "affordability is not just a concern for the end market consumers, but for any firm wishing to employ another firm's outcome as input to its own process". Therefore from the supplier perspective a frugal solution has to be developed to achieve the needs of underserved consumers in constrained environments, while for the consumer it should be low-cost along all its lifecycle.

**Hamacher (2014)** depicts the frugal innovation process with a chain-linked model. The framework is constituted of a core innovation process which includes two parts: first understand the problem to be solved and then address customer needs with a product. Four additional elements are linked to the core process: three represent the sources of knowledge (research, external collaboration and internal resources) and the last is the driver of frugal innovation (compassion).

**Zeschky et al. (2014)** analyse how frugal innovations are built upon cost and good-enough innovation, as represented in *Figure 9*.

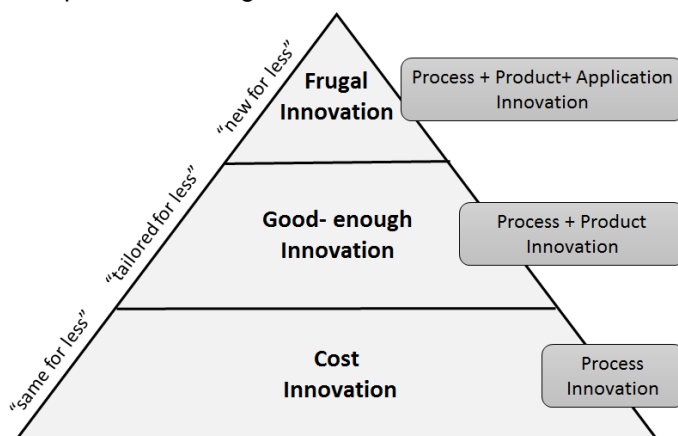


Figure 9 - Innovation Pyramid - Adapted from Zeschky (2014)

The author places at the base of the pyramid cost innovations, which are cheaper alternatives of western products obtained through process innovation. In the middle are located good-enough innovations, which are cost innovations, but particularly targeted at resource-constrained customers. To meet particular requirements non-value-adding functions are eliminated, while value-adding features are specifically designed. At the top of the

pyramid frugal innovations are found, since they include both cost and good-enough innovations, but involve an entirely new market application.

## 2.2 Supply Chain Management

### 2.2.1 Evolution of Supply Chain Management

The concept of Supply Chain Management (SCM) appeared in the 1980 when companies started to be increasingly challenged by intense global competition and ever-rising customer expectations. The application of just-in-time (JIT) manufacturing approach to increase flexibility and lower inventory, made companies realize the potential benefits of buyer-supplier partnerships (Tan, 2001). Specific trends in global sourcing and emphasis on time-based competition contributed to greater environmental uncertainty (Mentzer et al., 2001). Furthermore the shift from manufacturing quality to fast and precise product delivery as a competitive differentiator, created new opportunities for the development of companies' supply chains (Muysinaliyev et al., 2014). Organizations realized that effective and efficient management of supply chains is essential for present and future survival (Olhager et al., 2002).

According to Simchi-Levi (2000, p.1) Supply Chain Management refers to “a set of methods used to effectively coordinate suppliers, producers, depots, and stores, so that commodity is produced and distributed at the correct quantities, to the correct locations, and at the correct time, in order to reduce system costs while satisfying service level requirements”. SCM is the management philosophy that extends enterprise's activity outside the company and brings together downstream suppliers and upstream customers (Christopher, 1992). According to Ellaram (1991) SCM can be described as an integration of processes, systems and organizations to optimize the movement of goods from the supplier to the customer. Mentzer et al. (2001) derives three core SCM characteristic: (1) a systemic approach that views the supply chain as a whole, (2) a strategic orientation toward converged cooperative efforts, and (3) a customer focus to create unique value.

The main goals of SCM can be categorised as follows:

- Enable firms to deliver products at less costs and with superior value, by increasing the effectiveness and efficiency of the supply chain as a whole (Tan et al., 1998; Christopher, 1998)
- Enhance sustainable competitive advantage by systematically and strategically coordinate product, information and financial flows within and across companies (Serdarasan, 2013; Mentzer et al. 2001; Cooper et al. 1997)
- Reduce costs by matching supply and production to demand (Chou, et al, 2004)
- Improve customer satisfaction by offering greater delivery speed and flexibility (Flynn et al., 2010; Lambert and Cooper, 2000)
- Attain operational excellence to reduce inventory, lead time, production costs, wasted time and energy (Verma et al., 2006; Feller et al., 2006)

Supply chain management functions operate on three levels: the strategic, the tactical and the operational (Fox et al., 1993). Decisions within each level differ according to the importance and the time horizon considered. In particular they increase in detail level and decrease in planning horizon moving from strategic to operational (Fleischmann and Meyr , 2003). Strategic decisions concern the design and the structure of the supply chain, and have long-term effects, normally several years. Tactical decisions involve supply, production and distribution planning, and are reviewed from 6 to 24 months.

Operational decisions specify all detailed activities for direct execution and have a horizon ranging from days to a month (Singh & Shah, 2001).

SCM is aimed at examining and managing supply chain networks. A Supply Chain (SC) consists of two subcomponents: “(1) the organisations that make up the structure of the supply chain, and (2) the processes that make up the flows across the supply chain” (Park et al., 2013, p.50). According to Goetschalckx et al. (2002) the structure of the supply chain is constituted by the geographically dispersed facilities, such as suppliers, manufacturing plants, warehouses and markets, and the transportation links between them. The interconnected physical resources are involved in the four main processes of procurement, production, distribution and sales, which characterize traditional supply chains (Saunders, 1997; Fleischmann et al., 2002). The combination of all these efficiently performed activities generates value for the end customer (Christopher, 1998; Janiver-James, 2011).

### **Traditional Supply Chain (TSC)**

According to Mentzer et al., (2001, p.4) a supply chain is “a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer”. We conclude that a supply chain is characterized by three flows: material, information and money (Ayers, 2001). The materials, flow forward from the supplier to the end customer, the financial flow moves backward from consumption point to raw material source and the information is bidirectional (Zongwei, 2013). The organizations in the supply chain work together to better control, manage and improve these flows (Aitken, 1998). As Zongwei (2013, p.44) affirms “for a supply chain to achieve its maximum level of effectiveness and efficiency, material flows, money flows and information flows throughout the entire chain must be managed in an integrated and holistic manner, driven by the overall service and cost objective”. Since modern networks are highly complex and often a single organization can be part of numerous supply chains, different classifications have been proposed to characterize the SC. According to the organisational scope supply chains can be classified in ‘direct’, if only the immediate suppliers and customers are included, ‘ultimate’, if all firms until ultimate supplier and ultimate customer are reached, or ‘extended’, if it is somewhere in between the previous systems (Mentzer et al., 2001). The organizations are classified in relation to their nature as primary, if they directly add value to the output, or supporting, if they add value indirectly by sustaining the primary ones. Furthermore according to degrees of separation from the focal firm, organizations are grouped in tiers. The number of tiers describes the horizontal structure of the supply chain, which may be long or short, while the number of organisations within each tier determines the vertical structure of the supply chain (Park et al., 2013). Finally the functional scope of the supply chain expresses the types of business processes present in it (Arshinder and Deshmukh 2008; Cooper, Lambert, and Pagh 1997). Companies have realized that competition is shifting on the supply chain level (Christopher, 1992) and therefore establish relationships to tie their success to the SC as a whole (Cooper et al., 1997). In fact due to increasing complexity of the global environment, the performance of an organization is more likely to depend on the decisions and actions taken in its entire supply chain (Naslund & Williamson, 2010). However Alzawawi (2013) believes that “the traditional supply chains are based on a linear production paradigm which relies on constant input of virgin natural resources and unlimited environmental capacity for assimilation of wastes”.

## 2.2.2 Sustainable Supply Chain Management

### Green Supply Chain (GSC)

The concept of Green supply chain has been originated from three driving forces: the growing environmental concerns, such as resources exploitation, global warming and industrial pollution (Sheu et al., 2005; Hsu and Hu, 2007; Zhu and Sarkis, 2004); the competitive, regulatory and community pressures over corporations to take up ecological responsibility (Barve & Muduli, 2011; Darnall et al., 2008); and the increasing number of environmental conscious end-consumers (Solvang et al., 2007).

GSC stems from the inclusion of ecological factors into supply chain management principles (Gupta et al., 2013). GSCM can be defined as the set of activities executed in the design, sourcing, production, distribution, and disposal of goods and services to improve the environmental performance of the whole supply chain (Srivastava, 2007; Zsidisin and Siferd, 2001). GSCM practices involve suppliers, who need to guarantee the quality of their products, manufacturers, that are required to reduce the cost of waste in the system, and customers, which should improve their purchasing behaviour (Handfield et al., 2004; Darnall et al., 2008). All these actions enhance the development of environmental innovations to reduce the direct and indirect negative impacts of an organization (Hal, 2000).

Different researchers agree that the efficient management of firm's down and up-stream relationships, with focus on green practices, can increase both environmental and economic performance, leading to financial and operational benefits (Vachon and Klassen 2006; Seuring and Muller 2008; Pagell, Wu et al. 2010). According to Srivastava (2007, p.16) "GSCM can reduce the ecological impact of industrial activity without sacrificing quality, cost, reliability, performance or energy utilization efficiency". Zhu and Sarkis (2004) add that it allows companies to achieve profit and market share objectives, while lowering environmental risks. Furthermore green supply chains improves the organization's public perception and deliver greater customer value since they reduce waste, preserve natural resources and prevent pollution (Zhu and Geng, 2001; Hervani et al.; 2005). To summarize GSC create win-win opportunities for all business stakeholders ensuring various advantages which are listed in *Table 4*.

Table 4 – Advantage of green supply chain implementation

Advantages / Authors		Authors									
		Zhu and Sarkis (2004)	Srivastava (2007)	Darnall et al. (2008)	Hasan (2013)	Zhu and Geng (2001)	Rao & Holt (2005)	Fortes (2009)	Hervani et al. (2005)	Sheu et al. (2005)	
Economic	Increase revenues	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Raise market share	✓		✓	✓		✓		✓		
	Deliver competitive advantage	✓		✓		✓	✓	✓	✓		
	Reduce cost	✓	✓	✓	✓	✓	✓	✓			
Environmental	Prevent pollution	✓		✓	✓	✓	✓		✓	✓	
	Protect nature	✓		✓					✓	✓	
	Conserve resources		✓		✓		✓		✓		
	Minimize waste	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Preserve the product-life quality		✓					✓			
	Raise eco-efficiency	✓	✓	✓	✓	✓	✓	✓			

Since all stages of a product's lifecycle influence its environmental impact (Zhu et al., 2007; Gupta et al., 2013), GSCM is the sum of various conjunctive processes: Green Supply Chain Management = Green Purchasing + Green Manufacturing/ Materials Management + Green Distribution/Marketing + Reverse Logistics (Hervani et al., 2005). Rao and Holt (2005) further divided the GSC activities into four categories, which are inbound logistics, production or internal supply chain, outbound logistics and reverse logistics. The first focuses on suppliers' integration to create a participative decision making process; the second aims at developing efficient manufacturing processes, which reduce pollution, energy and waste; the third deals with innovative practices in marketing, packaging and transportation, and the fourth guarantees profitable recycling and remanufacturing of products.

The different practices employed in GSC are summarized in *Table 5*.

*Table 5 – Best practices of green supply chain*

(1) Sacaluga and Frojan (2014); (2) Rao and Holt (2005); (3) Hervani et al. (2005); (4) Zhu and Sarkis (2004)

Inbound logistics	Design
Training suppliers about environmental objectives (1) (2) (4)	Replace hazardous materials (2) (4)
Purchase environmental friendly materials (3)	Use LCA analysis (1)
Cooperate for eco-design, production and packaging (1)	Reuse, recycle, recovery of material, component and parts (2) (4)
Certify suppliers (ISO 14000) (1) (3) (4)	Use environmentally-friendly raw materials (2)
Provide environmental requirements for purchased items (4)	Reduced consumption of material (4)
Green purchasing: reduce waste, substitute scarce materials (3)	Design for environment (3) (4)
Promote environmental innovation (2)	Cooperate with customers for eco-design (1) (4)
Chose suppliers by environmental criteria (1) (2)	Improve energy use (2) (3)
Recycle and re-use packaging (1) (3)	Reduce solid waste production (2) (3)
Share know-how within the same industry (2)	
Production	Outbound logistics
Environmental friendly raw materials (2)	Green marketing and eco-labelling (2) (3)
Reduce use of raw materials (4)	Environmental friendly waste management (2)
Minimize energy consumption (3)	Standardized reusable packaging (1) (2)
Recycle, recover and repair products (4)	Recover of end-of-life products (2) (3)
Optimization of processes to reduce waste and emission (1) (2)	Good warehousing layout (1)
Pollution prevention (1) (2) (3)	Closed-loop approach for waste, energy and materials (1) (2)
Adopt cleaner technologies (2)	Environmental friendly distribution (2) (3)
Lean production (1) (2)	Easy access to information (2)
Minimise non-value adding activities (2)	Re-design logistic networks (1)
Reduce buffers (2)	Reduce number of warehouses (1)

### **Sustainability Historical Development**

Sustainability is the integration of social and environmental factors in the economic activity (Dyllick and Hockerts, 2002; Carter and Rogers, 2008; Gupta et al., 2013). In 1987 the Brundtland Commission described sustainability as the development that "meets the needs of the present without compromising the ability of future generations to meet their needs" (WCED, 1987, p.8). Until the 1990s the term was inappropriately interchanged with 'environmentalism' and an explicit consideration of social aspects was missing. In the 2000s authors expanded earlier definitions adding to the environmental and social

scopes, the economic dimension of profiting sustainability. Elkington (1998) developed the 3BL (Triple Bottom Line) accounting framework, which measures sustainability as the intersection of environmental, social and financial performance. The 3BL evaluate a firm’s success according to its results in the three dimension of People, Profit and Planet. According to Elkington (2004) companies pursuing sustainable consumption leverage competitive advantage by increasing revenues and reducing impacts on nature and society. In the same decade the concept of CSR (Corporate Social Responsibility) started being considered necessary for a company’s financial success (Vogel, 2005). CSR refers to the idea that corporation’s commitment to ethical business behaviour contributes to economic development and improves the life quality of the society as a whole (WBCSD, 1998). The extension of social and ethical responsibility over a network of stakeholders (Carter and Jennings, 2004; Humphrey and Surgeon, 2005; Halldorsson et al., 2009) originated the concept of Purchasing Social Responsibility (PSR). Table 6 lists the previously analysed theories and describe to which degree they cover sustainability concepts.

Table 6 – The coverage of sustainability concepts - Source Park et al. (2013)

Stage in supply chain: streams of SCM research	Design	Sourcing	Production	Distribution	Consumption/Use	Disposal
Reverse logistics	◐	○	◐	◐	●	●
Triple bottom line	○	◐	●	●	◐	◐
Green SCM	●	●	●	●	◐	◐
Corporate social responsibility	○	●	◐	◐	●	◐

○ : Very limited if any consideration  
 ● : Comprehensively addressed  
 ◐ : Partially or only more recently considered

**Sustainable Supply Chain (SSC)**

SSCM evolved as an integration of several approaches studying sustainability (Park et al., 2013) and integrates the three dimensions of the 3BL framework to achieve economic, environmental and social goals. The term has been used for the first time in 1997, when New (1997) argued that SCM should explicitly consider ethical, political and economic implications. Numerous definitions were then given in the attempt to unify diversified concept from various angles of analysis.

**Seuring and Müller** (2008, p.2) defined SSCM as “the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements”. According to the authors SSC are triggered from internal and external pressures applied on focal companies, which in turn are passed on to suppliers. The main drivers that motivate firms to the move towards creating sustainable supply chains, can be classified as (1) legal demands/regulation, (2) customer demands, (3) response to stakeholders, (4) competitive advantage, (5) environmental and social pressure, (6) reputation loss, (7) internal business process, and (8) financial reasons (Seuring and Müller, 2008; Mann et al., 2010). According to the authors (p.7) SSCM “has to take into account a wider range of issues and, therefore, look at a longer part of the supply chain”, which means that to avoid risks associated to global sourcing, the

responsibilities of focal firms are extended beyond first-tier suppliers. To ensure that products are truly 'sustainable' along all operational process, trustful and integrated partnerships must be built with 'lean and green' suppliers. The increased cooperation in the supply chain leads to much deeper information flows, which provides suppliers with detailed insights of product's life-cycle. Ultimately (p.7) SSCM "deals with a wider set of performance objectives", that apart from the traditional goals of quality, speed, flexibility and cost, takes into account the environmental and social dimension of sustainability.

**Carter and Rogers** (2008, p.10) stressed the fact that by integrating social, environmental, and economic goals in business processes, SSCM can "improve the long-term economic performance of the individual company and its supply chains". They further developed a SSCM framework, where sustainability is evaluated in the dimensions of the triple bottom line and achieved through four enablers:

1. Strategy - sustainability must play an important part in formulating business strategy
2. Risk management - develop contingency plans for supply and demand disruptions
3. Organizational culture - integrate high values and ethical standard in firm's behaviour
4. Transparency - manage communications with stakeholder and suppliers in a visible way

The highest economic results and the best sustainability level are placed in the intersection of environmental, social, and economic performance. Companies which seek to simultaneously maximize performance of all three 3BL dimensions will outperform organizations that attempt to maximize only a single dimension (Carter & Rogers, 2008).

**Pagell & Wu** (2009) believe that SSC can enhance a company's performance in three dimension: profit, society and nature. According to the authors companies need to undergo three phases in order to achieve SSC. First sustainability must become an integrated part of the firm's culture, which means that managers should possess proactive disposition and a deep commitment level to orient the innovation capability toward long-term sustainability goals. Second new behaviours, such as collaboration with non-traditional supply chain members and a focus on supply base continuity, will arise. Third an economically viable supply chain, that performs high in all the sustainability dimensions, can be achieved and must be maintained through periodic rewards and incentives.

According to Eltantawy et al. (2009) SSCs manage products and services in a fair manner that meets or exceed societal norms, even if not legally required. Tate et al. (2010) concludes that sustainability in supply chains can be seen as the incorporation of the 3BL approach into operations and SCM strategies. Finally Sacaluga and Frojan (2014) describe SSCM as a proactive approach that aims at reducing the negative impacts of supply chain's activity on people and nature.

Sustainable supply chains provide some triggers, e.g. higher development costs, need of extra training and coordination complexity, but their implementation offers numerous benefits, listed in *Table 7*.



Table 7: Benefits of SSC implementation

(1) Hasan (2013); (2) Craig & Dale (2008); (3) Morana (2013) (4) Teuteberg & Wittstruck (2010); (5) Brammer et al. (2011)

Benefit	How it is obtained
Enhance reputation (1) (2) (3) (5)	Engage in sustainable behaviour to be more attractive for suppliers, customers, employees and shareholders
Obtain long-term competitive advantage (2) (3) (4) (5)	Increase customer satisfaction and loyalty by fulfilling the demand for environmentally friendly products
Reduce production costs (1) (3) (4) (5)	Innovate the design ability to reuse, disassembly and recycle materials, components and packages
Lower labour costs (2) (5)	Create better working conditions that increase motivation and discourage absenteeism
Reduce health and safety costs (2)	Implement safer warehousing and transportation
Improve product quality (1) (2) (3) (5)	Strengthen strategic alliances and introduce ISO 14000 standards
Proactively shape future regulation (2) (5)	Model difficult-to-replicate processes
Minimize risk (1) (3) (5)	Use ethical labour and fair trade practices

### 2.2.4 Supply Chain Management and Frugal Innovation

Only few authors attempted to study supply chain management for frugal innovations, Radjou & Prabhu (2015) and Millstone (2014), however some practical implications about SC design for these type of products can be derived also from the work of Fisher (1997) and Randall et al. (2003).

**Radjou and Prabhu (2015)** describe the SC strategies which are best suited for frugal products commercialized by western corporations and explain for each decision its advantages. They propose a decentralised production strategy, in which manufacturing facilities are moved back to developed markets (reshoring) to cut distribution costs, reduce carbon emissions, decrease time-to-market and increase internal collaboration. Then factory-agnostic products with modular design and standardized components are suggested, in order to enable postponement techniques to cost-effectively mass customize at the point of distribution. Regarding procurement decisions, the authors underline the benefits of local sourcing, e.g. reduce risk and increase flexibility, and the importance of choosing suppliers according to responsiveness and reliability criteria rather than costs. For the distribution activity local networks and resource sharing are advised, to deal with last-mile challenges and keep asset fully utilized. Finally they recommend the implementation of an ERP software to share inventory level and order data from suppliers and retailers.

**Millstone (2014)** focuses on the relevance of the design phase which should leverage an open-innovation system for knowledge sharing and ensure that the greatest number of frugal attributes are integrated in the product. Furthermore she suggest the shortening of the supply chain by placing numerous small-sized factories close to the suppliers and to the final market, in order to limit the environmental impact of transportation. The author also recommends the use of responsible sourcing practices and the development of labour intense manufacturing activities. Finally she stresses the importance of companies offering services rather than products and highlights that efficient transportation is a necessary condition for the circular product flow between business and customer.



Finally **Fisher (1997)** and **Randall et al. (2003)** studied how according to the nature of the product, i.e. innovative or functional, two different supply chain have to be structured, i.e. responsive or efficient. The authors affirm that for functional products, which are characterized by stable demand, long life-cycle and low contribution margins, the supply chain has to be designed to minimise production and distribution costs while maximizing plant and workforce utilization rate. On the other hand for innovative products, which have unpredictable demand, short life-cycle and high contribution margins, is suggested a responsive supply chain that leverages lead time reduction and good inventory management. In this context frugal innovation products are placed between the two models, since they employ modular design, postponement and supplier selection for flexibility criteria (responsive SC), but also need economies of scale and large batch sizes to make offerings affordable (efficient SC).

