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“FRUGAL INNOVATION AND DEVELOPMENT: WHAT DO WE
KNOW?”

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**“FRUGAL INNOVATION AND DEVELOPMENT:
WHAT DO WE KNOW?”**

TABLE OF CONTENTS

INTRODUCTION.....	1
1. THE PHENOMENON OF FRUGAL INNOVATION.....	3
1.1. <i>WHAT IS FRUGAL INNOVATION?</i>	3
1.1.1. <i>Definition of frugal innovation</i>	3
1.1.2. <i>Three criteria at the base of frugal innovation</i>	7
1.1.3. <i>Development of a frugal solution by a firm</i>	8
1.1.4. <i>Examples of frugal innovation: A Liter of Light and the ChotuKool</i>	9
1.2. <i>HISTORICAL PERSPECTIVE OF FRUGAL INNOVATION</i>	11
1.2.1. <i>The notion of frugality in history</i>	11
1.2.2. <i>Historical examples: British fashion in 1941</i>	13
1.3. <i>A CONSTELLATION OF NOTIONS AROUND FRUGAL INNOVATION</i>	15
1.3.1. <i>Explanation of the notions</i>	15
1.3.2. <i>Evaluation according to a common framework</i>	22
1.4. <i>FRUGAL INNOVATION AND ACTUAL TRENDS</i>	25
1.4.1. <i>Ecosystem of frugal innovation</i>	25
1.4.2. <i>Frugal innovation and sustainability</i>	28
1.5. <i>RESEARCH QUESTIONS</i>	30
2. RESEARCH METHODOLOGY	33
2.1. <i>WHAT IS A SYSTEMATIC LITERATURE REVIEW?</i>	33
2.2. <i>THE NEED OF A SYSTEMATIC LITERATURE REVIEW ON FRUGAL INNOVATION</i>	35
2.3. <i>METHODOLOGY</i>	38
2.3.1. <i>Papers' selection</i>	38
2.3.2. <i>Bibliometric analysis of the sample</i>	40
2.3.3. <i>Method for the meta-analysis</i>	42
3. ANALYSIS OF FRUGAL INNOVATION.....	44
3.1. <i>EMPIRICAL SETTING</i>	44
3.2. <i>CHARACTERISTICS OF FRUGAL INNOVATION</i>	51

3.3. <i>ACTORS</i>	58
3.4. <i>END USERS AND BENEFICIARIES</i>	61
3.5. <i>ENGAGEMENT AND RELATIONSHIPS</i>	66
3.6. <i>OUTCOMES</i>	71
4. GENERAL CONSIDERATIONS ON FRUGAL INNOVATION	78
4.1. <i>FINDINGS ON FRUGAL INNOVATION</i>	78
4.2. <i>LIMITATIONS AND FURTHER RESEARCH</i>	83
4.3. <i>CONCLUSION</i>	85
ACKNOWLEDGMENTS	87
BIBLIOGRAPHY	88
SITOGRAPHY	94

LIST OF TABLES

<i>Table 1.1: definitions of frugal innovation</i>	<i>6</i>
<i>Table 2.1. Source, keywords, methodology and main focus of papers under review</i>	<i>36</i>
<i>Table 2.2. List of keywords</i>	<i>39</i>
<i>Table 2.3. Statistics about relevant papers</i>	<i>40</i>
<i>Table 2.4. Top authors in the sample.....</i>	<i>41</i>
<i>Table 2.5. Distribution of methodologies in the sample</i>	<i>42</i>
<i>Table 2.6. Variables analysed for each category.....</i>	<i>43</i>
<i>Table 3.1. Top 10 countries in the development</i>	<i>45</i>
<i>Table 3.2. Top 10 countries in the adoption</i>	<i>47</i>
<i>Table 3.3. FI diffusion among industries</i>	<i>50</i>
<i>Table 3.4. Innovation type.....</i>	<i>52</i>
<i>Table 3.5. Key focus of FI.....</i>	<i>52</i>
<i>Table 3.6. Developers of FI</i>	<i>59</i>
<i>Table 3.7. Social goal of FI.....</i>	<i>62</i>
<i>Table 3.8. Relationship actor-motivation-group targeted</i>	<i>66</i>
<i>Table 3.9. General collaboration at local/foreign level</i>	<i>67</i>
<i>Table 3.10. Collaboration in the development phase at local/foreign level</i>	<i>67</i>
<i>Table 3.11. Collaboration in adoption phase at local/foreign level</i>	<i>68</i>
<i>Table 3.12. Engagement by developers at local/foreign level</i>	<i>68</i>
<i>Table 3.13. Collaboration by developers at local/foreign level and development/adoption phase.....</i>	<i>69</i>
<i>Table 3.14. Type of impact reported.....</i>	<i>72</i>
<i>Table 3.15. Measurement of impacts</i>	<i>74</i>