### 2.3 Conclusions

Frugal innovations target the low-mid market segment with affordable solutions that effectively respond to customer's needs. In the last years frugal products gained public attention due to their ability to effectively tackle macro-economic changes. These transformations include the growth of the global middle class, the increased awareness about sustainability concerns, but also the strengthening of social responsibility issues. Frugal innovation's focus on simple and robust solutions that can balance low profit margin with high sales volumes. In order to reach these extreme performance objectives and overcome the high-quality at low-cost trade-off, new business models need to be developed. In particular product's features have to be redesigned from scratch, while adapting existing technologies. Furthermore to obtain knowledge about the local context and understand specific needs, external collaboration should be fostered. The literature review shows how the concept of frugal innovation can be used as an integrating mechanism, which embraces all the relevant characteristics of other innovation theories emerged in developing countries. Relevant examples demonstrate how frugal products do not only represent profitable business opportunities, but can also enhance the sustainable development of local communities and the environment. However the literature review shows that previous studies lack in consistency, since they approach frugal innovation from a macro-viewpoint and therefore fail to provide practical implications. The concept of SCM appeared to face increasingly global competition and ever-rising customer expectations as it was proved to enhance sustainable competitive advantage, reduces lead times and minimise the costs of corporations. Progressively the growing complexity of global networks and increasing concerns about sustainability issues, forced companies to extend their responsibility to bottom and upstream tiers. Corporations started to introduce the 3BL approach in their supply chain operations, developing SSCs that not only improve long-term economic performance, but also prioritize environmental and social goals. SSCM developed as a response to increasing external pressures for reducing the negative effects of supply chain activities. However researchers acknowledge it guarantees various benefits, as it reduces cost and risks, while increasing quality. Even if SSCM possesses the integration capabilities and the global optimization objectives that could provide a powerful context for enhancing frugal product's sustainability, few research on the theme has been performed. SCM is seen as an efficient instrument that can leverage the competitive advantage of frugal innovation products, but studies on the link between supply chain practices and frugal products are scarce and unstructured.

### 3. Research Methodology

The research methodology employed is a multi-methodology approach (Mingers and Brocklesby, 1997) based on four complementary investigation strategies: Literature Review, Grounded Theory, Semi-structured Interviews and Case-study Analysis (Saunders, et al., 2009). While the first two methodologies are employed for the development of the framework, the other two are necessary for the validation of the model. The combination of different approaches for the qualitative research analysis was chosen in order to a) facilitate the gathering of relevant information, b) allow data triangulation, c) enable theory testing and d) collect feedbacks for the model validation.

This chapter describes how each methodology has been applied in the present study. Section 3.1 explains the systematic data collection performed through the literature review. In Section 3.2 the grounded theory is used as basis for the organization and structuring of information. Then Section 3.3 presents the activities performed to select the sample and to develop the interview guides. Finally in Section 3.4 the multiple-case study approach is described and the notions from the field investigation are summarized.

Figure 10 resumes the structure of the chapter and the methodologies employed.



Figure 10 - Methodology overview

#### 3.1 Literature Review

The first research strategy consisted of a comprehensive literature review. As suggested by Flick (2009) it was decided to start the study by using theoretical, empirical and methodological literature, with the purpose of contextualizing, comparing and generalizing the research findings. Furthermore it was important to employ existing literature for grounding argumentations and show that the developed theories are in concordance with current research (Strauss and Corbin, 1998).

The literature review had the aim of identifying and selecting a collection of best practices which can be employed to manage frugal products. To achieve the final goal two intermediate objectives were fixed: on one side the research focused on the area of sustainable supply chain management in order to gather strategies that could be transferred to the frugal innovation context, and on the other side various sources of knowledge were screened to find examples of frugal products.

As the former topic is a consolidated field, the search of relevant material was performed through online libraries, publishers and databases, e.g. Google Scholar, Wiley and Springer, using the keywords “sustainable supply chain”, “green supply chain”, “corporate social responsibility”, “sustainability” and “closed-loop supply chain”. The research returned over 300 results, but after an initial data treatment 90 documents were judged relevant for further analysis and at the end of the review 47 papers were selected for in depth investigation. The majority of the articles were discarded from the sample as they

did not contain any practice which could be used in the frugal innovation domain and were therefore out of our research scope.

On the other hand the latter topic required a more detailed search due to the lack of clarity and novelty of the theme. In order to identify examples of frugal products both academic and non-academic material has been employed. Firstly different databases, namely Google Scholar, Science Direct and Research Gate, have been screened to select per-reviewed papers. Secondly consultancy reports, online journals, foundation disclosures and specific websites, which were appropriate for the study, have been examined. The terms employed for the keyword research were “frugal innovation”, “jugaad”, “social innovation”, “resource-constrained innovation”, “inclusive innovation”, “reverse engineering” and “bottom of the pyramid”.

The most significant sources of knowledge that were employed in the frugal innovation data sampling are represented in *Table 8* and divided in five categories according to the genre. Different fonts of information have been used due to the newness of the theme, which limited the information availability, and to allow data triangulation (Yin, 2013).

*Table 8 - Sources for the frugal innovation literature review*

<b>Academic Papers</b>	<b>Foundations and Organizations Disclosures</b>
Wooldridge (2012)	OECD
Radjou et al. (2012)	Nesta UK
Rao (2013)	Inclusive Business Action Network
Basu et al. (2013)	Seed
Hamacher (2014)	Inclusive Business Hub
Tiwari and Herstatt (2014)	Business Call to Action
Brem and Wolfram (2014)	Miller Centre
Pansera and Owen (2015)	Greater Impact Foundation
Angot and Ple (2015)	Siemens, Tata, Renault
Lehnerey al. (2016)	Venture Capital for Africa
<b>Consultancy Reports</b>	<b>Websites</b>
Roland Berger (2014 , 2015)	Mc Kinsey on Society
Mc Kinsey (2014)	Energy Map
AT Kearney (2014)	The Venture Alumni
Cambridge Consultants (2015)	Change Makers
Accenture (2015)	GSBI Accellerator Pitch
Capgemini Consultants (2016)	Social Impact
<b>Magazines, Books and Newsletters</b>	Impact Journalism Day
Radjou and Jaideep (2012)	African Startup Ventures
Radjou and Jaideep (2015)	Global Giving
Harvard Business Review	Young World Inventors
The Economist	United Nation Momentum for Change
The Guardian	Off Grid Quest
Stanford Insights	Ted
	United Nations Development Programme

The research returned over 120 products that related to frugal innovation or similar concepts. The interpretation and treatment of data was strongly necessary to narrow the boundaries of the investigation and identify only those solutions which can be classified as frugal. The criteria employed to select relevant product and services were two: they had to be a) cheaper than available alternatives in the market and b) tackle social or environmental issues. As a result from the research the database presented in *Table 9* was created. It contains 62 frugal innovations that belong to 12 industry sectors and have been developed in 21 different countries.

*Table 9 - Company sample*

Company	Product	Industry	Country	Size	SC Echelon
MotionECO	Biodisel	Oil & Gasses	China	Micro	Upstream
Husk Power Systems	Rice Husk Gasification	Oil & Gasses	India	Large	Upstream
Eco-Fuel Africa (EFA)	Carbon neutral fuel	Materials	Uganda	Small	Upstream
ProPlanet	Recycled tapperware	Materials	Colombia	Small	Upstream
Rematerials	ModRoof	Materials	India	Micro	Upstream
Clean Cookstoves	Technology and fuels	Materials	USA	Small	Upstream
Conceptos Plasticos	Recycled plastic houses	Utilities	Colombia	Small	Upstream
300\$ House	Affordable housing	Utilities	USA	Medium	Upstream
Reaction	Exo	Utilities	USA	Small	Upstream
Renault	Dacia Logan	Automotive	Romania	Large	Midstream
Tata Motors	Nano	Automotive	India	Large	Midstream
Mitti Cool	Mitti Cool Refrigerator	Consumer goods	India	Small	Midstream
Godrej & Boyce Manufacturing	ChotuKool	Consumer goods	India	Large	Midstream
Kenya Stove	Ecological stove	Consumer goods	Kenya	Micro	Midstream
Ghana Bamboo Bikes	Bamboo Bicycle	Consumer goods	Gahna	Small	Midstream
Mozambikes	Advertising Bicycle	Consumer goods	Mozambique	Medium	Midstream
Solar Cooker International	CooKit	Consumer goods	USA	Micro	Midstream
Solar Serve	Cookstoves	Consumer goods	Vietnam	Small	Midstream
Glatt Stove	La Estufita	Consumer goods	Mexico	Medium	Midstream
Optic Group ICH	Recycled PET glasses	Consumer goods	Mexico	Small	Midstream
BanaPads	Banana pad for women	Consumer goods	Uganda	Large	Midstream
M-Kopa solar	IV Solar Home System	Consumer goods	Kenya	Large	Midstream
Nokia	Nokia 1200	Electronics	Finland	Large	Midstream
Logitech Computer	Mouse M215	Electronics	USA	Large	Midstream
DataWInd Inc	Ubislate 7	Electronics	India	Large	Midstream
Foldscopes	Folding microscope	Health care	USA	Micro	Midstream
Coolar	Solar energy fridge	Health care	Germany	Micro	Midstream
General Electric	Logiq Book	Health care	USA	Large	Midstream
General Electric	MAC 400	Health care	USA	Large	Midstream
Siemens	Tomography Scanner	Health care	Germany	Large	Midstream
Philips	Monitoring System	Health care	Netherlands	Large	Midstream
Embrace Global	Embrace Warmer	Health care	China	Large	Midstream
Tata Chemicals Limited	TataSwatch	Health care	India	Large	Midstream
D-Rev	ReMotion Knee	Health care	USA	Small	Midstream
BMVSS	Jaipur Foot	Health care	India	Large	Midstream

Table 9 - Company sample (continuing)

Company	Product	Industry	Country	Size	SC Echelon
CVDW	Child Vision	Health care	England	Small	Midstream
GRIT	Grit Freedom Chair	Health care	USA	Small	Midstream
Ion Ag+	Water Filter	Health care	Mexico	Micro	Midstream
Mettler Toledo	Basic Weighing Scale	Industrials	Switzerland	Large	Midstream
G-Thrive	gthrive	Industrials	USA	Micro	Midstream
First Energy	Oorja	Industrials	India	Medium	Midstream
IluMexico	Solar Systems	Industrials	Mexico	Medium	Midstream
HabiTec	Wood Furniture	Industrials	Angola	Small	Midstream
KickStart	Water pump	Industrials	USA	Medium	Midstream
Lotus Foods	Rice sales	Retail	USA	Micro	Downstream
Global Cycle Solutions	Sun King Mobile Light	Retail	Tanzania	Small	Downstream
Onergy	Solar system	Retail	India	Medium	Downstream
We Care Solar	Solar Suitcase	Retail	Tanzania	Micro	Downstream
Pollinate Energy	Solar Systems Retail	Retail	India	Small	Downstream
Global Easy Water Products	Irrigation system	Retail	India	Small	Downstream
Empower Generation	Solar products	Retail	Nepal	Small	Downstream
Thrive	Solar products	Retail	India	Small	Downstream
A Little World	Rural banking	Financials	India	Large	Downstream
Safaricom	M-Pesa	Financials	Kenya	Large	Downstream
Kopo Kopo	Mobile money platform	Financials	USA	Small	Downstream
Aravind Eye Hospital	Eye Care System	Consumer services	India	Large	Downstream
Narayana Health	Health City	Consumer services	India	Large	Downstream
Naandi:	Water services	Consumer services	India	Medium	Downstream
Echale a tu casa	Affordable housing	Consumer services	Mexico	Micro	Downstream
Jibuco	Drinking water access	Consumer services	Rwanda	Medium	Downstream
mPedigree	Heath application	Information Technology	Nigeria	Micro	Downstream
M-Farm	Agriculture application	Information Technology	Kenya	Micro	Downstream
<b>62 Products</b>		<b>12 Industries</b>	<b>21 Countries</b>		

A more detailed analysis of the sample can be consulted in Annex A. In particular a characterization of the dataset is performed to investigate the distribution of the companies according to the size and the industry sector.

### 3.2 Grounded Theory

The second investigation strategy employed is the Grounded Theory (GT). GT is a general inductive research methodology that aims at generating theory from the simultaneous collection and analysis of data (Glaser and Strauss, 1987). The method consists of a well-developed set of procedures and analytical techniques that “seek to move beyond particular meanings to identify general patterns and regularities” (Charmaz, 1983, p. 93).

By using a “construct oriented” approach it was created a set of formal and substantive theoretical constructs that provide a full explanation of how to adapt SCM practices for frugal innovations (Dillon, 2012). GT does not start with pre-existing conceptualizations, as the objective is to build theory rather than testing hypotheses. Furthermore, by deriving principles from data, grounded theory is more likely to offer insights that resembles the reality and provide a meaningful guide to action (Strauss and Corbin, 1998). The method “provides researchers with analytic tools for handling masses of raw data” (Strauss and Corbin, 1998, p.28) and achieve generalization through the abstraction of concepts.

Even if Glaser and Strauss (1967) advocate that GT should be performed without looking at existing literature, the author preferred to employ a through literature review as it helped in the design of theoretical frameworks and in the comparison with empirical evidence (Eisenhardt, 1989). The grounded theory approach was therefore employed in the second stage of the research and in particular it offered the methodological foundation for developing the frugal innovation model for SCM.

The procedure used for the GT research was based on three main processes: open coding, axial coding and selective coding. The coding process was necessary to move from the empirical material to the abstraction of the developed theory.

1. Open coding: the data collected from the literature review was articulated to develop conceptual categories and generate properties that describe their qualities. Microanalysis has been employed, i.e. line-by-line analysis to suggest relationships among categories, to compare and uniform the data obtained from different sources, namely *Table 8*. Finally, theoretical sampling was used to obtain more abstract and general concepts to describe the phenomena. The main categories developed were related to patterns and set of actions to solve problems or overcome specific issues, e.g. sale strategies, design features, distribution solutions.
2. Axial coding: the initial lower-level concepts were combined into higher-level categories by identifying similarities. Data was reassembled and linked for a more precise explanation of the phenomenon and with the aim of adding depth and structure to the categories. The conditions, interactions and consequences of the issue were recognised as to discover how categories related to each other. The activities previously decomposed were constantly compared between each other and reconnected according to shared objectives, e.g. affordability, social inclusion, availability.
3. Selective coding: categories were refined and integrated to form the core concepts that constitute the framework. Unnecessary components were removed to guarantee the consistency of the developed theory.

### 3.3 Semi-structured Interviews

A semi-structured interview is a set of questions on pre-determined topics. The aim is to provide a basis for interpreting statistically significant findings and to generate hypotheses for later quantitative studies (Flick, 2009). This type of research strategy is suitable to address subjective theories, to explore interviewee's opinion about the topic and to validate the collected empirical material. Normally an interview guide is developed and it contains open questions followed by hypothesis-directed and confrontational ones.

Open questions "may be answered on the basis of the knowledge that the interviewee has immediately at hand" (Flick, 2009, p.156) and therefore include explicit opinions and immediate assumptions. Hypotheses-directed questions "are oriented to the scientific literature about the topic or are based on the researcher's theoretical presuppositions" (Flick, 2009, p.157), hence they are used to make implicit knowledge more explicit. Confrontational questions "respond to the theories and relations that the interviewee has presented up to that point in order to critically re-examine these notions in the light of competing alternatives" (Flick, 2009, p.157).

The following sections will first explain the criteria employed to select the interview sample and then describe the interviewees. Due to the novelty of the theme it was decided to contact companies, as well as experts in the field of frugal innovation. This enabled the collection of different types of validation: the first set was more focused on the comparison between the practices recommended in the framework and the ones performed by the firm, while the second set comprised suggestions and feedbacks to the model.

#### 3.3.1 Companies

In order to choose the companies to be interviewed, it was decided to employ the sample previously created in the literature review section, namely *Table 9*. From the 62 firms contained in the table, 19 were discarded, as they did not perform most of the phases included in the framework and could not be used for the validation process. In particular these enterprises offered services that did not involve any procurement, production and disposal activities. Even if their solutions were employed to derive best practices for the frugal innovation process, the amount of actions undertaken was too limited to enable the framework testing. Lastly the final dataset includes 43 companies. It represents a consistent and balanced sample, as it entails a cross-country and cross-industry set of firms from different SC echelons and of various dimensions, as discussed in Annex A.

The 43 companies have all been contacted twice by mail and 6 of them answered positively, allowing the interview. *Table 10* summarizes the information about the interviewee, while a more detailed description of the firms is presented in Section 3.4. It was decided to include in the table the name of the person interviewed, as well as the position held in the company. This information guarantees the reliability and validity of the answers, as it can be seen that all the respondents are committed in managerial roles and therefore have a deep knowledge of the strategy and the processes performed by the firm.



Table 10 - Companies Interviewed

Company	Interviewee	Position	Date
Gahna Bamboo Bikes	Solomon Owusu Amankwaah	Development Scientist & Strategist	11/06/2016
Glatt Stove	Carlos Glatt	Founder and CEO	13/06/2016
IluMexico	Ana Lucia Coll	Strategy and Innovation Director	12/07/2016
Mozambikes	Rui Filipe Mesquita	Co-Founder and Managing Director	18/07/2016
Jibu	Anne Welsch	Corporate Relationship Manager	18/07/2016
Global Cycle Solution	Rebecca Wentworth	Product & IT Manager	04/08/2016

### 3.3.2 Experts

It was decided to complement the companies' interviews with experts' consultations. Experts with a strong knowledge of the frugal innovation phenomenon were therefore selected to create a secondary sample.

In order to identify potential interviewees, two different strategies were used. On one side research institutes that are directly studying frugal innovations or related concepts were detected. This group comprised 4 research centres connected to universities and 1 non-profit association. After establishing a contact per mail, 3 out of 5 institutions answered positively to the interview request. On the other side individual specialists that have published articles, books and held conference on the theme were identified. This set entailed 8 experts, 7 of which were associated to universities. Mails have been directly written to the professionals and 3 offered their availability for the interview.

Table 11 shows the experts that have been interviewed and their position in the research institution.

Table 11 - Experts Interviewed

Interviewee	Institution	Position	Date
Tom Harmsen	Leiden - Delft - Rotterdam University	Coordinator of the Centre for Frugal Innovation in Africa (CFIA)	22/06/2016
Rajnish Tiwari	Hamburg University of Technology	Co-Founder and Managing Director of the Center for Frugal Innovation (CFI)	23/06/2016
Cornelius Herstatt	Hamburg University of Technology	Co-Founder and Managing Director of the Center for Frugal Innovation (CFI)	23/06/2016
Jaideep Prabhu	University of Cambridge	Director of the Centre for India & Global Business	27/06/2016
Venkata Gandikota	Nordic Frugal Innovation Society (NFIS)	Founder & President of the NFIS	29/06/2016
Elizabeth Sweeny	Santa Clara University	Programs and Partnerships Director of the Frugal Innovation Hub (FIH)	13/07/2016



### 3.4 Case-study

The case-study is an analytical research strategy based on empirical investigation of a specific phenomenon within its real-life context (Yin, 2013). The method is particularly appropriate for exploratory research as it generates theory (Gersick, 1988) and captures the processes in a very detailed and exact way (Flick, 2009). Furthermore it answers to the questions “why” and “how” the phenomenon occurs (Yin, 2013), producing great insights and relating the theory with the field investigation. To overcome the problem of generalizing theoretical understanding, multiple case-studies have been studied (Flick, 2009). This establishes reliability and guarantees the validity of the findings.

This section analysis in detail the six companies that agreed on being interviewed. In particular a clear protocol was created in order to summarize the information about the firms in a standardized manner. First multiple sources of evidence were consulted (Yin, 1984) to collect data. Then the material was categorized and sorted in a board in order to produce organic knowledge and systematize the large amount of data gathered.

The objective of the boards is to structure the companies' activities, as to facilitate the validation process, which is going to be presented in section 5.1. In particular the boards were used before the interviews to prepare questions specific for each company, and were update after the surveys with the additional information that emerged from the discussion. Due to space constraints and in order to avoid repetitions, the following sheets already include all the data gathered and constitute the post-interview version.

The sheet is divided into four parts: 1) contains an overview of the enterprise, 2) contextualises the problem addressed, 3) describes the business model, and 4) evaluates the triple bottom line impact. Structuring the board in sections allows quick consultation, but as well simplifies the conversion of narrative reporting in a standard format. The business model section follows the seven phases structure (design, procurement, production, distribution, sales, use and disposal) that is employed in the framework, see section 4.1. This organization of company's practices in the value-chain phases is crucial to then link the singular actions performed by a firm to the developed model. Furthermore the inclusion of a 3BL impact section facilitate a qualitative assessment of the product's sustainability performance.

*Table 12, 13, 14, 15, 16, and 17* present the board created for each of the interviewed company.

Table 12 – Company characterization: Gahna Bamboo Bikes Board

GHANA BAMBOO BIKES Key Facts			
<b>Product/Service</b>	High-quality multipurpose affordable bamboo bicycles		
<b>Sector</b>	Transportation	<b>Size</b>	Small
<b>Country</b>	Gahna	<b>Foundation Year</b>	2011



Problem Identification		
Low employment rate and widespread poverty	Environmental degradation	Traffic congestion

Business Model: invest profit from bicycle sales into community development in Gahna	
<b>Design</b>	<ul style="list-style-type: none"> <li>• Develop high quality bicycle frames using local and abundant bamboo.</li> <li>• Leverage the advantages of environmental-friendly raw material which is 100% organic and recyclable.</li> <li>• Design light and stable frames, which can handle rough terrain and carry heavy loads.</li> <li>• Offer different bicycle models according to the client necessities and customize the product with handmade paintings.</li> <li>• Ensure that feedbacks from the clients are included in the design to increase quality targets.</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>• Vertically integrated by creating its own bamboo plantation. For each bamboo used, the company plants ten new trees to guarantee material availability.</li> <li>• Certify the quality of the tires by collaborating with well-established partners.</li> <li>• Focus on the component availability and delivery time for the supplier selection.</li> <li>• Environmental and recycled materials are inexistent in the market.</li> <li>• Long-term partnerships are not a concrete option because frames represent most of the sales (70-80%).</li> </ul>
<b>Production</b>	<ul style="list-style-type: none"> <li>• Use labour-intense practices in small scale plants to reduce initial asset investments.</li> <li>• Minimize automatization to lower electricity consumption, create local employment opportunities and guarantee customized design.</li> <li>• Train workers through an initial boost-camp to overcome employees' lack of skills.</li> <li>• Import state of the art technology and expand the production line to benefit from economies of scale.</li> <li>• Automate time consuming processes (e.g. cutting) and keep manual value-adding activities (e.g. gluing).</li> </ul>
<b>Distribution</b>	<ul style="list-style-type: none"> <li>• Standard mail service are used for the transportation.</li> </ul>
<b>Sales</b>	<ul style="list-style-type: none"> <li>• The price is similar to average new bicycles: 250\$ for the frame and 300\$ for a complete bike, plus distribution costs. Second hand products cost around 150-200\$.</li> <li>• The main target market are European countries, while Gahnian clients are very few.</li> <li>• Partnerships with top ranking hotels are being established to develop renting services.</li> <li>• For every 10 bicycles produced, 1 is being donated to local communities.</li> </ul>

Triple Bottom Line Impact		
Economic	Social	Environment
Simulate economic development Support government with taxes Create employment opportunity	Alleviate poverty Empower rural women Support local associations	Frame is completely recyclable Natural resources are preserved Improve air and water quality

Table 13 - Company characterization: Glatt Stove Board

GLATT STOVE (La Estufita) Key Facts			
<b>Product/Service</b>	Highly-resistant portable stove that works with environmental friendly fuel		
<b>Sector</b>	Household Goods	<b>Size</b>	Medium
<b>Country</b>	Mexico	<b>Foundation Year</b>	2013



Problem Identification		
Diffused wood-cooking diseases	High cost of cooking fuels	Increasing deforestation

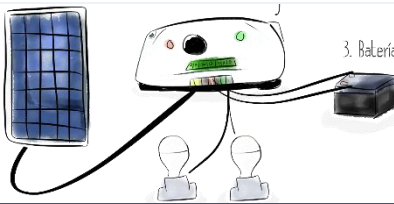
**Business Model: produce the most economic, ecological and efficient alternative to wood cooking**

<b>Design</b>	<ul style="list-style-type: none"> <li>• Develop the product to be simple, portable (1.3 kg) and aesthetically appealing.</li> <li>• Employ strength and durable materials (guaranteed for over 2 years).</li> <li>• Design numerous prototypes to find the best characteristics and then offer a unique standardized model. Create a universal platform that can be employed by different types of users and for various tasks.</li> <li>• Employ a modular architecture to facilitate disassembling and material recycling.</li> <li>• Engage with stakeholder to get feedbacks from clients and specialists.</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>• Vertically integrated by producing its own liquid fuel. The gas is ecological (emissions are 7 ppm vs 750000 ppm generated by wood burning), efficient (one liter lasts over 5 hours, while ethanol only 3 hours) and easy to transport.</li> <li>• Guarantee that suppliers are certified regarding labour practices and environmental protection. Employ local, ethical and fair-trade sourcing (certified B-corp).</li> </ul>
<b>Production</b>	<ul style="list-style-type: none"> <li>• Use automated and centralized production strategy to reduce unitary cost.</li> <li>• Local production based in Mexico.</li> <li>• Build a volume-driven plant with series manufacturing to leverage economies of scale.</li> <li>• Focus on process efficiency to minimize carbon emissions.</li> <li>• Use cross-industry analogy: imitate production process used for aluminium cans.</li> <li>• Offer better working conditions compared to the minimum legal requirements.</li> </ul>
<b>Distribution</b>	<ul style="list-style-type: none"> <li>• Develop different distribution channels: supermarkets and corner-shops for urban areas, micro-retailers for rural zones. Ensure product availability even in remote regions employing regional representatives of local communities.</li> </ul>
<b>Sales</b>	<ul style="list-style-type: none"> <li>• The price is lower than available alternatives: 10\$ the stove (normal camping gas cost around 30\$), 1\$/liter the fuel (bio-ethanol costs around 5\$/liter).</li> <li>• Partner with official institutions: 50% of the sales are totally paid by the customers, 50% are financed by the government through a 9\$ contribution.</li> <li>• Employ various marketing strategies: commercialize in public events, enable product testing in rural villages and engage with testimonials.</li> </ul>
<b>Use</b>	<ul style="list-style-type: none"> <li>• Train and educate customers through videos and workshops.</li> <li>• Suggest practices to reduce fuel consumption and follow sustainable behaviours.</li> <li>• Avoid product misuse by reducing the features (no flame regulation) and simplifying the use (just one hole to insert and recollect the fuel).</li> </ul>
<b>Disposal</b>	<ul style="list-style-type: none"> <li>• Components can be easily disassembled to reuse raw materials.</li> <li>• Aluminium is 100% recycled and the plastic 60% recycled.</li> <li>• Cradle to cradle: reuse plastic bottles for the production of plastic shovels.</li> </ul>

Triple Bottom Line Impact		
Economic	Social	Environment
Reduce the cooking costs Stimulate local economies Create investments opportunities	Improve people's health Increase time for working Offer better working conditions	Reduce deforestation Decrease carbon emissions Minimize waste production

Table 14 - Company characterization: IluMexico Board

ILUMEXICO Key Facts			
<b>Product/Service</b>	Affordable solar energy solution for marginalized rural areas		
<b>Sector</b>	Renewable Energy	<b>Size</b>	Medium
<b>Country</b>	Mexico	<b>Foundation Year</b>	2010



**Problem Identification**

Lack of access to electricity	Impoverishment of rural areas	Air pollution caused by kerosene
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**Business Model: deliver solar powered products using innovative distribution and sales model**


<b>Design</b>	<ul style="list-style-type: none"> <li>• Create wide range of products: home energy systems, water pumps, refrigerators, street lightening, electric fences and grid connected systems.</li> <li>• Offer solar systems of different dimensions according to the purpose: households, community centres, schools and health clinics.</li> <li>• All products are designed by in-house engineers to target both rural and urban population. Solutions are developed to bear extreme conditions and be practical, functional, easy to use and of high quality.</li> <li>• Listen, learn and implement solutions based on customers' experience and feedbacks.</li> <li>• Creating a suite of add-on products for a constant growing energy demand and needs.</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>• Foster strategic alliances with enterprises strongly committed to corporate social responsibility (e.g. Energizer, General Motors).</li> </ul>
<b>Production</b>	<ul style="list-style-type: none"> <li>• All products are manufactured in Mexico. Engage local population in the whole process of manufacturing, installation and maintenance.</li> <li>• Guarantee better working conditions (certified B-corp) and offer specialized training to the employees.</li> <li>• Install an ERP system to obtain instant data and support informed decisions (TaroWorks to share financial, commercial and historical data).</li> <li>• Create a replicable methodology with an open project access.</li> </ul>
<b>Distribution</b>	<ul style="list-style-type: none"> <li>• Develop an innovative last-mile distribution network to reach isolated communities (hub and spoke model). Employ a decentralized strategy based on small regional branches close to the final customers. Hire local technicians to work at the distribution centres.</li> </ul>
<b>Sales</b>	<ul style="list-style-type: none"> <li>• Partner with micro-finance institutions to help customers purchase the system.</li> <li>• Every family can choose a customized payment plan according to its capabilities.</li> <li>• The business model is designed to work on a 100% market based approach.</li> <li>• Marketing activities in remote areas are performed by rural promoters.</li> </ul>
<b>Use</b>	<ul style="list-style-type: none"> <li>• Provide technical assistance, maintenance services and local knowledge through regional distribution centres and representatives.</li> <li>• Offer accompanying workshops on financial and environmental education, sustainability, gender equality and participation tools.</li> <li>• Users can intuitively regulate the intensity of light through an electronic controller.</li> <li>• Enhance social participation schemes.</li> <li>• Possibility to install centralized systems for communitarian use that enhance sharing.</li> </ul>

**Triple Bottom Line Impact**

Economic	Social	Environment
Limit public investment on energy Increase family's income Reduce customer's energy cost	Increase quality of life Empower local communities Improve health conditions	Reduce CO <sub>2</sub> emissions Avoid dependency on fossil fuel Prevent grid connection

Table 15 - Company characterization: Mozambikes Board

MOZAMBIKES Key Facts			
<b>Product/Service</b>	Affordable quality branded bicycles locally assembled		
<b>Sector</b>	Transportation	<b>Size</b>	Medium
<b>Country</b>	Mozambique	<b>Foundation Year</b>	2012



Problem Identification		
Long travel distances to reach water, health centres and schools	Limited access to transportation	Inefficient bicycle industry

**Business Model: provide Mozambicans a safe, cheap and efficient mean of transport**

<b>Design</b>	<ul style="list-style-type: none"> <li>• Very simple bike aimed to carry heavy loads and work on bumpy roads (they feature reinforced and thicker tire, rear carrier, reflectors and a front light).</li> <li>• Universal model designed for both men and women.</li> <li>• High quality product: two times lighter than available alternatives (alloy frame vs. steel).</li> <li>• Talk to the customers to get feedbacks and improve the product</li> <li>• Expand product portfolio to include a variety of technologies and accessories that complement the existing bicycle (e.g. lights, baskets and helmets).</li> <li>• Design components for multi-purpose (e.g. the front light can be used as a lantern).</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>• Multiple sourcing from different Chinese retailers with a centralized delivery.</li> <li>• Partner with suppliers to define component specifications and ensure quality standards.</li> <li>• Work on a volume-driven scale to reduce costs (1200 bikes per shipment order).</li> </ul>
<b>Production</b>	<ul style="list-style-type: none"> <li>• Centralized assembly in Mozambique with home-grown trained technicians.</li> <li>• Bicycle are customized according to the client's needs.</li> <li>• Act with fair trade practices: employees earn 5 times the average Mozambican salary. Perform labour intense activities with the use of simple hand tools.</li> <li>• Assisting technicians to become small entrepreneurs.</li> <li>• Stimulate local secondary markets for bicycle accessories.</li> </ul>
<b>Distribution</b>	<ul style="list-style-type: none"> <li>• Build a last-mile channel and retail network to reach rural areas by partnering with large nationwide distributors: they receive commissions for regional warehousing and transportation to its network of retail locations.</li> </ul>
<b>Sales</b>	<ul style="list-style-type: none"> <li>• For-profit social enterprise that is completely financially self-sustainable.</li> <li>• Target 3 customer groups: clients who are able to afford the bike (pay 35\$), people who earns less than the minimum wage (get it for free through donations), corporations that purchase the bike for advertising (pay 130\$) and offer it to rural communities. The price for a standard bicycle in Mozambique is around 100\$.</li> <li>• Establish partnerships with different stakeholders (municipality, volunteering organizations and MNCs) to collect donations for social projects.</li> <li>• Partner with identified and trusted retailers.</li> <li>• Roll out the bicycles as a micro-loan program in partnership with KIVA.</li> </ul>
<b>Use</b>	<ul style="list-style-type: none"> <li>• Provide training and after-market service, including workshops for female riders and road safety campaigns.</li> <li>• Create decentralized maintenance centres. Offer manuals and tool kits for self-repair.</li> </ul>
<b>Disposal</b>	<ul style="list-style-type: none"> <li>• All waste products are recycled.</li> </ul>

Triple Bottom Line Impact		
Economic	Social	Environment
Reduce transportation costs Create local employment Increase branding firm's sales	Guarantee access to water, education and health Diminish overall distances	Reduce air pollution Decrease resilience on car or bus Avoid landfill for long-lasting bike



Table 16 - Company characterization: Jibuco Board

JIBU Key Facts			
<b>Product/Service</b>	Distribution network to provide lasting access to affordable drinking water for everyone		
<b>Sector</b>	Consumer service	<b>Size</b>	Medium
<b>Country</b>	Uganda, Rwanda	<b>Foundation Year</b>	2012



Problem Identification		
Limited access to drinking water	Extensive water-borne diseases	Latent economic potential

**Business Model: build a network of locally-owned franchise businesses to forge social entrepreneurs**

<b>Design</b>	<ul style="list-style-type: none"> <li>• Provide radically convenient (\$1 for 20L), high-quality drinking water to all underserved urban populations (safer and cheaper than the cost of wood for boiling water, affordable for over 80% of eastern Africans).</li> <li>• Use attractive, functional, returnable bottles (20 L, 7 L, 1.5 L volumes) sealed with a government quality certification. Employ an eco-friendly ultra-filtration equipment.</li> <li>• Leverage well-placed, high traffic storefronts to provide other life-improving products and services to their customers.</li> <li>• Peer-partner with local entrepreneurs to create a more effective co-investment model.</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>• Work with 2 African producers to supply robust and certified plastic bottles.</li> <li>• Source the solar-powered filters by Healing Waters International, who produces pressure-tested, custom-fit systems.</li> </ul>
<b>Franchising Model</b>	<ul style="list-style-type: none"> <li>• Raise capital through investments, low interest debt and grants to provide local entrepreneurs with water filtration equipment, financing, in-store supplies, a common brand, and training.</li> <li>• Franchisees pay a start-up fee and a per-liter-sold fee: breakeven is reached in 3 months.</li> <li>• Train and finance African entrepreneurs to stimulate responsible economic growth and be independent in solving their communities' challenges.</li> <li>• Develop an open source model intended to be copied by competitors.</li> </ul>
<b>Distribution</b>	<ul style="list-style-type: none"> <li>• Develop a decentralized distribution network: decrease the need for large infrastructure projects to pipe water. Partner with competitors to share transportation costs.</li> <li>• Leverage proximity by selling to 90% of the underserved population within walking distance of the store (2 km radius between each franchise).</li> </ul>
<b>Sales</b>	<ul style="list-style-type: none"> <li>• For-profit company that prioritizes impact-maximization with a high volume/low margin model: sell the product at 1/4 the market price to 6 million people in the next 5 years.</li> <li>• Franchisees sell direct-to-consumer and avoid most middleman retail mark-ups, transportation expenses and the cost of throw-away plastic.</li> <li>• Locate the stores near the community water sources that are closest to high population density areas. Focus on deep penetration and massive scaling: create hundreds of honeycombed community-focused storefronts.</li> </ul>
<b>Use</b>	<ul style="list-style-type: none"> <li>• Leverage the water distribution network as a platform to provide other essential products and services.</li> <li>• The filter operates on a renewable pump that minimizes energy consumption: pushes 30 liters per minute and uses less energy than a toaster.</li> </ul>
<b>Disposal</b>	<ul style="list-style-type: none"> <li>• All the bottles are re-usable and no throw-away plastic waste is created.</li> <li>• The durable plastic material can last for over 2 years.</li> </ul>

Triple Bottom Line Impact		
Economic	Social	Environment
Create sustainable financial flows Stimulate new local businesses Reduce the cost of water	Reduces water-borne disease Better access to safe water Create entrepreneurial opportunity	Minimize transportation impact Avoid pipe water infrastructure Limit plastic waste production

Table 17 - Company characterization: Global Cycle Solutions Board

GLOBAL CYCLE SOLUTIONS Key Facts			
<b>Product/Service</b>	Durable solar-powered lamps affordable for rural villagers		
<b>Sector</b>	Renewable Energy	<b>Size</b>	Small
<b>Country</b>	Tanzania	<b>Foundation Year</b>	2009



Problem Identification		
Lack of access to grid electricity	Lack of expendable income	High dependence on kerosene

**Business Model: create access to quality technologies through local micro-entrepreneurs**

<b>Design</b>	<ul style="list-style-type: none"> <li>• Offer a cheaper and better alternative to lamps (pays off in 8 months and is 15x brighter than kerosene). Employ a universal mobile phone charging port.</li> <li>• Design the product with a water-tight cover to protect it from dirt and liquids.</li> <li>• Select durable components (e.g. longest lasting solar lighting with phone charger).</li> <li>• Multifunctional format: place, hang and grab.</li> <li>• Modular architecture for easy disassembly.</li> <li>• Expand to product line to clean cook-stoves, agriculture accessories and water filters.</li> <li>• Perform field research in rural areas to identify the most-needed and cost-effective technologies for the villagers. Collaborate with universities, innovators and SMEs for product development and design.</li> </ul>
<b>Procurement</b>	<ul style="list-style-type: none"> <li>• Partner with two different suppliers: one based in Nairobi, the other in China.</li> <li>• Select environmental friendly products according to availability.</li> </ul>
<b>Production</b>	<ul style="list-style-type: none"> <li>• Complete outsourcing of manufacturing activities.</li> </ul>
<b>Distribution</b>	<ul style="list-style-type: none"> <li>• Work on high volumes to obtain cost benefits.</li> <li>• Hub-and-spoke model: regional offices provide technical and entrepreneurial support to micro-entrepreneurs, who perform the last-mile distribution of products.</li> <li>• Perform regional logistic activities on motorcycle to increase flexibility and efficiency.</li> <li>• Share asset with competitors to reduce costs.</li> </ul>
<b>Sales</b>	<ul style="list-style-type: none"> <li>• Create a resilient network of well-trained micro-entrepreneurs.</li> <li>• The sales agents (Rafikis) are hand-selected, community-recommended villagers trusted by local people. They sell products face-to-face and earn a commission on the trade (around 15% of the sales price).</li> <li>• Offer financing solutions (e.g. Pay-as-you-go) for solar product distributors and energy service providers.</li> <li>• Institutionalize ethical and fair business practices at all levels.</li> </ul>
<b>Use</b>	<ul style="list-style-type: none"> <li>• Rafikis perform after-sale-services and create long-lasting relationships.</li> <li>• Employ highly-efficient batteries and bulbs to reduce energy consumption (30h of light).</li> <li>• Offer two years of warranty to repair damaged products.</li> <li>• Partner with schools and NGOs to perform workshops: educate about the benefits of solar lightning and clean cook-stoves.</li> </ul>
<b>Disposal</b>	<ul style="list-style-type: none"> <li>• Components are long-lasting to avoid quick obsolescence: LED bulb rated for 10 years of daily use and batteries 5 years.</li> <li>• Collection of broken products to perform refurbishment activities.</li> </ul>

Triple Bottom Line Impact		
Economic	Social	Environment
Produce energy savings Create additional incomes Create jobs for entrepreneurs	Promote gender parity in hires Offer life-changing technologies Improve life-quality in rural areas	Reduce indoor air pollution Decrease kerosene usage Improve security and safety

## 4. Framework for Frugal Innovation Supply Chain (FISC)

This chapter presents the framework for frugal innovation supply chain (FISC) developed after the systematic literature review. Section 4.1 describes the procedure employed to create the framework by analysing the activities undertaken and the results obtained. It also presents the final model, whose components are explained in Section 4.2. Then in Section 4.3 the scope of the framework and the benefits that derive from its application are investigated. Section 4.4 consist of the glossary, which defines all the practices included in the model. Finally a conclusion on the implications and limitations of the framework ends the chapter (Section 4.5).

### 4.1 Framework development

In order to efficiently develop the framework, a structured procedure has been followed. In particular the activities carried out to collect and organize the necessary information are represented in *Figure 11*. The following paragraphs will explain in detail the method employed.

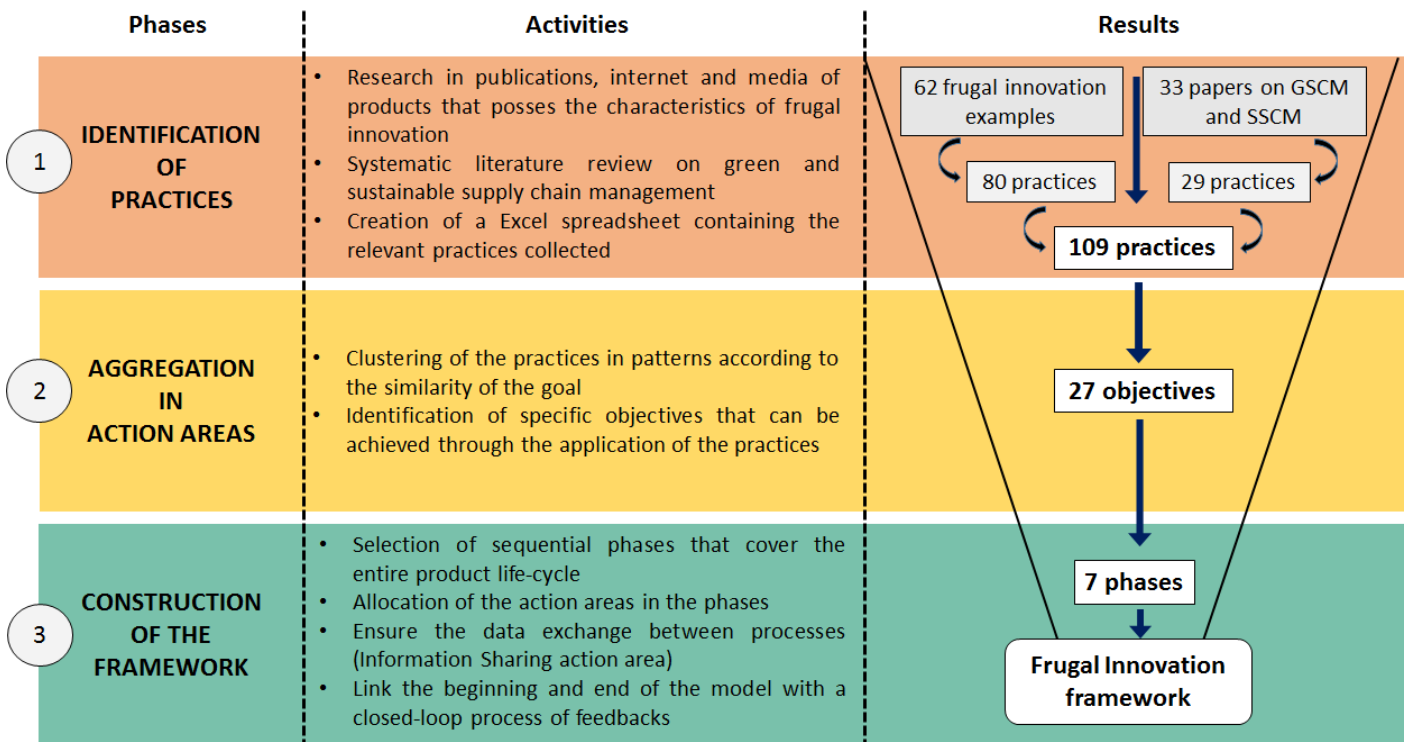


Figure 11 - Framework development



The procedure consists in three main phases, which include several activities.

The **first stage** has the objective of collecting the best practices, which can be employed to manage frugal innovations. To gather, organise and analyse the data, literature review and grounded theory were the research strategies used. As discussed in Section 3.1 the main result of the systematic literature review on frugal innovation is *Table 9*, which contains the sample of 62 products and services. By applying the open coding technique to the 62 solutions, 80 best practices were identified and listed in an Excel based database. On the other side the output of the extensive literature review on green and sustainable supply chain management was further examined and from the 47 articles initially selected, 33 papers contained relevant material for the study. In particular 29 practices were identified and integrated in the spreadsheet. The final output is a database composed of 109 practices that represent efficient strategies to implement frugal innovation, while balancing sustainability goals.

The **second step** aims at sorting and organizing the practices previously collected. In order to better structure the database it was necessary to define a clustering criteria. Axial coding was employed to link and aggregate the practices with the same scope. In particular objectives that explained the use of a set of practices were defined and used as condition to form groups. For example practices as employ 'robust materials' and design products to be 'easy to repair' have the same objective, which is making the object last longer, and therefore could be connected under the label 'durable'. This led to the creation of action areas: each of them contains a goal and the activities which can be performed to achieve it. At the end of this process all the 109 practices were allocated to 27 objectives.

In the **third point**, the framework structure was created. The basis of the model is constituted by the five processes that characterize SSCM (design, procurement, production, distribution and disposal) and adds two additional activities which are crucial in frugal business models (sales and use). The result is a system composed by seven sequential phases that cover the entire life-cycle and represent a generic value chain. Then the action areas formerly defined have been allocated to the different phases. Some modules were specific to a unique process, while others were common to different phases. At this stage of the framework development selective coding was employed to guarantee the consistency of the model. In order to graphically represent the closed-loop process, made of feedbacks collection and evaluation, the beginning and the end of the model have been linked through arrows. Furthermore to ensure that data and information are exchanged between the phases a cross-sectional area was created.