LIST OF FIGURES

<i>Figure 1.1. Classification in sophistication</i>	23
<i>Figure 1.2. Classification in sustainability</i>	24
<i>Figure 1.3 Classification in emerging market orientation</i>	25
<i>Figure 2.1. Paper selection process</i>	38
<i>Figure 2.2. Representation of new publications per year</i>	41
<i>Figure 2.3. Representation of methodologies' distribution</i>	42
<i>Figure 3.1. Countries where developed (grouped by area)</i>	45
<i>Figure 3.2. Countries where adopted (grouped by area)</i>	46
<i>Figure 3.3. Countries where developed (grouped by income)</i>	48
<i>Figure 3.4. Countries where adopted (grouped by income)</i>	48
<i>Figure 3.5. Geo of frugal innovation</i>	49
<i>Figure 3.6. FI diffusion among sectors</i>	50
<i>Figure 3.7. FI word cloud</i>	51
<i>Figure 3.8. Characteristics' frequency</i>	53
<i>Figure 3.9. Simplicity degree of FI</i>	54
<i>Figure 3.10. Functionality degree of FI</i>	55
<i>Figure 3.11. Affordability degree of FI</i>	55
<i>Figure 3.12. Product innovation and its characteristics</i>	56
<i>Figure 3.13. Business model innovation and its characteristics</i>	57
<i>Figure 3.14. Process innovation and its characteristics</i>	58
<i>Figure 3.15. Developers' motivation</i>	59
<i>Figure 3.16. Other actors' motivation</i>	60
<i>Figure 3.17. Motivation of each developer</i>	61
<i>Figure 3.18. Group targeted (general overview)</i>	63
<i>Figure 3.19. Groups targeted by actors</i>	64
<i>Figure 3.20. Group targeted by foreign firms</i>	64

<i>Figure 3.21. Group targeted by foreign non-firms</i>	64
<i>Figure 3.22. Group targeted by local firms</i>	65
<i>Figure 3.23. Group targeted by local non-firms</i>	65
<i>Figure 3.24. Relationship actor-motivation-group targeted</i>	66
<i>Figure 3.25. Collaborations in the development</i>	70
<i>Figure 3.26. Collaborations in implementation, diffusion, adoption</i>	71
<i>Figure 3.27. Impact's frequency</i>	72
<i>Figure 3.28. Economic impact</i>	73
<i>Figure 3.29. Environmental impact</i>	73
<i>Figure 3.30. Social impact</i>	74
<i>Figure 3.31. Measurement of impacts' frequency</i>	75
<i>Figure 3.32. Impacts' measurement</i>	76
<i>Figure 3.33. Developers' measurement</i>	77
<i>Figure 3.34. Developers' measurement (alluvial diagram)</i>	77