The output of these activities is the complete FISC, represented in *Figure 12*.

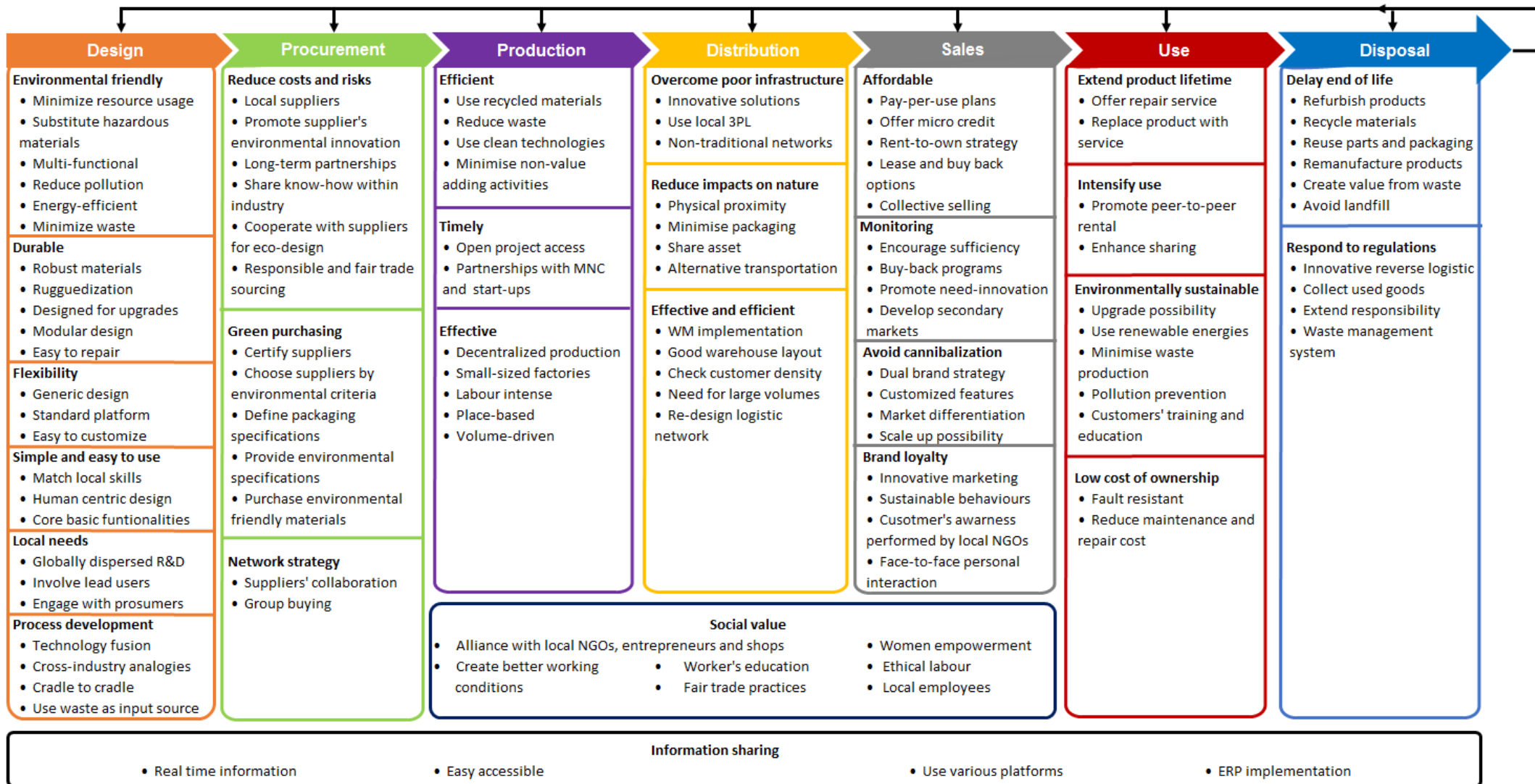


Figure 12 - Framework for Frugal Innovation Supply Chain (FISC)

## 4.2 Framework elements

The developed model is built upon three elements: 1) the phases, 2) the objectives and 3) the practices. While the first element is placed in the arrow shapes on the top, the other two are grouped in modules, which form the action areas located in rectangular blocks. Within each action area there is an objective written in bold and a set of practices that belong to the specific objective. In the next paragraphs these elements are going to be presented more in detail.

### 4.2.1 Phases

The **phases** form a linear course which encompasses all value chain's processes from conceiving the idea till the disposal of the product.

1. The **design** phase consists of the activities undertaken to define characteristics and specifications of the product, as to fulfil specific requirements. It determines the functionality, the aesthetic, the cost and the environmental impact of the solution. The design as well includes the iterative process of prototype development and testing, in order to refine product features according to customers' feedbacks. Furthermore, the design requires to consider the manufacturing process, the distribution and the recycling process as to establish the best product architecture, the appropriate materials and the proper technology, which fulfil the frugal innovation definition.
2. The **procurement** phase deals with the sourcing of materials, suppliers' selection and management of firm's downstream relationships. It defines the quantity and frequency of the purchases, as well as the conditions of the buyer-supplier collaborations. In particular the terms of sourcing strategies encompass: time horizon, geographical location and number of suppliers. Procurement activities determine the quality, the cost, the availability and the environmental/social impact of the final product.
3. The **production** phase refers to the process of transforming raw materials into finished goods. Production decisions include the identification of the optimal manufacturing strategy and the establishment of employees' working condition. Specifically it determines the capacity, location and automatization level of the plant, as well as the sequence of manufacturing activities. The objective of production activities is to satisfy customers' demand in the most efficient manner. It means improving the price-quality ratio, while creating positive impacts on the ecosystem and local communities. The production strategy also determines which activities should be performed in-house and the tasks that can be outsourced to third parties.
4. The **distribution** phase involves the transportation and storage of products. The process covers the planning and the design of the logistic network, as well as the selection of an inventory management policy. The number and location of retailers and warehouses is established, as well the resources necessary for the transportation activities. Furthermore it is evaluated if partnerships with logistic service provider should be created. Well-planned distribution strategies guarantee product availability to the highest number of end-customers, while minimising the environmental impact of transport, inventory and packaging.
5. The **sales** phase consists of the set of actions performed to match customers demand with company's offer. It encompasses the crafting of a marketing strategy and the development of a purchasing plan to fulfil sales volume objectives. In specific it covers the identification of customer

groups and potential clients, the communication with consumers, and the pricing strategies. The company has to analyse the various target markets and define if product differentiation is needed. Furthermore the branding approach and the upstream relationship with the final clients have to be selected, as well as the proper sales channels must be identified. The sale phase determines the number of people that can purchase the product, but also the quantity and type of goods each person buys. These decisions strongly influence the economic model, the social impact and the ecological footprint of the company.

6. The **use** phase manages the relationships between the company and the end-user. It determines the procedures for corporations to positively influence consumers' behaviours, and also to collect feedbacks to enhance quality and customer's experience. Firms can chose to be involved in the training and education of the clients to stimulate sustainable practices, but as well to offer or teach maintenance and repair practices. The objective is to reduce the total costs of ownership and extend the product lifetime. Furthermore the use phase impacts on what degree solutions are shared between peers.
7. The **disposal** phase defines the waste management system employed to process end of life products. It guarantees the proper recycling of materials, reuse of components and refurbish of products. The activities undertaken must comply with governmental regulations and ensure that environmental, health and safety standards are being followed. Decision determine whether the activities can be performed internally or should be outsourced to third parties, according to the capabilities required. Furthermore the disposal phase deals with the reverse logistic operations to collect, sort and recycle used goods or materials. The aim is to reduce raw material consumption by avoiding landfilling and controlling waste treatment. Disposal processes strongly influence company's environmental impact, but require an intense commitment of resources and capital.

#### 4.2.2 Objectives

The **objectives** specify for each phase the milestones that the firm has to achieve. They highlight those key points that have to be considered while crafting a strategy specific for frugal innovations. In fact their function is to guide decision-makers in choosing the correct priorities for every phase. The 27 objectives are derived from different areas and can be:

- Features that the product should possess to be classified as a frugal innovation, e.g. low cost of ownership, durable or environmentally sustainable
- Goals established for the company as a whole, e.g. respond to regulations, reduce impacts on nature or delay end of life
- Specific characteristics of the process that outline more detailed performance measures for the particular phase, e.g. overcome poor infrastructure or effective and efficient distribution strategy

### 4.2.3 Practices

The **practices** are all the actions collected from the literature review and example analysis, which have been systematized and rewritten in a keyword format. They can be:

- More specific product qualities, e.g. human centric design, fault resistant or multi-functional
- Strategic and operational activities that the company should perform to reach the particular objective, e.g. partnership with MNC and start-ups to obtain a timely production, or fair trade practices and local employees to increase the social value.

Figure 13 shows how the practices are distributed in the phases.

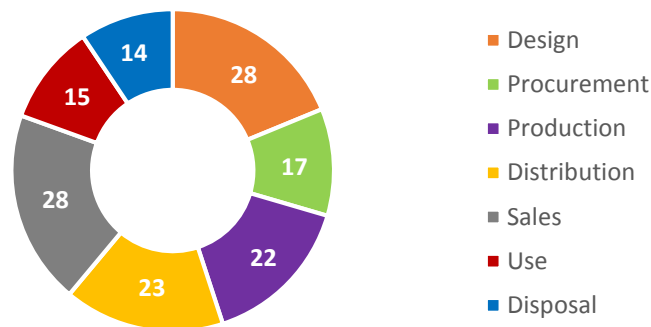


Figure 13 - Practices distribution in phases

A premise must be made before commenting the results: as the social value action area is common to the production, distribution and sales, these phases possess a 'virtually' higher number of practices. In fact the 8 practices, which belong to the social value objective, have all been added to each of the phases rather than being broken down into the three groups.

The graph highlights that not all the phases are equally balanced. In particular the Design and the Sales are those processes, which entails the highest number of practices. This can be explained by the fact that these phases have the greatest influence on the affordability of the product. Firstly, by determining the product features, materials and technology employed. Secondly by developing tailored micro-credit plans to reduce upfront client's investments. Therefore due to the frugal innovation target market – low and mid end segments – most of the analysed examples stressed the importance of these phases to ensure market success.

On the other hand it can be seen how the Disposal, Use and Procurement activities contain the fewest actions. This is due to the lower impact that these practices have on the product price and quality. In fact companies tend to focus and prioritize on those phases which are strongly value-adding and allocate fewer resources to complex and costly activities, e.g. disposal. Furthermore two of these activities (procurement and disposal) are not directly affecting by the final client, which in cost-driven environments favours price advantages rather than green practices.

### 4.3 Framework scope and use

The FISC aims to be a pro-active tool that helps decision-makers in managing frugal products and improve companies' economic, environmental and social performance in the entire value-chain. Its scope is to offer guidelines to choose the most appropriate strategies and ensure that they fit to the unique frugal innovation characteristics. Furthermore it provides a structured approach not only to the innovation process, but as well to the operational and strategic decisions. The framework encourages systemic thinking by suggesting best practices for all the processes along the product's life-cycle.

The FISC is a generic tool that should be adapted to the specific application. The action were built as independent modular blocks, which means that according to the context some of them might not be employed. Additionally it is designed to be used from both companies who already have frugal products in their portfolio, as well as by corporations who have no prior experience with frugal innovations. The firsts have the opportunity to validate their practices and evaluate if new ones could be implemented. The seconds can use it as a checklist to prioritize objectives and decide the actions that should be implemented.

The objective of the FISC is to facilitate firms in crafting their strategy attaining several benefits:

- Firms can have quick access to the knowledge on frugal innovation and its best practices. In particular successful business models can be used as basis for developing new products or as inspiration for innovative solutions. Additionally the framework formalizes what is normally found as unstructured information into an organized worksheet, which corporations can follow systematically.
- The division of the framework into smaller modules enables companies to set intermediate objectives and perform incremental changes. Each action area shows what can be achieved and how it can be accomplished. The key attribute of the instrument is its simplicity: the lean design makes it easy to use and extremely practical for working.
- The framework encourages companies to use a holistic approach to the development of the solution. It means that from the beginning the user has to think about business models, which are viable in every aspect. It anticipates possible constraints that may appear only at the end of the process and therefore reduces the costs for changes. The framework stimulates the creation of integrated solutions rather than just products.

### 4.4 Framework glossary

The FISC is complemented by a glossary, which aims at defining each practice presented in the framework. In this way users are facilitated in understanding what is the specific application of the practice and misinterpretation are avoided. The vocabulary is divided into nine sections: seven correspond to the development phases, while two represent the action areas *Social Value* and *Information Sharing* that are common between various processes. The glossary contains a brief description of every practice and is presented in the following paragraphs, *Table 18*.

Table 18 - Framework glossary: Design phase

DESIGN PHASE	
<b>Minimize resource usage</b>	Design the product to use as few raw materials as possible, require short time to be produced, employ few human resources' effort and limited financial investments
<b>Substitute hazardous materials</b>	Select and develop alternative materials that have lower environmental impact and are less harmful on human health
<b>Multi-functional</b>	The product can be used in various contexts and by clients with different characteristics
<b>Reduce pollution</b>	Identify materials, processes and practices that avoid the generation of waste or emissions released in the air, land or water
<b>Energy-efficient</b>	Develop solutions that reduce the amount of energy consumed during use to provide the same service
<b>Minimize waste</b>	Reduce the amount of waste produced by the product along its lifecycle
<b>Robust materials</b>	Employ materials that last in time and withstand wear
<b>Ruggedization</b>	Designed for harsh physical environments
<b>Designed for upgrades</b>	Possibility of replacing old versions with new ones without dismissing the entire product
<b>Modular design</b>	System composed of different modules created independently
<b>Easy to repair</b>	Requires minimal knowledge to fix the product
<b>Generic design</b>	The product can be used in different markets and by different customers
<b>Standard platform</b>	Various type of products can be built using the same set of technical components, technology and processes
<b>Easy to customize</b>	Product differentiation can be performed without incurring in high costs or process complications
<b>Match local skills</b>	No specific education is needed to use the product and the customers intuitively perceives how to use it
<b>Human centric design</b>	Develop usable and useful systems that are tailor made to satisfy user's needs and requirements
<b>Core basic functionality</b>	Focus on the essential features and remove non-value adding functionalities
<b>Globally dispersed R&amp;D</b>	Leverage local innovation departments
<b>Involve lead users</b>	Include creative users in the design process to improve innovation capabilities
<b>Engage with prosumers</b>	Develop relationships with customers to obtain rapid feedback about the product
<b>Technology fusion</b>	Employ different existing technology in the same product
<b>Cross-industry analogies</b>	Look for possible solutions in other industry domain
<b>Cradle to cradle</b>	Employ a biomimetic approach to design the product with organic materials that can be reprocessed and then reused in a new product
<b>Use waste as input source</b>	Create products that can use the output of other processes as input materials

Table 18 - Framework glossary: Procurement phase

PROCUREMENT PHASE	
<b>Local suppliers</b>	Supply materials from physically proximate sources
<b>Responsible and fair trade sourcing</b>	Ensure supplier's wages, health and social conditions are adequate
<b>Long-term partnerships</b>	Establish long lasting strategic alliances with suppliers
<b>Share know-how within industry</b>	Transfer information to suppliers about best practices that can be employed
<b>Cooperate with suppliers for eco-design</b>	Involve supplier in the design process to leverage the implementation of better solutions
<b>Promote supplier's environmental innovation</b>	Stimulate suppliers to improve their process toward environmental efficiency



Table 18 - Framework glossary: Procurement phase (continuing)

<b>Certify suppliers</b>	Employ quality management procedures to assure that the supplier's product is produced, stored and shipped in conformance with legal requirements and ISO standards
<b>Choose suppliers by environmental criteria</b>	Favour suppliers that meet or exceed regulatory standards for environmental impacts and comply to ISO 14001 management systems
<b>Define packaging specifications</b>	Collaborate to identify the best packaging options that minimize waste production
<b>Provide environmental specifications</b>	Define material's characteristics concerning its impact on nature
<b>Purchase environmental friendly materials</b>	Chose materials and packaging according to their ecological footprint, in order to avoid single-use disposable items, improve recyclability and favour suppliers' engagement with clean technologies
<b>Suppliers' collaboration</b>	Facilitate partnerships and asset sharing within suppliers
<b>Group buying</b>	Leverage collective purchase orders to obtain price discounts

Table 18 - Framework glossary: Production phase

<b>PRODUCTION PHASE</b>	
<b>Use recycled materials</b>	Employ raw materials that are obtained from retrieved products
<b>Reduce waste</b>	Minimize the production of scrap by fully benefiting of the inputs
<b>Use clean technologies</b>	Develop efficient processes that work on renewable energies and minimise emissions
<b>Minimise non-value adding activities</b>	Perform only activities that cannot be eliminated without scarifying on the output quality
<b>Open project access</b>	Leverage external source of knowledge and distribute outside internal know-how
<b>Partnerships with MNC and start-ups</b>	Collaboration with other entities is used to accelerate development time
<b>Decentralized production</b>	Numerous manufacturing plant are located close to the target markets
<b>Small-sized factories</b>	Production of each plant is limited to small quantities
<b>Labour intense</b>	Most of the processes are performed manually and cover the majority of the costs
<b>Place-based</b>	Leverage the unique natural, human and physical characteristic of the location
<b>Volume-driven</b>	Guarantee consistent sales volumes and use economies of scale

Table 18 - Framework glossary: Distribution phase

<b>DISTRIBUTION PHASE</b>	
<b>Innovative solutions</b>	Develop alternative distribution methods based on trusted local networks and community personnel to overcome infrastructural constraints and reach remote areas
<b>Use local 3PL</b>	Collaborate with local entities to outsource distribution activities
<b>Non-traditional networks</b>	Unusual channels are used to transport products
<b>Physical proximity</b>	Minimize the transportation distance
<b>Minimise packaging</b>	Lower the quantity of materials needed to pack the product and employ reusable packaging
<b>Share asset</b>	Partner with other firms to share physical and human resources
<b>Alternative transportation</b>	Employ bicycles or motorbikes to deliver the product
<b>WM implementation</b>	Software application to support the planning and controlling of resources and materials in the warehouse
<b>Good warehouse layout</b>	Efficient utilization of the space to reduce lead times and costs
<b>Check customer density</b>	Verify that the number of customers is sufficient to compensate distribution costs
<b>Need for large volumes</b>	Maintain high utilization level of resources
<b>Re-design logistic networks</b>	Design the logistic network taking into account the infrastructural constraints



Table 18 - Framework glossary: Social Value Action Area

<b>SOCIAL VALUE ACTION AREA</b>	
<b>Create better working conditions</b>	Ensure the working environment respects safety and health standards that are needed for the employee's well-being
<b>Ethical labour</b>	Working times, remuneration and human rights are aligned with international standards
<b>Worker's education</b>	The company provides improves the skills and the knowledge of their employees
<b>Fair trade practices</b>	Support suppliers, producers and local communities in developing countries ensuring better trading conditions
<b>Local employees</b>	Create working places in local communities to improve their economic development
<b>Women empowerment</b>	Advocate gender equality by increasing women participation in the economic activities and improve their life quality
<b>Alliance with local NGOs, entrepreneurs and shops</b>	Partner with local entities to support their activities and stimulate small businesses

Table 18 - Framework glossary: Sales phase

<b>SALES PHASE</b>	
<b>Pay-per-use plans</b>	The customer pays when he uses the product and no initial investments is needed
<b>Offer micro credit</b>	The client receives a small loan at low-interest rate to finance the purchase
<b>Rent-to-own strategy</b>	The client pays some money every month and after a predefined number of payments, he owns the product
<b>Lease and buy-back options</b>	The consumer pays some money every month and when he does not want the product anymore the company gets it back
<b>Collective selling</b>	Collaborate with other producers to sell products on larger scale and increase negotiation power
<b>Encourage sufficiency</b>	Focus on demand-side moderation by reduce and mitigating end-users' overconsumption practices
<b>Buy-back programs</b>	The firm offers to pay the customer the residual value of the product and take it back when it reaches the end of life
<b>Promote need-innovation</b>	Offer products that satisfy customers' needs rather than wants and respond to basic necessities
<b>Develop secondary market</b>	The company facilitates the sale of used products and complementary goods
<b>Dual brand strategy</b>	Differentiate the products offered by the same firm by creating different sub-brands
<b>Customized features</b>	Enable final clients to personalize the product
<b>Market differentiation</b>	Differentiate the product characteristics according to the target market
<b>Scale up possibility</b>	Complement a low-frill product with add-on features that improve its design and increase functionalities
<b>Innovative marketing</b>	Use non-traditional strategies to promote the product
<b>Sustainable behaviours</b>	Highlight the social and environmental outcomes of the product
<b>Customer's awareness performed by local NGOs</b>	Collaborate with no-profit organization to sensitize clients about the positive impact of the product
<b>Face-to-face personal interaction</b>	The seller is a person the clients knows and a personal relationship is established

*Table 18 - Framework glossary: Use phase*

<b>USE PHASE</b>	
<b>Offer repair service</b>	The company is in charge of fixing the product when a component fails
<b>Replace product with service</b>	Change from providing ownership of the good, to offering the functions of it to the clients
<b>Promote peer-to-peer rental</b>	Individuals are encouraged to rent their product to other clients
<b>Enhance sharing</b>	Enable different individuals to access the service and use the product
<b>Upgrade possibility</b>	The product can be updated to the newest version without incurring in expensive costs
<b>Use renewable energies</b>	Favour renewable energy sources for the provision of electricity
<b>Minimize waste production</b>	Use the product avoiding unnecessary waste production
<b>Pollution prevention</b>	Control and reduce as much as possible the pollution generated while using the product
<b>Customer's training and education</b>	The company teaches to the clients how to improve the efficiency of the product and how they can perform self-maintenance
<b>Fault resistant</b>	Avoid misuse of the product that would lead to breakdowns
<b>Reduce maintenance and repair costs</b>	Provide to the client all information to self-repair the product or offer low-cost fixing services

*Table 18 - Framework glossary: Disposal phase*

<b>DISPOSAL PHASE</b>	
<b>Refurbish products</b>	The manufacturer repairs defective products and resells them at lower price
<b>Recycle materials</b>	Convert waste materials from end-of-life products into useful raw materials for the manufacturing of new goods
<b>Reuse parts and packaging</b>	Disassemble goods to include some of their components into other products and collect used packaging to employ them again
<b>Remanufacture products</b>	Combine reuse, repaired and new parts to manufacture a product
<b>Create value from waste</b>	Upcycle materials by collecting the waste of a process and employ it as an input for another activity
<b>Avoid landfill</b>	Verify if the materials cannot be recycled and keep landfill as the last available opportunity
<b>Innovative reverse logistic</b>	Develop alternative and non-conventional solutions to re-collect products, components and materials
<b>Collect used goods</b>	Establish a network to obtain and transport the products from the clients to the firm
<b>Extend responsibility</b>	Take the responsibility for the product end-of-life and ensure that proper disposal activities are undertaken
<b>Waste management system</b>	Institute specific procedures to manage efficiently the activities of collection, transportation and treatment of waste

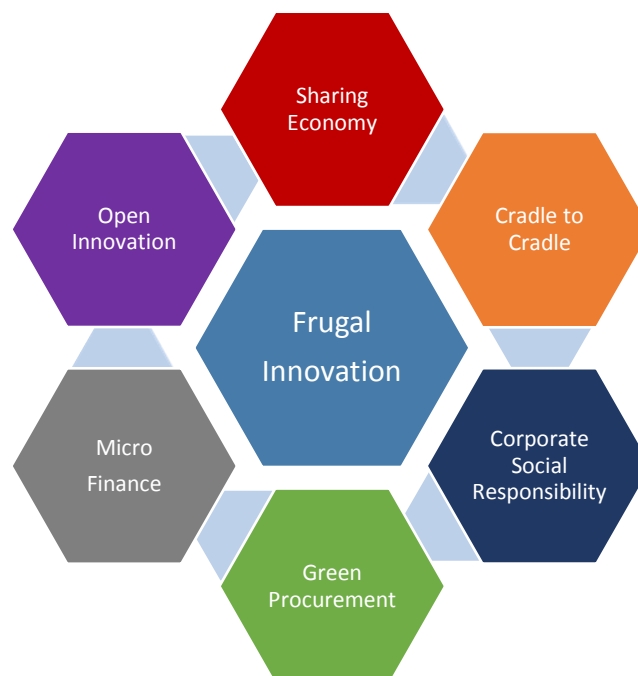
*Table 18 - Framework glossary: Information Sharing Action Area*

<b>INFORMATION SHARING ACTION AREA</b>	
<b>Real time information</b>	Generate and share updated data between the processes
<b>Easy accessible</b>	Facilitate access to information to target a wide range of people
<b>Use various platforms</b>	Employ several communication tools to reach customers with different telecommunication systems
<b>ERP implementation</b>	Develop informatics systems to share information with suppliers, customer and internal departments

## 4.5 Framework conclusions

After presenting the FISC, its components and the meaning of the actions contained, it is possible to derive some conclusions.

First it is relevant to underline how the framework includes and integrates different managerial concepts into a single tool. In fact for most of the phases, the model has used principles that stem from various business theories and linked them to the frugal innovation approach. This has been possible thanks to the common objectives that the theories share and reveals how frugal innovations are strongly interrelated to other management approaches. The connection between some of the concepts has already been suggested in the literature, but its evolution from the theoretical domain to the practical application has never been performed before. Therefore the framework represents the most complete and structured work that synthetizes various business approaches into the frugal innovation environment. This interconnection is shown in *Figure 14*, where a colour code expresses to which phase the specific theory is linked.



*Figure 14 - Link between frugal innovation and other management theories*

Secondly, it is necessary to define the limitations of the model. In particular it is strongly product-oriented and its scope does not include frugal services. This is due to the great difference between the processes of service development and product manufacturing. The phases and the practices should be differentiated and a complete new model should be created to target frugal innovation as a service. Then it is assumed that prior to use of the framework a series of activities have been performed. These tasks include problem identification, market analysis, solutions assessment and all actions that guarantee the product responds to the customer needs.

Finally it should be clarified that the practices suggested are not universally the best solution and according to the context another option might be favourable. An extensive analysis of successful examples has been performed, but to the novelty of the theme, the variety of environment and the different target markets, often alternative decisions can be taken.

## 5. Validation

This chapter describes the testing of the FISC. Section 5.1 presents how the information collected from the multiple case-studies was used to perform a quantitative analysis of the data. First the process employed to generate measurable outcomes is explained. Then the results are examined in detail. Section 5.2 contains a qualitative analysis of the output generated through in-depth semi-structured interviews. In the initial part the interview guides are discussed and finally the findings are organized to create structured knowledge.

### 5.1 Quantitative analysis

This section has the objective of employing the results from the case-study methodology to obtain measurable values that can be used for the validation of the framework. In particular the information gathered from each individual company was structured, standardized and then aggregated, with the aim of testing if the activities suggested are actually being implemented in practice. The data collected allowed to derive conclusions about the phases, the objectives and the practices that constitute the FISC.

#### 5.1.1 Application of the case-studies to the validation of the framework

After creating the descriptive tables presented in Section 3.3, it was necessary to verify how the framework can be applied to the specific cases. In order to test the FISC, the *Tables 12, 13, 14, 15, 16, and 17* were used as guidelines to identify if the strategies performed by the firms are reflected in the framework. It means that for every case-study, the activities executed by the enterprise were connected to correspondent practices in the framework, linking the two tools previously developed.

In particular for every component of the model a colour code is used:

- Yellow underline – the practice is performed by the company
- Red underline – the practice is not performed by the company
- No underline – the practice does not apply to the specific case-study of the company analysed

Then for all the actions which are being executed, a brief description explains how the activities are being accomplished and justifies the choice of employing the yellow underline. To verify and support the categorization of the practices, during the interview companies were asked to confirm or reject the pre analysis undertaken by the author. Therefore the reliability of the procedures could be validated and the practices accurately reflect firm's processes.

*Figure 15* shows an example of how the process has been employed for the Design phase of the company Glatt Stove. The graph already represents the post-interview version, containing the corrections suggested by the enterprise.

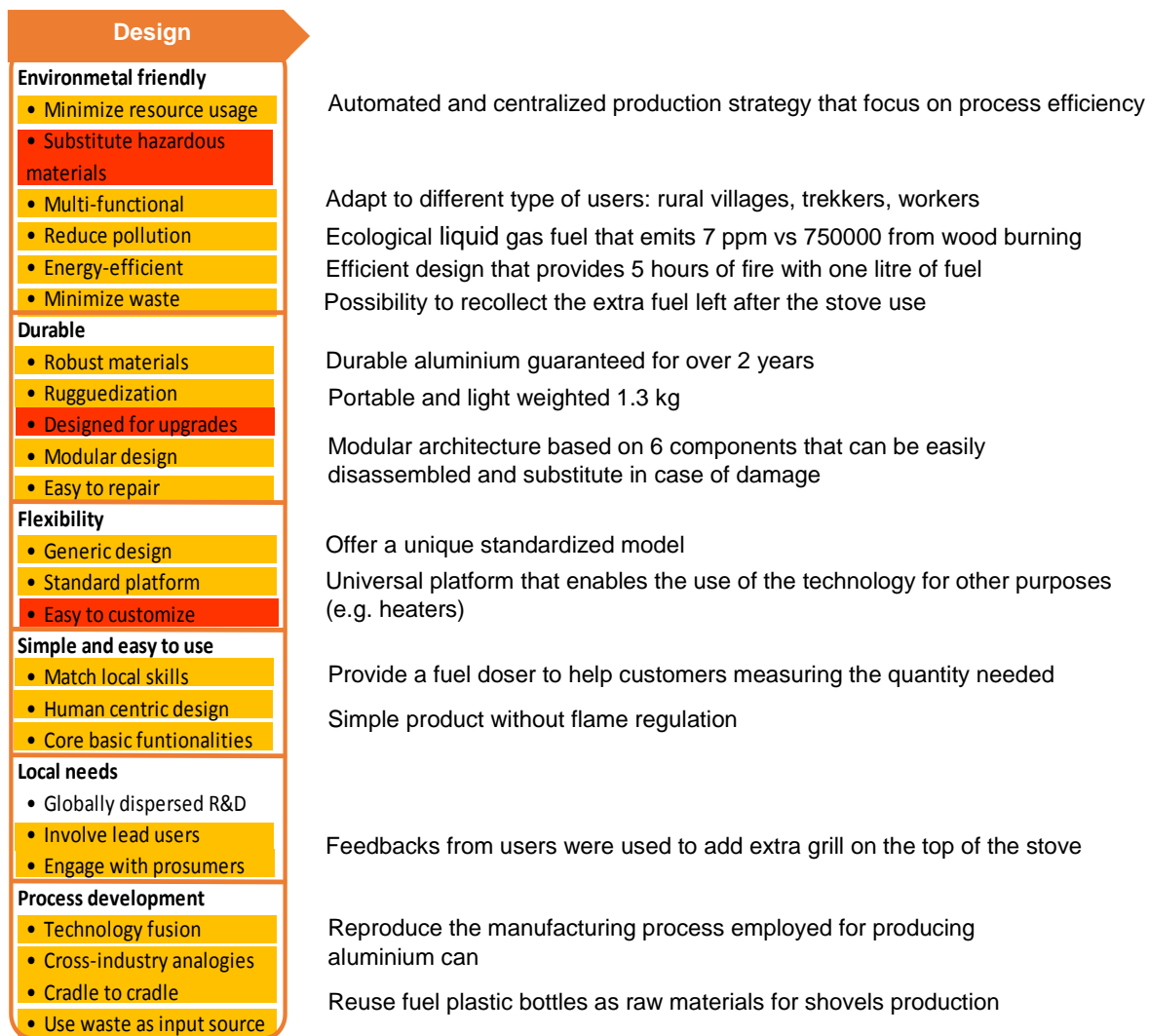


Figure 15 - Glatt stove example for practices categorization

Then the process was iterated for every phases in order to obtain a framework that is unique for the enterprise and expresses to which degree the practices contained in the model are being implemented by the specific firm.

Figure 16 displays the complete FISC applied to Glatt Stove example after the whole iteration, while the ones for the other companies can be consulted in the Annex B. These graphs enable enterprises to have a quick overview of their strengths and liabilities and can be used as basis for re-designing processes and operations. In particular they highlight on which areas to focus in order to improve global performance and form the groundwork for implementing new practices. For instance in the Glatt Stove example, some activities were not being performed due to 1) regulation constraints (e.g. fuel bottles could not be reused as inflammable liquids must be always sold in new flasks), 2) economic reasons (e.g. centralized production lowered manufacturing costs), or 3) simply the option was not being considered while crafting the strategy (e.g. share distribution resources with other firms). By identifying the reason for the practice not being implemented, the company is able to decide whether introducing a new activity is value-adding, as in the third example, or is not a viable option, as in the first two examples.

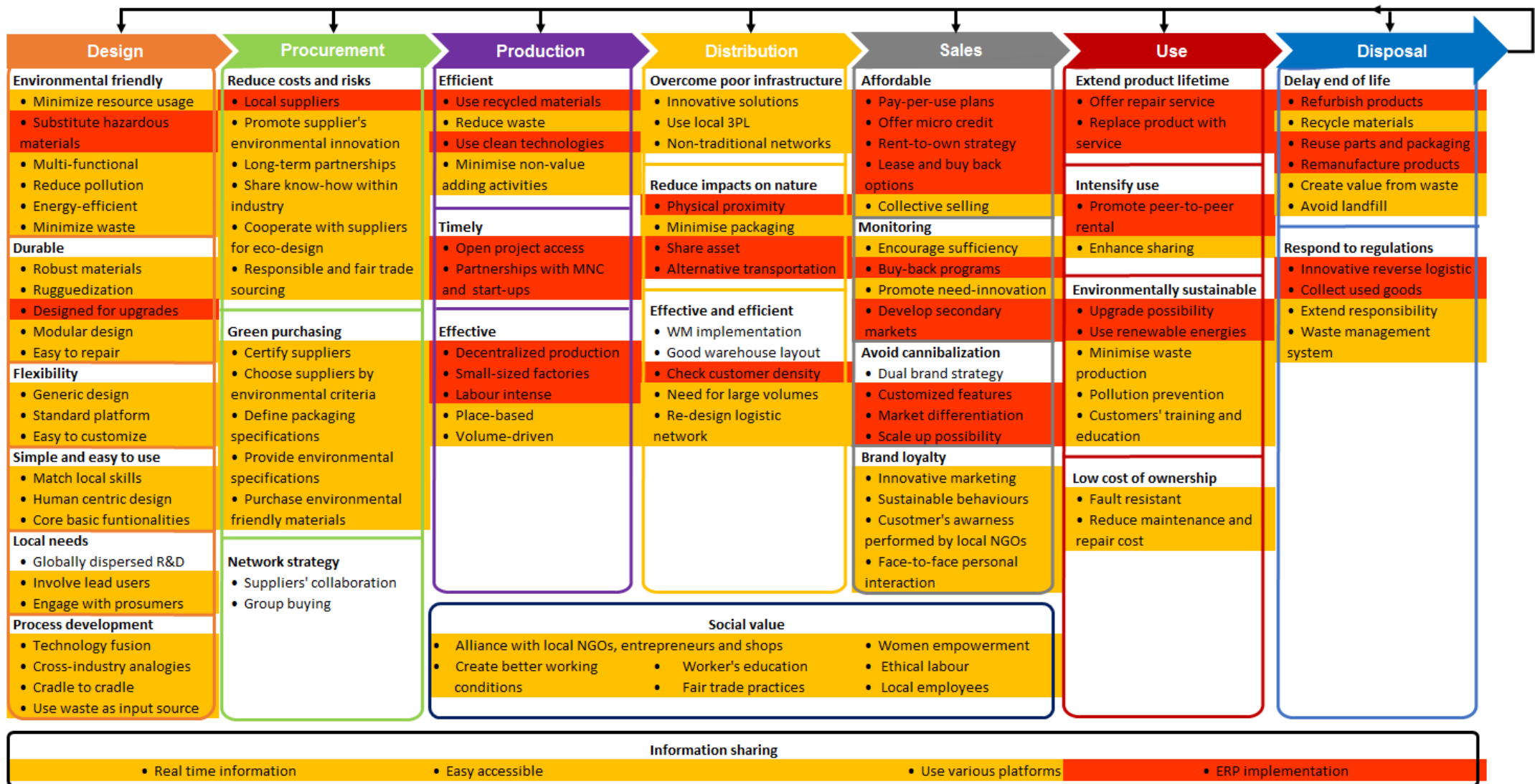


Figure 16 - Glatt stove framework

### 5.1.2 Case-study findings

While the underlined framework presented above is an instrument for the individual company to evaluate their practices, the following section presents how the results from all the 6 case-studies were combined to derive conclusions about the model and validate the FISC. In particular to obtain quantitative outcomes the method employed consisted of three steps:

- a) assign a binary variable to each practice: 0 if is underlined in red , 1 if is underlined in yellow
- b) iterate for all the 6 companies' frameworks
- c) aggregate the values

The final output of the process consists in the framework represented in *Figure 17*. It contains for every practice the number of companies that have implemented it (Value of the practice), but as well the cumulative result for the objectives (Value of the objective) and the total value for the phases (Value of the phase). The first statistic is placed on the right side of the practice, the second is written in bold characters beside the objective, and the third is located at the bottom of the phase in red font. The legend positioned below the framework shows how to identify and distinguish the three types of results within the model. These outcomes aggregated at different detail level were necessary to analyse the framework with increasingly precision.

Before investigating the results it is necessary to make some considerations about the limitations of the sample employed and its repercussion on the framework testing:

- The sample is not well balanced because all the companies used for the case-study are SME, 4 are medium sized and 2 small sized. As the practices were derived from a dataset where 35% of the enterprise were large corporations, but none of them is included in the sample, this inequality may cause the inapplicability of certain practices to the SME context and therefore reduce the number of activities performed. It means that some practices can score 0, since they are specific to large companies, and cause a lowering of the values used for the validation process.
- The sample size is relatively small as it is limited to only 6 elements. This affected the possibility of deriving general implications and develop well-grounded assumptions. The reliability and statistical significance of the results was strongly influenced by the small subset, which increased the variability and reduced the confidence of the values obtained.
- All the enterprises have less than 7 years of activity and are still in the scale-up phase. Various practices that require strong competences, deep know-how and consolidated experience may not be performed by recent companies. For this reason some practices may obtain lower value at this stage of firms' maturity, but would score differently if the investigation is repeated in the future. It means that the validation is strongly influenced by the time it is performed.



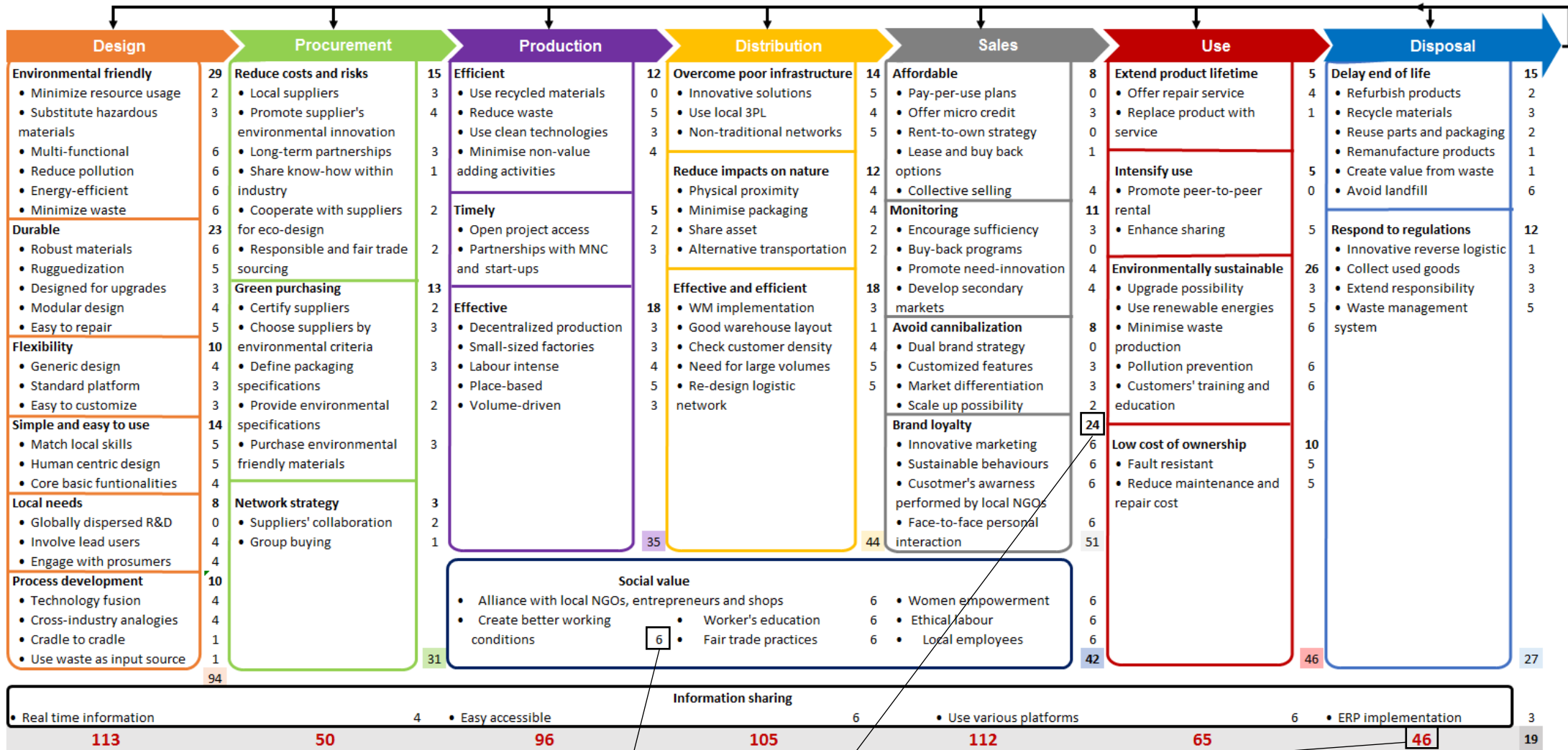


Figure 17 - Validation framework with aggregate results

Legend: Value of the practice      Value of the objective      Value of the phase



## Analysis of the Phase Level

This section investigates the result on the first level of analysis, in particular a broader perspective is used to examine how the phases performed in the empirical evidence. In order to derive well-founded conclusions two different tools were used: a bar chart and a table.

Initially a bar chart was created, *Figure 18*, containing in the upper part the value scored by the phase and in the lower section the gap that separates it from the maximum possible value, i.e. if all the practices were performed by all the companies. The value of the phase expresses the result obtained through the practices performed, while the gap shows the actions that were not performed. From the diagram it can be seen that two main groups stand out. The first is composed by *Design*, *Production*, *Distribution* and *Sales* that are the phases with the highest number of practices executed and on which the majority of the firms concentrated its efforts (values around 100). The second entails *Procurement*, *Use* and *Disposal* where many practices could not be implemented due to cost constraints or alternatives unavailability (values around 50). On the other hand by looking at the gaps emerges that the *Use* phase presents the lowest value, while the *Design* has the highest. It means that in the *Use* phase most of the practices are being performed, since firms judged extremely relevant teaching to their customers how to reduce total costs of ownership and limit pollution or waste production. Contrarily for the *Design* several of the suggested actions could not be accomplished, due to absence of the desired materials and the impracticability of developing fully optimized processes.

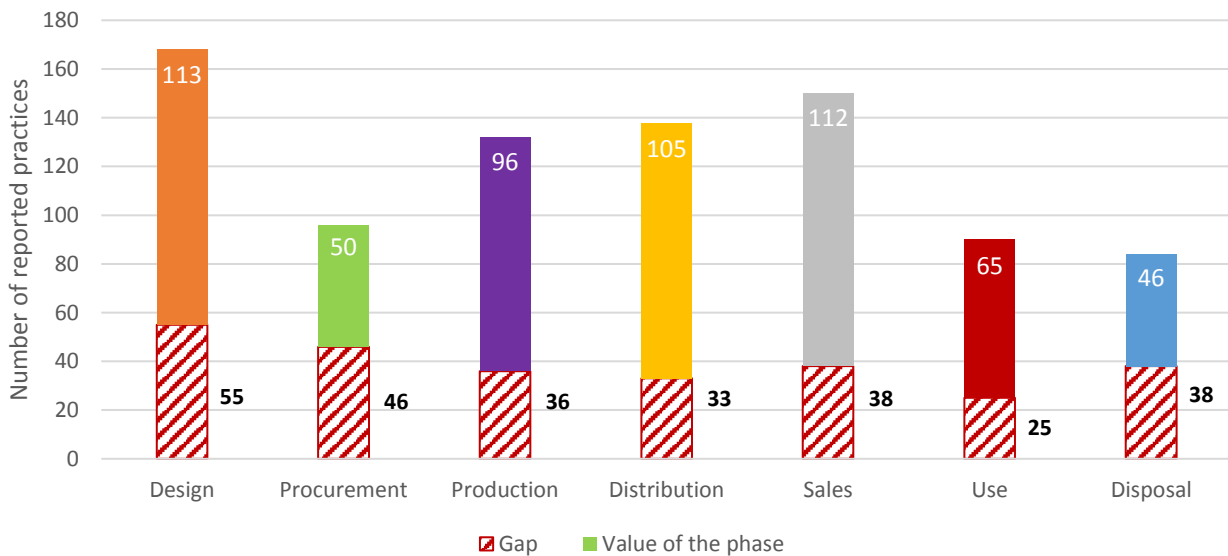


Figure 18 - Bar chart with phases' values

Then the results were further analysed by calculating the performance ratio and the mean value of each phase. The first expresses how the phase scores against its maximum value and how many of the practices suggested have actually been executed by firms, while the second represents the average number of companies that performs the practices contained in the phase. The formulas (1) and (2) demonstrate how the values have been calculated, while the outcomes are summarized in *Table 19*.

$$\text{Performance ratio} = \frac{\text{value of the phase}}{\text{value of the phase} + \text{gap}} \times 100 \quad (1)$$

$$\text{Mean value} = \frac{\text{value of the phase}}{\text{number of practices contained in the phase}} \quad (2)$$

Table 19 - Phases' results

Phase	Performance Ratio	Mean value
Design	67%	4,0
Procurement	52%	3,1
Production	73%	4,4
Distribution	76%	4,6
Sales	75%	4,5
Use	72%	4,3
Disposal	55%	3,3
<b>Global</b>	<b>67%</b>	<b>4</b>

Looking at the table it emerges that all the phases obtained performance ratios higher than 50% and mean values greater than 3. It means that more than half of the companies implemented more than half of the practices of each phase. However it can be seen that *Procurement* and *Disposal* reached lower results compared to the other phases. The numbers are in line with the outcomes found in the bar chart and confirm the importance of the *Use* phase, which can be grouped with the *Design*, *Production*, *Distribution* and *Sales*, as they all score performance ratios in the order of 70% and mean values higher than 4. Furthermore by calculating the global results, a general conclusion about the framework can be derived: the majority of the practices contained in the model are proved to be relevant, as on average they are being performed by 4 out of 6 firms, and the observed data match the developed theory, since 67% of the suggested activities are actually being executed in the real cases.

### Analysis of the Objective Level

The second level of analysis aims at investigating in more detail the general outcomes previously found and decomposes phase's values into the specific results obtained by the objectives. In this way it can be evaluated to which extent the targets have been achieved, but also identify, which goals were prioritized within each phase.

It was decided to assess the performance of the objectives based on three different criteria: 1) the absolute value of occurrence; 2) the contribution to the phase ; 3) the relative value of companies attaining the objective. The values were calculated according to the formulas (3), (4) and (5).

$$Absolute\ value_i = \sum_j value\ of\ the\ practice_j \quad i = objective \quad (3)$$

$$Contribution_i = \frac{Absolute\ value_i}{Value\ of\ the\ phase} \times 100 \quad j = practice\ that\ belong\ to\ the\ objective\ i \quad (4)$$

$$Relative\ value_i = \frac{Absolute\ value_i}{N^\circ\ of\ practices} \quad (5)$$

The first result is the sum of the values scored by the practices that belong to the same objective and expresses the importance of the specific objective within the framework. The second outcome reveals the influence of the individual objective on the phase, by showing to which degree it impacts the value of the phase. The third value communicate the average number of companies that performed the practices contained in the particular action area, and therefore shows how many firms reached the associated objective.

The information obtained are summarized in *Table 20*. It was decided to employ a conditional colour formatting: the objectives that scored the highest results have cells with a darker colour underline and are written with bolded characters, while the components that obtained lower values have cells with lighter shades and normal font.

*Table 20 – Objectives’ results*

	Objectives	Absolute Value	Contribution	Relative value
Design	Environmental friendly	<b>29</b>	26%	4,8
	Durable	<b>23</b>	20%	4,6
	Flexibility	10	9%	3,3
	Simple and easy to use	14	12%	4,7
	Local needs	8	7%	2,7
	Process development	10	9%	2,5
	Information sharing	19	17%	4,8
Procurement	Reduce costs and risks	15	30%	3,0
	Green purchasing	13	26%	2,6
	Network strategy	3	6%	1,5
	Information sharing	19	38%	4,8
Production	Efficient	12	13%	3,0
	Timely	5	5%	2,5
	Effective	18	19%	3,6
	Social value	<b>42</b>	<b>44%</b>	<b>5,3</b>
	Information sharing	19	20%	4,8
Distribution	Overcome poor infrastructure	14	13%	4,7
	Reduce impacts on nature	12	11%	3,0
	Effective and efficient	18	17%	3,6
	Social value	<b>42</b>	<b>40%</b>	<b>5,3</b>
	Information sharing	19	18%	4,8
Sales	Affordable	8	7%	1,6
	Monitoring	11	10%	2,8
	Avoid cannibalization	8	7%	2,0
	Brand loyalty	<b>24</b>	21%	<b>6,0</b>
	Social value	<b>42</b>	<b>38%</b>	<b>5,3</b>
	Information sharing	19	17%	4,8
Use	Extend product lifetime	5	8%	2,5
	Intensify use	5	8%	2,5
	Environmentally sustainable	<b>26</b>	<b>40%</b>	<b>5,2</b>
	Low cost of ownership	10	15%	<b>5,0</b>
	Information sharing	19	29%	4,8
Disposal	Delay end of life	15	33%	2,5
	Respond to regulations	12	26%	3,0
	Information sharing	19	<b>41%</b>	4,8

The following conclusions can be derived from the table:

- Analysing the **absolute values** emerges that the objective *social value* obtained results (42), which are more than three times the average of the other occurrences (13) and it is therefore considered the most relevant by firms. It means that the companies interviewed were strongly engaged with local communities, while guaranteeing the best working conditions and ensuring the respect of ethical standard. Then a gap of around 15 points separates *social value* from other four objectives that reached absolute values above 20, namely *environmental friendly*, *durable*, *brand loyalty* and *environmentally sustainable*. These results underline how important it is for frugal products to minimize their impact on the ecosystem.
- Focusing on the **contribution** outcomes, arises the absence of a predominant objective in the *Design* phase (none is above 30%), while the *information sharing* appears as key target for the *Procurement* and the *Disposal* (38% and 41%). Furthermore it stands out the central role that the *social value* objective plays in the *Production* (44%), *Distribution* (40%) and *Sales* (38%) phases. Finally for the *Use* phase the *environmental sustainability* (40%) appears as a main characteristic the product should possess. The results stress the significance of implementing information systems in order to efficiently manage upstream and downstream relationships and confirm the relevance of tackling social and environmental issues along the entire development process.
- Investigating the **relative values** it is possible to depict that more than half of the companies achieved 60% of the objectives (values higher than 3). It is a very good result that validates the relevance of the objectives contained in the framework and ratify the clustering process of the practices. Furthermore it can be seen that the four objectives *brand loyalty*, *social value*, *environmental sustainable* and *low cost of ownership*, scored values higher than 5 and the first even reached the maximum mark (6). The result highlights how crucial it is for firms to build a trusted brand, which is deeply committed to its clients and positively influences their behaviours. Though there are two objectives that were being attained by less than 2 firms, namely *network strategy* and *affordable*. The first outcome can be explained from the fact that it is more specific to MNCs context rather than SMEs background. The second result is due to the fact that four of the five practices which are associated with the objective, i.e. *pay-per-use plan*, *offer micro credit*, *rent-to-own strategy*, and *lease and buy back option*, are mutually exclusive alternatives and are usually not all being implemented at the same time. The objective is going to be improved by unifying the four practices into a single one.

### Analysis of the Practice Level

The third level of analysis, studies the results obtained from the practices. It was decided to firstly calculate for each of the six attainable values, the occurrence of practices which obtained that result. Then the second outcomes shows for each specific value its percentage of the total. Finally the results were aggregated into three categories to generalize inferences. Looking at *Table 21*, which presents the output of analysis, three relevant conclusions can be drawn:

- 73% of the practices are being performed by at least half of the companies (values 3,4,5, and 6)
- 20% of the practices are being performed by all the companies (value 6)
- 6% of the practices are not being performed by any company (value 0)

Table 21 – Practices' results

Value	Occurrence	% of Total	Cumulative	Aggregated
0	7	6%	6%	27%
1	10	9%	16%	
2	12	11%	27%	
3	24	22%	49%	22%
4	19	17%	66%	51%
5	15	14%	80%	
6	22	20%	100%	

The first result confirms the validity of the FISC and the relevance of the majority of the practices contained in it. It can be concluded that the FISC suits to the practical cases and therefore can be effectively employed in the business environment. The second outcome highlights how various practices are already consolidated in the frugal innovation domain and are considered as a necessary condition to enter this type of market. In particular all the firms place great importance on the design of products with minimum environmental impact, and on the engagement with local communities. Finally the third result reveals the complexity that some practices require to be executed and underlines the difficulty faced by companies to overcome resource constraints. In fact between the 7 practices that scored value 0, 2 are specific to large corporations (*globally dispersed R&D, dual brand strategy*), 3 are mutually exclusive (*pay-per-use plan, rent-to-own strategy, lease and buy back option*) and the last 2 (*use recycled materials, promote peer to peer rental*) could not be implemented due to lack of internal capabilities. Therefore it can be concluded that made exception for the three practices of the *Use* phase, which are going to be improved, none of the actions suggested in the framework should be removed as all of them are relevant for the management of frugal innovations.

## 5.2 Qualitative analysis

This section aims at describing how the interviews have been used to reinforce the validation process and to collect feedbacks about the FISC. In particular the interviewees could explain why some practices were not being implemented, how the objectives have been prioritized and which phases were judged as more relevant. Finally, suggestions and critics to the framework were gathered in order to improve its structure and content.

### 5.2.1 Interview guide structuring

For this work two different interview guides were developed: the first aimed at companies and the second at experts. The following section includes a general description of the interview structure, while the complete interview guides can be consulted in the Annex C.

#### Company interview guide

The company interview guide is composed by 20 questions divided into 5 sections according to the theme analysed. The first set includes general questions about the firm with the objective of understanding if the company is familiar with the frugal innovation concept. Furthermore an explanation about the main drivers, challenges and practices to overcome them is pursued. In second place more detailed questions about the processes and the strategies employed are asked. The aim of the

interviews is to find out to which degree the decision making process is structured and investigate if guidelines or external consultancies were used.

Then, after showing the framework, the applicability of the proposed model to the firm is studied. The company is enquired about the actions undertaken and the possible advantages or hurdles of implementing the tool. The third group of questions explores the specific processes for all the life-cycle phases and tries to identify the strategies employed to overcome potential trade-offs. Finally the enterprise is asked about suggestions and critics to the model, in order to propose ideas which could improve its effectiveness. The questions are described below.

### Expert interview guide

The expert interview guide included 20 questions, which are equally divided into 2 groups. The first half investigates the specialist's experience in frugal innovations and begins by questioning the findings and the approach employed in his personal research. Then specific outcomes of the specialist's study are analysed, in order to derive conclusions about the most common difficulties faced by firms. The expert is enquired about the possibility of some actions or solutions be generalized to create a tool for helping companies in the management of frugal innovations. The last questions of the first part deal with possible models that the interviewee has been developing and investigate whether there is necessity to create guidelines for the implementation of frugal products or not.

The second half of the interview has the objective of collecting feedbacks about the proposed framework. Specifically, it is investigating the applicability of the theoretical model in the practical domain and the benefits that corporations could obtain through its use. More detailed questions about the phases are included in order to identify which activities are the most critical and decided whether some practices could be added or removed. Furthermore, it is tested if the model can be used in various markets, e.g. developing and developed countries, and be representative of companies from different sizes, e.g. SMEs and MNCs. To conclude experts are asked about suggestions and improvements to refine the framework. The questions are presented below.

### 5.2.2 Interview findings

This section summarizes the most significant answers to the questions previously described. It was decided to divide the main finding into two groups according to the interview guide used. In particular the first part presents the topics discussed with the experts, while the second section analyses the themes covered with the companies.

#### Interviews with experts

- **Research experience and investigation approach**

The majority of the interviewees has been working with frugal innovation institutes over 3 years and only one investigation centre is more recent, and it has been founded in 2015 (respondent 1). All the specialists agreed on the growing importance that frugal products will have in both emerging and developed countries, and the expansion of the phenomenon can be considered one of the main reasons that motivated their research. Everyone acknowledged the importance of "developing affordable solutions that are not only targeted at the BoP" (interviewee 5), but the investigation approaches

undertaken are different. Expert 1 collaborates with multinational companies in projects that involve the creation of specific products to tackle communitarian issues and tries to derive theoretical implication from the practice. Specialist 2 and 3 are focused on defining and framing the frugal phenomenon within other innovation concepts, but also perform consultancies for national firms in order to support the introduction of the frugal approach in product development processes. Interviewee 4 has a strong field experience based on the cooperation with many local entrepreneurs and the information gathered was used to spread examples of frugal solutions. Respondent 5 organizes workshops, conferences and events to increase awareness about frugal innovation, with the aim of creating a network for companies and people to interact. Finally expert 6 has been mixing research and practical components to work with students in the design, production and sales of frugal products.

- **Main challenges faced by firms and solutions implemented to solve hurdles**

The respondents identified three main challenges that inhibit companies from entering in the frugal innovation space: 1) “fear of cannibalizing their high-end products” (interviewee 5), 2) “preference for businesses with faster returns” (interviewee 4), and 3) greater difficulty compared to usual approaches (interviewee 2). They further specified that more capital, time and commitment is needed for developing successful frugal products and singular firms often don’t have all the required characteristics. On one side large companies that possess technical and financial resources, don’t have the motivation to wait for slow returns and prefer other market opportunities. On the other side small companies that are agile, strongly committed and patient, lack access to financial resources, people and physical infrastructure to scale (interviewee 4). Moreover all the specialists agreed that two common mistakes are often being done by firms and affect the frugal innovation favourable outcome: 1) think that the solution is just the tangible product, and 2) don’t include people from the local communities in the development activities. In particular many companies limit their efforts to the design of the product, without planning how to perform the other processes, and also fail in corresponding customers’ expectations due to the low engagement level with local populations.

The suggestions given to overcome the analysed challenges can be summarized in the following five practices (interviewee 2, 3, 4 and 5).

- 1) Start with the problem and not with a preconceived solution: firstly understand the underlined needs, the substitute products and the customers’ behaviours, and then develop the solution.
- 2) The solution is not just a product, but the entire business model: consider the whole system of designing, distributing, promoting and pricing the solution.
- 3) Use systemic thinking and consider the whole ecosystem: comprehend the context, the social community and the cultural patterns to guarantee the product fits to the specific environment.
- 4) Work with other parties and foster collaboration: establish strong partnerships between small / large, for-profit / non-profit, and private / public companies, in order to take advantage of complementary capabilities.
- 5) Involve people of the community you want to serve in the solution: local workers help defining product features, but also deliver and sell it to the client reducing cost and increasing brand loyalty.

As it can be seen from the recommendations given by the experts, the frugal innovation framework already includes these key principles in its structure and is therefore able to solve the main obstacles that firms face to develop frugal products.

- **Need for a frugal innovation framework**

Most of the experts affirmed that enterprises normally use “spontaneous processes” (respondent 6) and “unstructured approaches” (specialist 5) to develop frugal innovations. Strategic and operational decisions are often based on instinctive and improvised conclusions, which are supported only by previous experience in the field. On the other hand interviewee 4 believes that larger corporations have already created internal procedures to “test and scale solutions, built on a systematic try and error process”. All the experts acknowledge that in order to increase success rate, efficiency and reliance of the frugal innovation approach, a structured framework is needed. Some state that a general model cannot be developed yet, due to the newness of the phenomenon and the lack of examples, but it is extremely necessary for the future (interviewee 2 and 3). Others believe that many cases have already been studied and by looking for patterns that apply along different contexts, it is possible to derive successful best practices (interviewee 1, 4, 5, and 6). Furthermore two specialist suggested to “look at specific sectors, e.g. mobile telephony, energy or health, to extract principles” (respondent 4) and focus on “standardizing the development process rather than the product” (respondent 6).

- **General impressions about the framework and practices validation**

All the respondents were positively impressed with the framework. Interviewee 6 affirmed that she has “never seen such a comprehensive model”, as it covers the whole product life-cycle and matches technology development with business practices. Specialist 5 added that it is the most complete and well-structured tool for frugal innovations realized so far: he stressed the usefulness of the division in tabs, which can be employed to see where changes and improvements are needed. Respondent 2 underlined the importance of having modular components that can be assembled according to specific case. Interviewees agreed it would be “widely spread between companies” (6) and firms could use it “even for non-frugal products” (4), since it is extremely actionable and simple to read.

Based on the answer it can be seen that the framework has been generally accepted and the majority of the respondent validated the practices contained in it. None of the specialist would remove any practice from the model, however different points of view emerged. Some experts (2 and 4) stated that it is difficult to derive universal strategies when there are successful examples, in which practices opposite to the ones suggested were employed. They advised the use of decision trees to choose the most appropriate strategy according to the case. Other specialists (5 and 6) proposed maintaining in the model the most performed practices and then recommended to evaluate the specific context to verify whenever a different option is more favourable.

- **Obstacles to the framework implementation**

Based on the specialists’ answers three main obstacles to the use of the framework were identified. Interviewee 4 stressed the fact that to implement many of the practices suggested it is necessary to possess consistent financial and human resources. This creates various barriers for small enterprises and makes the framework “clearly oriented to large corporations” (expert 4). Furthermore, providing firms with a set of guidelines might create the idea that by merely performing the recommended actions,



the product will be successful. Respondent 5 affirmed that companies must understand that without taking into consideration the social and cultural behaviour, the solutions developed would not be effective. Finally interviewee 3 underlined the fact that due to the great amount of information contained in the framework, enterprises might focus on planning their activities before having deeply analysed the addressed problem. This leads firms to invest time and resources before knowing if the solution is the right one.

- **Critics and suggestions to the framework**

Three experts stressed that the model is very linear, while the presence of many feedback loops should be marked (interviewee 3, 4, and 5). “Too many steps separate the design and the use phase”, which makes company “commit great resources aiming at perfection, before getting proper feedbacks from the clients and be sure about the product success” (respondent 4). Specialist 5 suggests to employ iterative try and error process, rapid-prototyping approach and agile methodology to overcome these difficulties and test the solution before commercializing it. Interviewee 2 affirmed that measurable level of fulfilment must be established for the objectives, e.g. to which degree should the product be durable, because according to the context higher or lower values are desired. He proposed to determine these values with the help of relevant stakeholder that should also be included to prioritize the most important objectives. Furthermore two respondent (2 and 5) affirmed that even if “frugal products strive for sustainability, their key elements are affordability and accessibility” (5). In particular by “working on the cost structure, the distribution model and the revenue model to offer solutions to low income people” (4), frugal innovation have indirectly a positive social impact (2). Specialist 4 underlined that the framework is product oriented and focused on an engineering approach, which limits its applicability to the service domain.

All the interviewees acknowledged that a phase containing the problem definition should be added before the design. Moreover specialist 2 and 5 proposed setting “a price point in each phase” and “show cost targets” in order to facilitate the achievement of affordability goals and ensure that overheads are minimized. Respondent 1 suggested to make visible the dependency between the practices and “discuss the trade-off that sometimes needs to be made between actions, resulting in some objectives being reached and some not”. Interviewee 3 added that a critical paths should be identified in the practices, as to underline the connection between activities belonging to different phases. Finally specialist 6 recommended to add in the framework the stakeholder value, by showing the benefits that corporations could obtain with the implementation of a specific set of practices.

## Interviews with companies

- **Challenges faced to implement frugal innovation and solutions developed**

All the companies interviewed agreed that the main challenge was to create a financially sustainable business that targets the BoP with a for-profit model. Respondent 2 underlined that growing only from the revenue made with sales makes it difficult to scale in the early stages, but firms 4 and 5 confirm, NGO are not long lasting solutions. In fact they underline how non-profit organizations are constantly dependent on external founding and donations, which creates non-reliant businesses. On the other hand two companies underlined that it is a great barrier to secure the necessary funds to support the project. In particular firm 3 faced problems to “obtain funding to develop new technologies and find initial capitals

for the prototyping and design of the product". Moreover three respondents acknowledged how hard it is to "get the product to many dispersed clients" (2) and to "overcome infrastructural constraints, e.g. bad road conditions" (6). Additionally company 5 and 6 affirmed that guaranteeing the quality of the solution is challenging when the production process is performed in resource-constrained environment. As firm 1 said "it is difficult to find skilled workers" and when they are available it would be a too expensive option. Moreover respondent 4 encountered complications in establishing partnerships with local retailers, as the reliability could not always be assured. Two enterprises faced challenges in developing a profitable sales model that could "make the product affordable for low-income customers" (3). In fact to compensate for "small profit margins and consistent upfront investments" (6) high sales volumes needed to be obtained. Finally company 5 stated that applying western business model in developing countries leads to the failure of the project, as a deep understanding of the local culture, regulations and government is strongly needed.

The two most important solutions that companies implemented to overcome initial obstacles were: a) look after external partnerships, and b) create skilled working teams. The majority of the enterprises stressed that fostering collaboration with NGOs, governments and other firms, enables the integration of internal capabilities with complementary know-how, but also the reduction of initial investments and associated risks. Furthermore three respondents (4, 5, and 6) affirmed that "having an active board", "experienced people" and "strong local leadership" is vital to ensure the success of the solution. Interviewee 5 also added that for western corporations it is crucial to adopt local ownership, as it guarantees a better connection with communities and governments. Moreover company 3 underlined that developing the right business model is a necessary condition to get the solution to the clients: not only the product features must respond to the customer requirements, but also the sales and distribution strategies have to be planned according to affordability and accessibility constraints.

- **Decision approach and external support**

None of the enterprises employed a structured decision approach: the strategies for the different areas were crafted, revisited and changed many times as "disruptive innovation is characterized by a high level of uncertainty" (interviewee 2). The companies admitted that they did not know from the beginning how to organize their activities along the value chain, as the main priority was the design of the solution. The majority of the firms started by creating prototypes and test them with local communities, in order to get feedbacks and improve the business model, and then with time and experience began structuring their processes (company 1, 3, 4, and 6). As respondent 3 stated "strategies were decided, based on try and error" and after some years understanding the market, it was possible to create "best practices adapted for the specific application". On the other hand respondent 2 and 5 already had prior business practice and could define in earlier stages which approaches to employ in the phases.

Company 3 and 5 are the only two that crafted their strategies with the support of consultancy firms, accelerators and networks. In particular they underlined how external knowledge "added up to the internal decisions" (3) and has been valuable in specific areas, e.g. marketing and recruiting, but as well "helped to define the business model" (5). However every respondent acknowledged that "the most important thing are internal human resources" (3): they have stronger understanding of the local context, and with their commitment and motivation are able to improve the company's performance.

Regarding the use of financial help, different opinions emerged from the interviews. With the premise that all the companies benefited by initial funding to scale-up the idea, respondent 1 and 4 affirmed that “did not consider external grants and sponsorships as an option to support activities” (1) since the objective is to “make the company financially sustainable” (4). Therefore they preferred to employ only internally generated funds obtained from sales. On the other hand interviewee 5 and 6 are using financial support to invest greater capital in their operations, and are planning to strengthen their partnerships with banks and foundations.

- **General impressions about the framework**

Most of the companies acknowledged that the framework is “comprehensive” (1) and “a good combination of design and engineering” (2). It is “very useful to plan strategies” (2), and enables corporations to “see which actions are not being performed and understand why” (3). Moreover respondent 1 stressed that by adopting some of the practices contained in the model, the firm could “achieve much more efficiency and meet environmental targets”. Two enterprises affirmed that it would support the decision-making process, and that now they would employ it to implement more actions and add value to their processes (interviewee 2 and 3). Company 1 further underlined how “many practices could be easily integrated” as “acceptance might not be difficult”, but a couple of years are needed to increase revenue streams. The respondent also added that for large corporations fewer efforts are required to adopt some of the proposed ideas, since these enterprises have more resources available. On the other hand interviewee 6 stated that the model would be “useful for start-ups” as well, because it could offer an efficient tool for structuring their processes.

- **Main obstacles in adopting the framework**

When companies were asked about the main obstacles they would face to adopt the framework, different points of view emerged. Two firms agreed it could be “complicated to think about all the practices suggested during the first stages of development” (2) and believe that it is challenging to “do a business model, which considers all these aspects” (3). They suggested it could be used better in the “second phase of implementation of the idea” (2) and could help to “keep a guidance when the company has grown” (3). Furthermore respondent 1 underlined how in the scale up phase it is “complicated to implement very sophisticated processes, such as reverse logistics and recycling activities”. He explained that “when the company has a strict budget, goals need to be prioritized” and to carry out some of the suggested practices “much more funds are needed” (1). Interviewee 1 concluded how besides money difficulties, it is relevant to guarantee “people’s commitment and willingness to integrate new activities into the organizational structure”. Finally company 6 acknowledged that if the framework “is not contextualized in the specific environment” where the enterprise operates, resistance to its application might be greater.

- **Suggestions and critics to the framework**

The majority of the firms asserted the importance of having a phase at the beginning of the model, where it is verified whether the product responds to the market needs or not. In case some requirements are not fulfilled, the solution must be improved and a regular check of customers’ feedbacks can help in this iterative process. Another relevant critic collected from the interviews is the “lack of experimentation and necessity to see how the model place out in reality” (respondent 1). Companies acknowledged that the

theoretical validation “leads to ignore practical limitations” (1) and the implementation of the framework in the streamline of the organization would be much more enlightening to refine its structure.

Based on the answers gathered 5 significant suggestions could be derived (interviewee 2, 3, and 5):

- 1) Develop two versions of the framework: a simpler model that defines the minimal conditions to be fulfilled for managing frugal innovations, and a final form which includes all the practices suggested
- 2) Change the practices to direct questions: ask the company about its processes and check if it is valuable to implement new activities, according to the specific context
- 3) Enable firms to create a roadmap: by selecting determined practices the enterprises can define, which are the steps to move from the current to the future state
- 4) Interrelate the practices: connect the component of the framework in order to show the consequences that a decision has along the chain and determine, which is the best set of activities to be performed
- 5) Show the benefits of employing a specific practice: for each practice the advantage that companies could obtain through its use should be displayed in order to favour informed decisions

## 5.4 Conclusions

To summarize the major conclusions derived from the validation process it was decided to create *Table 22*. It contains on one side the measurable results obtained through the quantitative analysis, and on the other side the findings from the qualitative analysis. Furthermore it is divided into three sections, in order to organize the results according to the investigation level employed: first the practices' outcomes, then the phases' conclusions and finally the objectives' inferences.

By comparing the two different types of findings three main conclusions emerge:

- Most of the qualitative results match the ones obtained through the quantitative validation: the interviews proved that the data obtained from the case-studies are accurate and 7 out of the 8 key outcomes were directly confirmed by the respondents
- The only contrasting opinion concerns the social impact of frugal products: while expert state that “frugal innovation strive for sustainability” (respondent 5), but it's not their main goal, all the companies acknowledged how creating benefits for local communities is their primary aim. This divergent point of view is further confirmed in the quantitative analysis, as *social value* is the objective which entails the highest number of practices being executed
- While in the quantitative analysis the objective *brand loyalty* stands out for its great significance, as all its practices are performed by all the companies, the interviewees did not stress as much as expected its relevance: respondents focused on the benefits that local communities generate to enter in the frugal innovation market, but only 2 out of 6 specialists underlined how crucial it is for firms to engage with the final clients in the *Sales* phase

Table 22 - Validation main findings

	Quantitative analysis main findings	Qualitative analysis main findings
Practices Results	The majority of the practices contained in the model are proved to be relevant, as on average they are being performed by 4 out of 6 firms	The majority of the respondent validated the practices contained in the framework None of the specialist would remove any practice from the model
	The observed data match the developed theory, since 67% of the suggested activities are actually being executed in the real cases	It is the most complete and well-structured tool for frugal innovations realized so far that would be “widely spread between companies”
	6% of the practices are not being performed by any company, as they are highly complex and require strong capabilities	To implement many of the practices suggested it is necessary to possess consistent financial and human resources and in the scale up phase it is “complicated to implement very sophisticated processes”
Phases Results	22 practices are already consolidated in the frugal innovation domain and are considered as a necessary condition to enter this type of market	Frugal innovation’s key elements are “affordability and accessibility” therefore firms must be “working on the cost structure, the distribution model and the revenue model” to ensure the success of the solution
	<i>Design, Production, Distribution and Sales</i> that are the phases with the highest number of practices executed and on which the majority of the firms concentrated its efforts (values around 100)	The solution is not just the tangible product, but the entire business model: consider the whole system of designing, distributing, promoting and pricing the solution
	In the <i>Procurement</i> , and <i>Disposal</i> phases many practices could not be implemented due to cost constraints (values around 50)	To carry out some of the suggested practices “much more funds are needed”
Objective Results	The objective <i>social value</i> was considered the most relevant by firms (the value scored is more than twice the average)	Frugal innovation have indirectly a positive social impact, as they include people from the local communities in the development activities
	All the 6 companies achieved the objective <i>brand loyalty</i> , as firms realized it is crucial to build a trusted brand, which is deeply committed to clients	Involve people of the community you want to serve in the solution helps to overcome implementation obstacles

After completing the validation process it was decided to improve the FISC with a more compact version of it, following the suggestions obtained by the experts. The aim of creating a simpler model, represented in *Figure 19*, is to show how the phases are interrelated with each other and to provide a global vision for the development of frugal products. As the two frameworks have different applications, they are equally important and are designed to be used in a complementary manner. Two levels of analysis emerge:

Level 1: the circular representation should be employed in the first stages to identify companies' priorities, since it provides a holistic overview of the processes and supports strategic decisions.

Level 2: the linear graph is more detailed and helps decision-makers in selecting the right practices to be implemented, therefore its use is advised in a second stage and on the operational level.

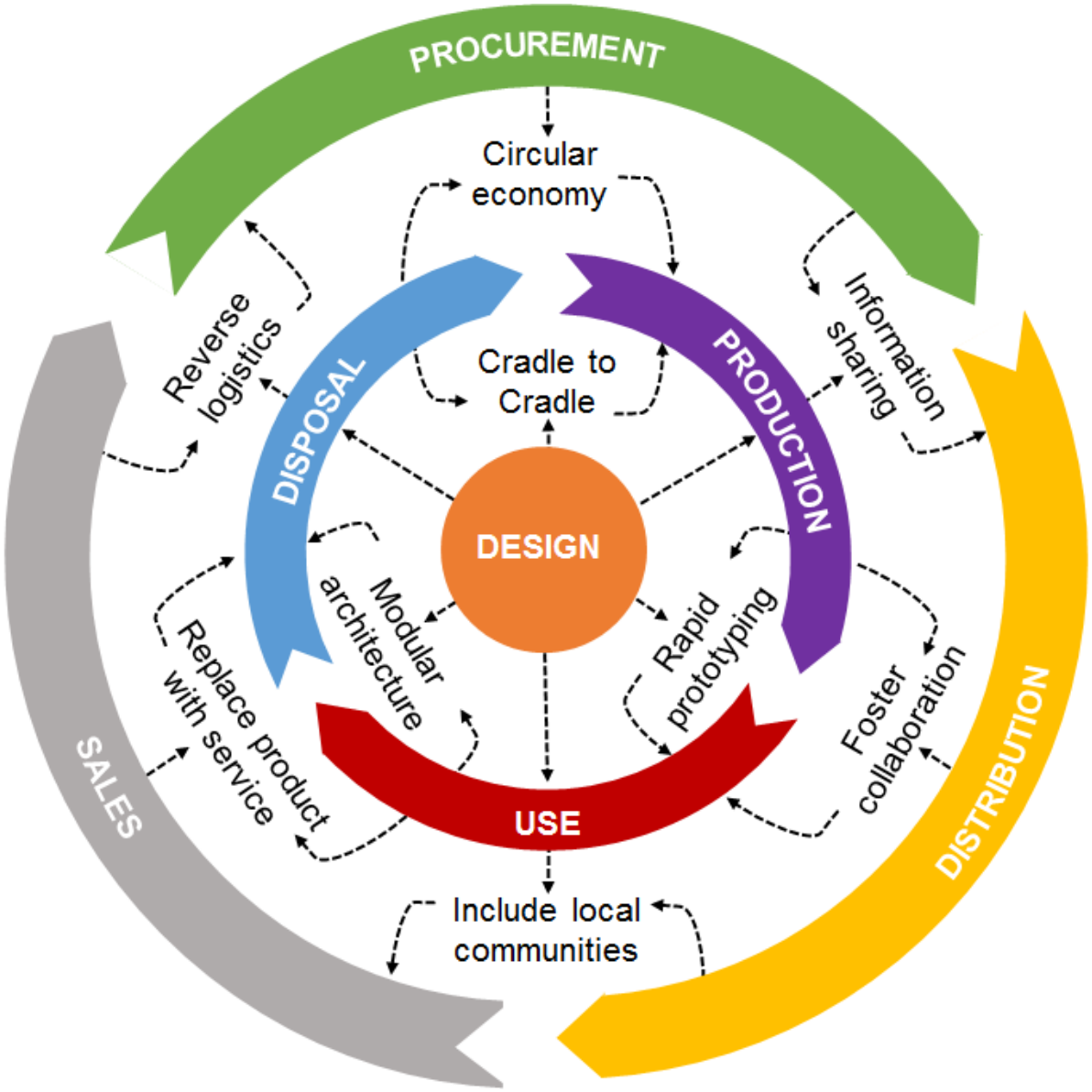


Figure 19 - Compact FISC

The *Design* is the central element of the framework, for the following three reasons: 1) it is the priority of each company, as it strongly affects the market success of the solution; 2) it directly influences all the

other phases, by defining the product characteristics, the materials and the technology; 3) it establishes whenever the developed innovation is frugal, since the functionality, the cost and the environmental impacts are determined. The other six phases are placed on two circumferences, with the inner circle containing *Production, Use* and *Disposal*, and the external ring comprising *Procurement, Distribution* and *Sales*. The specific positioning of the phases has the objective of connecting all the processes, and show how the external activities constitute the link between the inner ones, e.g. *Distribution* bridges *Production* and *Use*.

Moreover internal loops are created to suggest the most relevant practices that can be performed to effectively connect the phases. For example *reverse logistic* is valuable to ensure end-of-life products are collected from the clients and their materials are recycled. Likewise *rapid prototyping* is proposed to create a user-centred design process, which analyses the problem to be addressed, verifies if the client's requirements are met, and modifies product features according to user's feedback. These practices include the improvements that emerged from the interviews, i.e. *rapid prototyping, include local communities* and *foster collaboration*, as well as the ideal activities that should be companies' future goals, e.g. create *circular economy* or *replace product with service*.

The compact framework was created with the objective of being a tool for systemic thinking. It is extremely useful for companies to approach frugal innovation with a broader perspective. Furthermore the circular structure highlights how for frugal innovation an integrated approach is needed. It means that all the phases are equally necessary and each of them must be considered when developing the business model. The entire system should be created taking into consideration the other phases and the correlation between the processes. However after having analysed the problem to be addressed and developed the general strategy to be employed in the phases, the complete framework is still necessary to know which best practices to implement. In fact the frugal innovation framework is a much more comprehensive model that not only creates guidelines for the management of frugal products, but also supports corporations in evaluating and improving their processes. To conclude both frameworks are very practical dynamic tools that should be used in integrated manner to enhance the performance of companies in all the three sustainability dimensions. In particular during Level 1 firms start approaching frugal innovation and define their priorities, while at Level 2 specific practices start being executed.

To summarize the information about the two level of analysis and the use of the frameworks *Table 23* was created.

*Table 23 - Level of analysis*

Dimension	Level 1	Level 2
Framework to employ	Compact FISC	Complete FISC
Development Phase	Early stages	Late stages
Decision Type	Strategical	Operational
Objective of analysis	Define priorities	Choose practices
Perspective	Broad	Detailed

## 6. Final Conclusions and Future Work

In the next years companies will face radical changes in the business environment, due to the rapid growth of the global middle-class. Growing product consumption, increasing pressure on scarce natural resources and strengthening of social inequalities need to be addressed with innovative business approaches. Frugal innovation are recognised as a great solution for corporations to tackle these problems, since they equally balance profit generation, environmental protection and social empowerment. Research on frugal products demonstrates how costs and resources minimization can be achieved without scarifying on quality and customer satisfaction. The frugal business approach creates innovative solutions that use the limited material availability as an opportunity rather than a liability. Frugal products target under-served consumers with affordable and highly functional alternatives. They deliver great value from both the customer and the firm perspective, since people's needs are tackled in a profitable manner.

The literature review shows that very few work has been presented in the field of frugal innovation, moreover it is almost inexistent the work of sustainable supply chain management for this type of products.

Although frugal innovations seem to offer many advantages, some companies are still hesitating, and those ones that already commercialize these products, are facing some hurdles in their implementation. The problem relies in the lack of formalized approaches and structured processes, which would enable corporations to fully benefit from frugal innovations. To bridge this gap it was decided to develop an integrated framework for frugal innovations, which uses SSCM processes as foundation.

Firstly a systematic literature review on frugal innovation and sustainable supply chain management has been performed. The result is a collection of 109 best practices that, through the use of grounded theory, were allocated to 27 objectives and aggregated in 7 sequential phases. These three elements constitute the basis of the frugal innovation framework. The phases form a linear course, which encompasses all value chain's processes and covers the entire product life-cycle. Then to guide decision-makers in choosing the correct priorities for every phase, specific objectives are identified. Finally strategic and operational practices that the company should perform to reach the particular objective are suggested.

The FISC is a pro-active tool that offers guidelines to choose the most appropriate strategies and ensure that they fit to the unique frugal innovation characteristics. It encourages companies to use a holistic approach in the development of the solution, by stimulating the creation of integrated business models rather than just products. The framework can be used from companies who already have frugal products in their portfolio to validate their practices and evaluate if new ones could be implemented, as well as by corporations who have no prior experience with frugal innovations to prioritize objectives. It is the most complete work that includes and integrates various managerial approaches, e.g. sharing economy and cradle to cradle, into a single frugal innovation tool.



For the testing and validation of the framework two complementary methodologies have been employed: 1) multiple case-study, and 2) semi-structured interviews. The results confirm the validity of the FISC and the relevance of the practices contained in it, as 67% of the suggested activities are actually being executed in practice. Furthermore most of the respondents directly confirmed the quantitative outcomes and underlined the necessity of developing solutions that consider the entire system of designing, distributing, promoting and pricing the product. On the other hand while all the interviewed companies stressed the importance of creating positive social impacts on the local communities, various experts believe frugal innovation's key attributes are affordability and accessibility. In general it can be concluded that the theoretical FISC is reflected in the empirical evidence and can be used as an effective tool for managing frugal innovations in the business environment.

Three main areas for future research are suggested. First the validation process should be extended to a wider sample. The data obtained from a larger number of companies would increase the reliability of the results and enable the generalization of better grounded assumptions. Furthermore the testing of the framework should be expanded to other geographical areas, which are not limited to the African and South American context, and with corporations of more differentiated sizes. In specific the application of the FISC to large companies would be enlightening to verify financial and organizational constraints to practices' execution could be solved. This could help in the development of various version of the model according to the type of firm analysed.

Second it would be enlightening to create a product from the beginning following the guidelines of the FISC. It could be evaluated how the implementation of the suggested best practices enhances economic, environmental and social performance. Moreover measurable results might be obtained to assess the impact that frugal innovation have on the three sustainability dimensions.

Third a computer-based decision support tool (DST) should be developed. By using the frugal innovation framework as basis, an interactive instrument should be programmed. The DST would support companies in creating roadmaps for the implementation of specific set of practices, showing possible trade-offs between the objectives and highlighting the benefits, which can be achieved with the execution of new activities.

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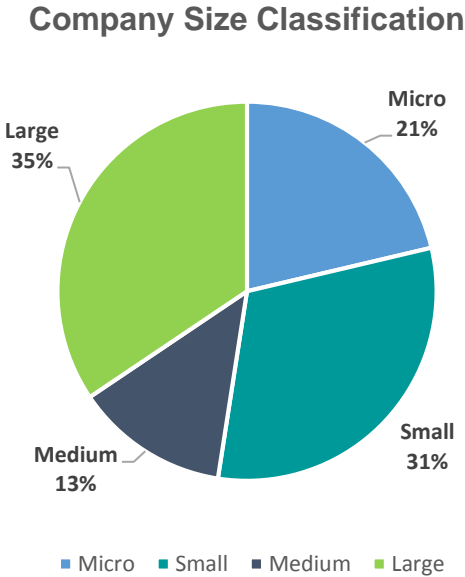
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# Annexes

## Annex A: Sample Characterization

The criteria used to classify companies by size was the number of employees. The decision is based on the fact that for most of the enterprises information about annual turnover, total balance sheet or investments were unavailable. According to the definition given by the European Union (2003) the categories are characterized by the limits presented in *Table A.1*.

*Figure A.1* shows how the company’s sample is distributed in the four different dimensions.



*Table A.1 - Criteria for establishing company size*

Size	Number of employees
Micro	Employees < 10
Small	10 ≤ Employees < 50
Medium	50 ≤ Employees < 250
Large	Employees ≥ 250

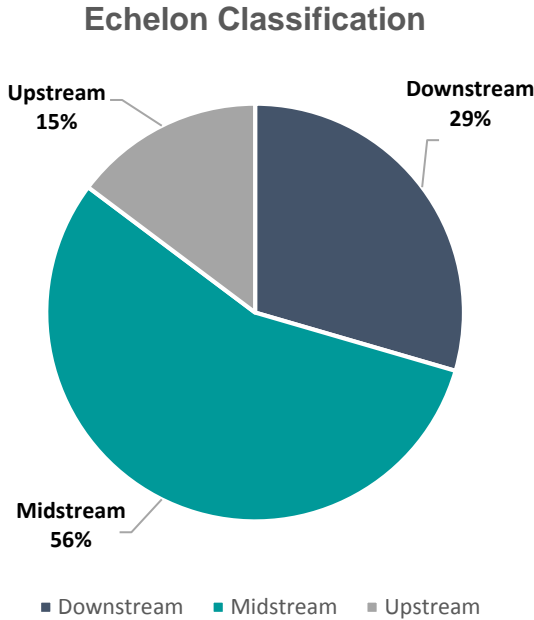
*Figure A.1 - Company classification by size*

As *Figure A.1* highlights, the dataset is well balanced. For each category at least 8 companies have been identified and there is no strongly predominance. Large companies entail the highest percentage because of the wider availability of material and information about their products. On the other hand it can be seen as by aggregating, Micro, Small and Medium enterprises, SMEs cover 65% of the sample. This is due to the fact that smaller firms are more agile and flexible to seize opportunities in resource-constrained environments. It can be concluded that SMEs are the most important actors in the frugal innovation context.

The classification of companies based on the supply chain echelon could not follow a predefined standard as a straightforward division of classes is not available. For this reason it was decided to firstly define which industry sectors belonged to each SC echelon and then associate the firms to the correspondent cluster. For an accurate and comprehensive segregation of the market it was established to consider 12 different industries (Meckenstock, Barbosa-Póvoa and Carvalho, 2015), namely (1) Materials, (2) Oil and Gasses, (3) Utilities, (4) Automotive, (5) Consumer goods, (6) Electronics, (7) Healthcare, (8) Industrials, (9) Consumer services, (10) Financials, (11) Information technology, and (12) Retail. The classification is based on the Dow Jones Global Index, but adds two additional sectors, i.e. Consumer services and Retail, as it was judged more appropriate to reliably represent the sample.

Then according to the type of activities involved, e.g. raw material extraction, production and assembly, or sales and services, the industries were assigned respectively to the upstream, the midstream, or the downstream SC tier.

The SC echelon division is summarized in *Table A.2*, while the percentage of companies within each group can be seen in *Figure A.2*.



*Table A. 2 - Division of industry sectors into supply chain echelons*

SC Echelon	Processes	Industries
Upstream	Raw material extraction	Materials Oil and Gasses Utilities
Midstream	Production and assembly	Automotive Consumer goods Electronics Health care Industrials
Downstream	Sales and services	Consumer services Financials Information technology Retail

*Figure A. 2- Company classification by supply chain*

*Figure A.2* shows that over half of the enterprises analysed is included in the midstream SC echelon and more than one third of the products within the class belongs to the healthcare sector. This can be explained from the fact that medical solutions play a key role in the frugal innovation environment. Moreover, the majority of the consumer goods and services can be classified as renewable energy solutions that provide solar electricity to rural populations. These solutions represent the greatest part of the downstream SC tier cluster, which includes around 30% of the companies. The upstream SC echelon scores the lowest percentage, because firms are more engaged in production of raw material obtained from recycling processes, requiring strong capabilities and facing complex issues, e.g. regulations or reverse logistic activities.

## Annex B: Companies' Frameworks

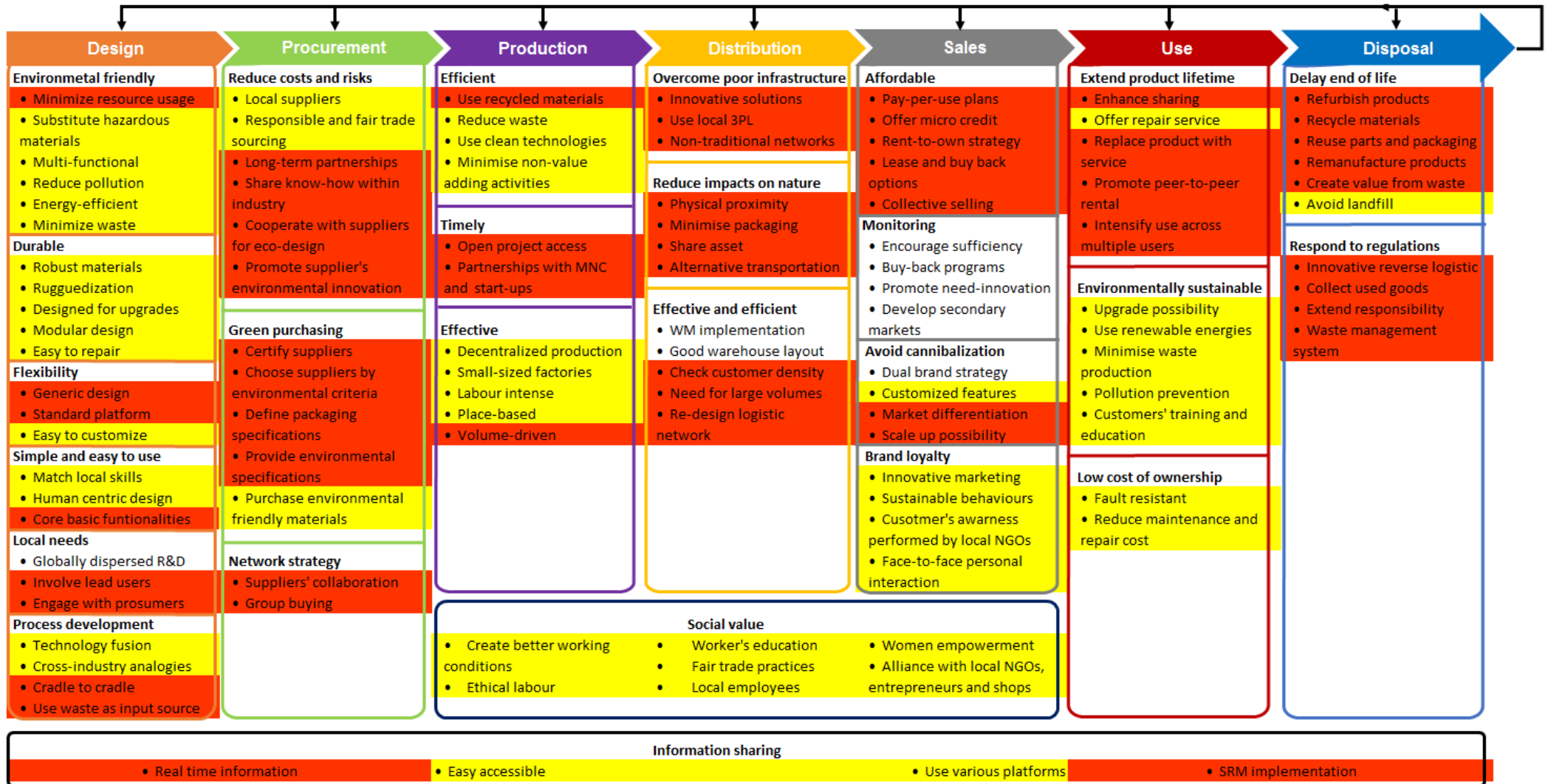


Figure B. 1 - Ghana Bamboo Bikes framework



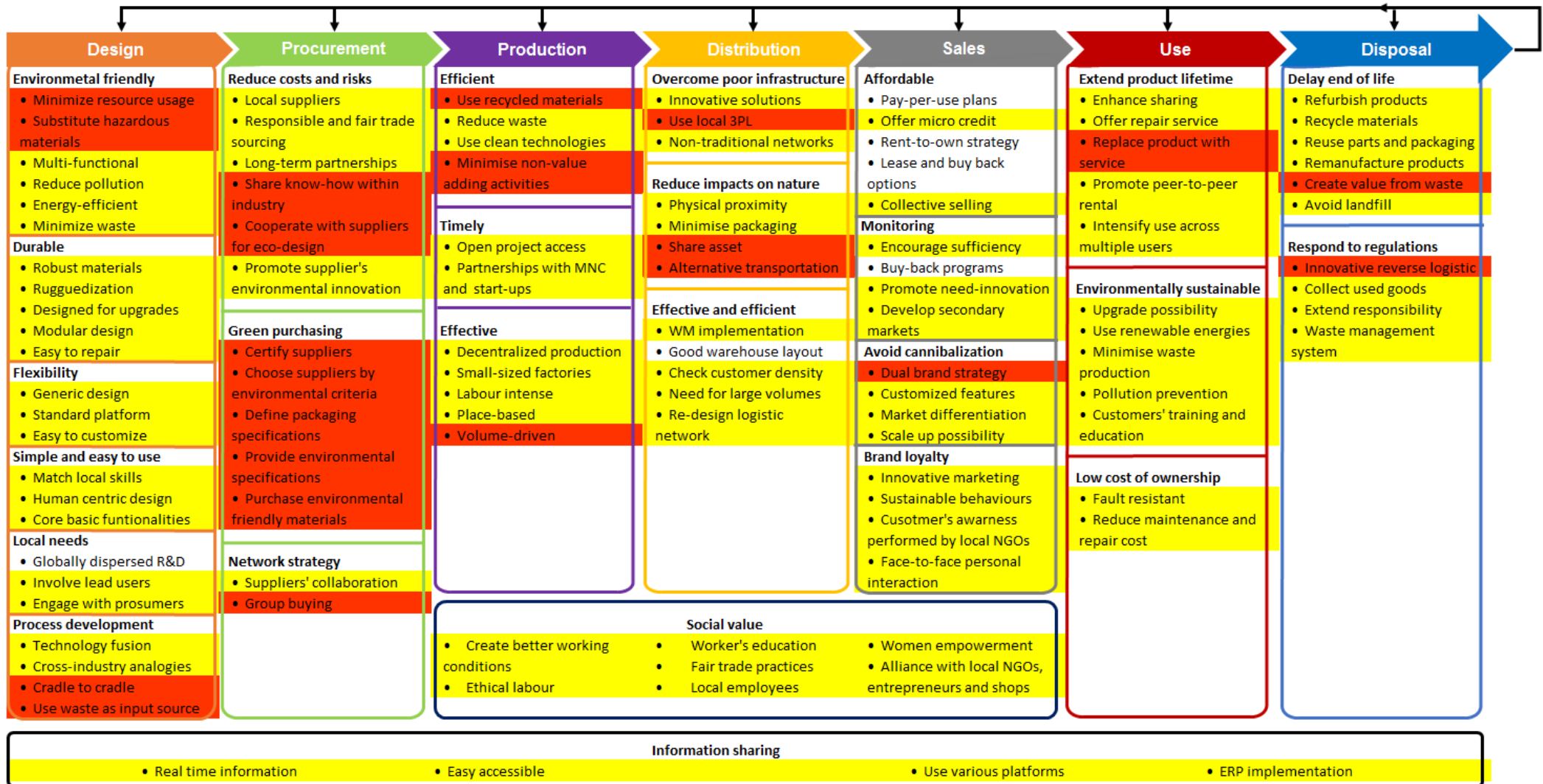


Figure B. 2 – IluMexico framework

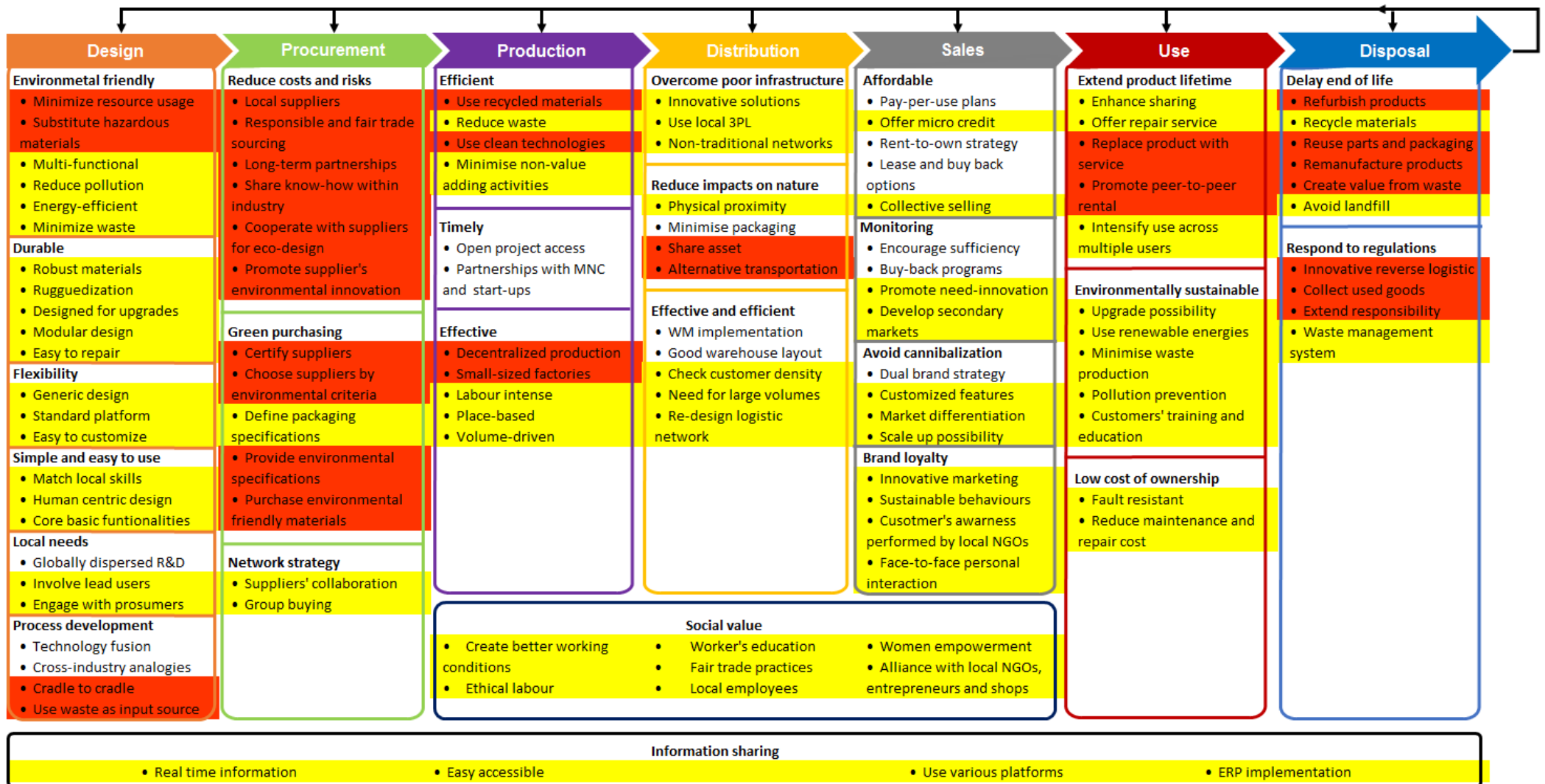


Figure B.3 – Mozambikes framework

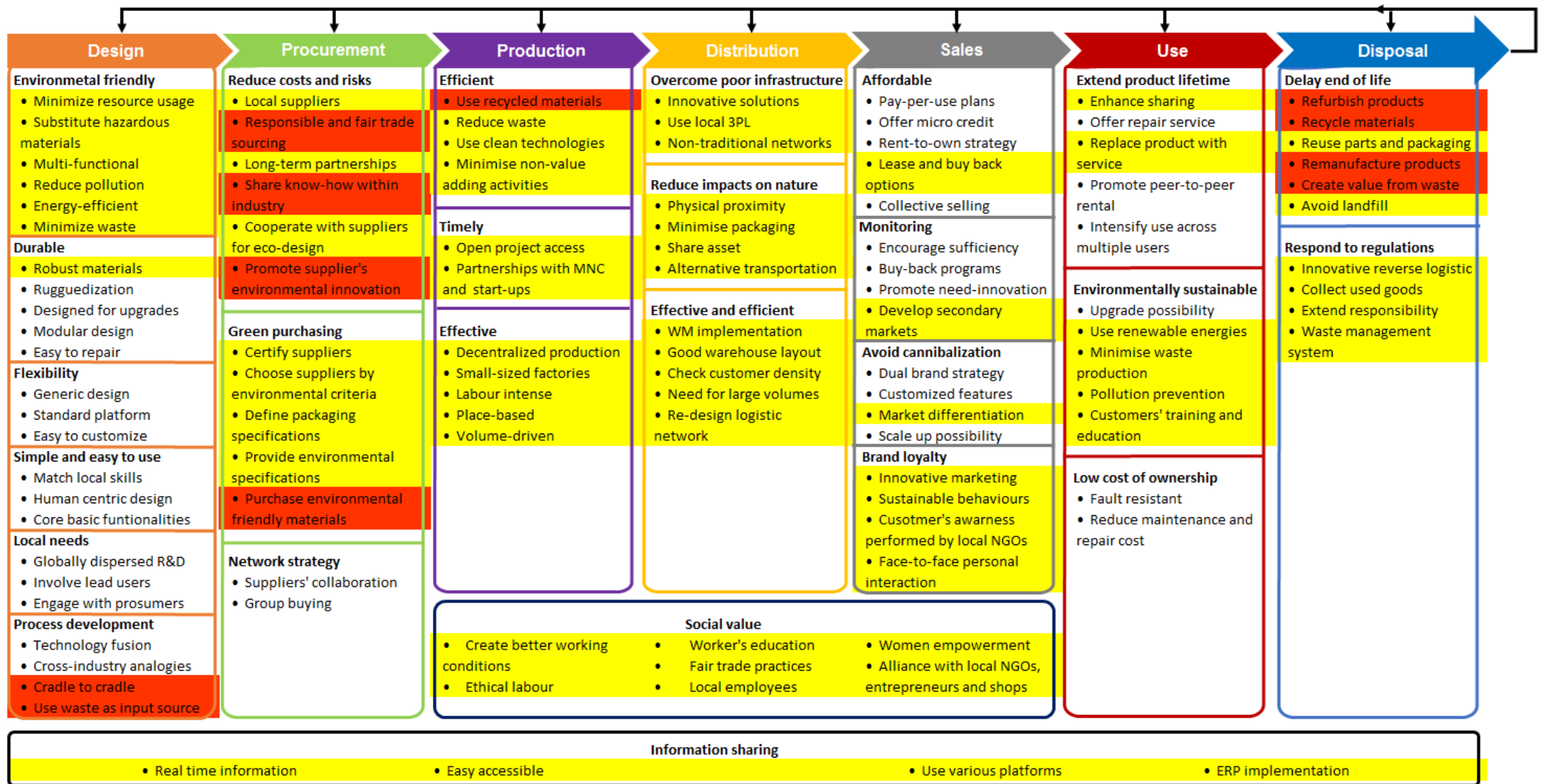


Figure B. 4 – Jibu framework

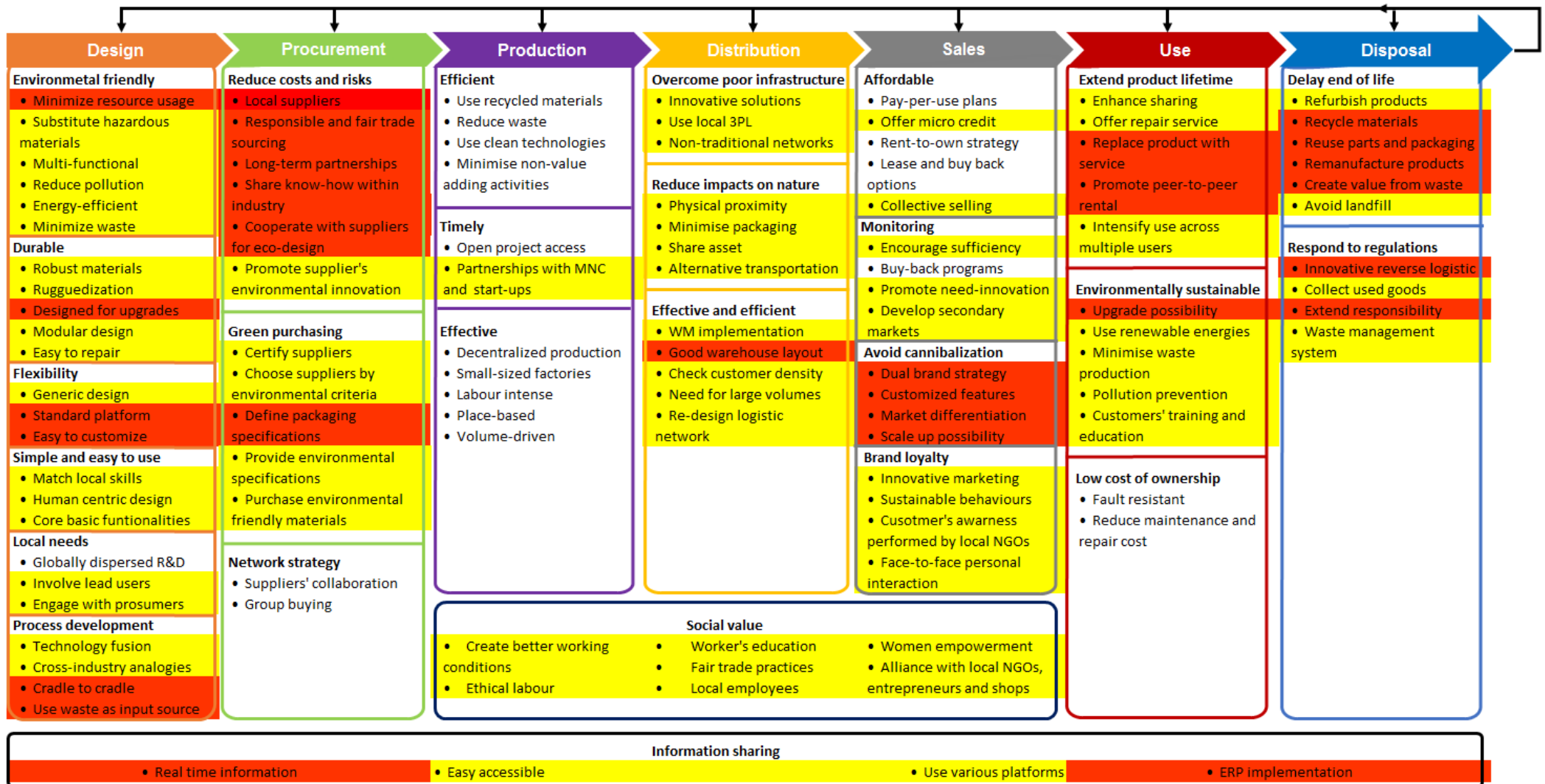


Figure B. 5 – Global Cycle Solutions framework

## Annex C: Interview Guides

### Company Interview Guide

- **General questions about the company**
  1. Do you know what frugal innovations are? What is your perception about it?
  2. For how many years has your company been commercializing these type of products?
  3. Do you think they deliver competitive advantage and helps you to outperform competitors?  
How do they internally perform compared to other products you offer?
  4. What were the drivers that motivated you to commercialize frugal innovations?
  5. Which challenges did you face in their implementation?
  6. How did you try to overcome difficulties and which practices did you employ?
- **Company's approach to frugal innovation**
  7. How do you manage frugal innovation along the product life-cycle?
  8. Which decision base do you use to choose the best strategy for each phase? To which degree are your process structured? Did you employ any guideline or framework to support your decisions?
  9. Are the business functions autonomous in their choices or do you prefer to centralize decisions? Is this strategy efficient? Why?
  10. Did you know that some organizations help start-ups to scale up their idea with financial help and knowledge support? Did your company benefit form financial or logistical support from governments, NGOs or other institutions? Is it important for the growth of your project?
- **Applicability of the proposed framework in the company**
  11. Referring to the model, which actions does your company undertake and which not? Why?
  12. Does the framework suit the products / services your company offers? Is it too general or too specific?
  13. Do you think this structured framework could support your decision-making process? Which advantages could it offer to your company?
  14. Which would be the main hurdle in employing the proposed model?
- **Specific questions about the company's processes**
  15. Have you established any strategic alliances with upstream or downstream partners? How useful and which advantages did you get form these partnerships?
  16. Did you know that product design determines 70% of total costs and 90% of the product's environmental impact? How did you choose the optimal design for your product? Did you engage with external stakeholder, such as lead users?
  17. Since a key characteristic of your product is to be affordable, you probably had to lower profit margin and compensate with large sales volume. How did you manage this issue, e.g. economies of scale? Nonetheless do you think that volumes should in general be reduced to promote sufficiency models?
  18. How did you manage the transportation issues for last-mile challenges? Did you leverage local innovative solutions?

- **Suggestions and critics to the framework**

19. Which actions and practices would you add to the model?
20. Do you have any suggestion to improve the framework and its effectiveness?

## Expert Interview Guide

- **Questions about the expert's experience**

1. For how many years have you been studying frugal innovation?
2. Why did you start getting interested about these type of product?
3. Was your investigation approach more theoretical or rather empirically based? Did it often happen that you went out in the field to visit companies commercializing frugal products?
4. Which were the main challenges faced by firms and how did they try to solve these hurdles?
5. Were companies using a structured approach to frugal innovation? Did they have guideline or employ best practices to choose the most appropriate strategies?
6. Do you think that it is possible to derive general actions that could enhance the introduction of frugal product in the market? How did you perform it? Which were the main difficulties to adapt universal actions to the specific context?
7. Is the research on frugal innovation providing solutions that help companies in developing better frugal innovation? Which could be good examples to support this theory?
8. Did you already work on creating a framework for the management of frugal innovation? Which was the scope of it? How did turn out?
9. Do you believe that a tool to support corporations in choosing the right set of actions to efficiently implement frugal innovation is needed? Why? How should it look like?
10. In your opinion frugal innovation could be right solution to tackle sustainability issues while satisfying middle-class demand? Why?

- **Expert's opinion about the framework**

11. Does the framework suit the unique characteristics of frugal products? Is it too general or too specific? What is your impression about it?
12. How much could the structured framework support the decision-making process?
13. Which is your opinion about its applicability in the field? Do you think corporations would employ it while crafting their strategy?
14. Which advantages could the framework offer to companies? Do you think that by implementing some of the new practices contained in it, the efficiency of firms' processes could be improved?
15. Which are the main hurdles in employing the proposed model? How could they be mitigated?
16. Which actions and practices would you add to the model? Which would you remove?
17. Looking at the different phases do you believe some are more critical than others and therefore need greater attention? Would you remove/add any of them?
18. Do you think there might be differences in its use according to the company/market characteristics, e.g. MNC or SME and developing or developed countries?
19. Which critics do you have about it? Why?
20. Do you have any suggestion to improve the framework and its effectiveness? A final version of it could be used as a supporting tool in practical applications?