INTRODUCTION

Frugal innovation is an increasingly relevant and debated topic for scholars, practitioners and policymakers. Until recently, frugal innovation was an unknown phenomenon, but it gained attention in a relatively fast period of time. In fact, while at the end of 2009, Google Scholar counted only 11 publications with the keyword "frugal innovation", at the end of April 2016, they reached the mark of 1340. In 2009, the theme was for the first time brought to the attention of the big audience, when the business magazine "The Economist" published the article titled "Healthcare in India: Lessons from a frugal innovator", defining frugal innovation not only as the process of redesigning products, but also "rethinking the entire production process and business models". Nevertheless, the origin of the phenomenon and its theoretical background are still unclear and there is still a lot of discussion in defining what frugal innovation is. In fact, a commonly accepted definition is missing and many scholars investigate the topic from a different point of view or related with other issues; moreover, the constellation of notions around frugal innovation creates an even more blurred theoretical framework, considering that often, there are inaccuracies and contradictions between the different definitions.

Frugal innovation has usually been related to emerging markets and developing countries, but quite recently it has been highlighted the growing impact that it has also in advanced economies; not without reason, the European Union, in providing policy instructions to deal with the Grand Challenges in the global context, has stressed that "frugal innovation may be applied in advanced countries and in specific sectors such as those linked to the Key Enabling Technologies (KETs)" (EU European Commission, 2016).

From this situation concisely described, it emerges how this phenomenon is gaining increasing importance with implications also in the long run, but it is in its primary phase of the study, so a well-defined theory that explains it, is still missing. The purpose of this work is trying to understand what frugal innovation is, through its nature, context and characteristics, and its development and diffusion. All the existent literature and case studies on the phenomenon under discussion have been reviewed, in order to develop the analysis and provide interesting contributions. The research questions, that the elaborate will try to answer, focus around the characteristics that define frugal innovation, the context in which is developed and the relationship between the different actors involved and, finally, the measurement of the impacts. The elaborate is structure as follow: the first chapter is aimed at providing a theoretical background necessary to understand the subsequent work; so, a broad definition of frugal innovation is presented, as well as the main features and the explanation of the related concepts; moreover, the phenomenon is analysed from a historical perspective, through the presentation

of the history and ancient cases of frugality, and from a current perspective, by analysing the actual trends and some cases of frugal solutions. The first chapter concludes with the research questions. The second chapter instead, is dedicated to the methodology: first it is explained what is a systematic literature review and the reason why there is the need of one on frugal innovation, and then it describes the entire research process adopted, from the findings of articles to the analysis of the individual case studies of the sample. The third chapter exhibits the results of the analysis conducted and is divided into six sections in order to study the phenomenon in the most comprehensive way as possible; thus, the empirical setting, the characteristics of frugal innovation, the actors involved, the beneficiaries and the relationship between them and lastly the outcomes and effects of the phenomenon under review are displayed. Chapter four traces some general considerations on frugal innovation, presenting the main findings of the investigation with respect to the literature reviewed; in this last part are also presented the general limitations of the work and some insights for further research.

1. THE PHENOMENON OF FRUGAL INNOVATION

In what frugal innovation consists is still under a great debate; there is not a clear and universal accepted definition, but a set of notions that attempt to depict and analyse the phenomenon according to different perspectives and from an empirical point of view. Moreover, multiple and different concepts, such as jugaad, grassroots, reverse, inclusive innovation, partially overlap with the one of frugal innovation, thus creating misconceptions and misalignment. The theoretical antecedents and underpinnings are still unclear and many scholars have tried to comprehend the phenomenon relating it to the context of emerging or developing economies. For these reasons, the first chapter is aimed at gaining an extensive understanding of the theoretical basis, to better understand the phenomenon of frugal innovation, to identify the various actors involved and their ecosystem and to create a common framework in order to move forward in the research in the future. The chapter starts describing the topic of frugal innovation from a semantic and theoretic point of view and it follows exploring history and antecedents of frugality; the third part is dedicated to the explanation and contextualization of the different concepts related to frugal innovation; the chapter continues by analysing the actual tendencies and the open matters on the phenomenon, finally, it concludes with the presentation of the research questions of the following work.

1.1. What is frugal innovation?

The first subsection of chapter one is simply named "What is frugal innovation?". The objective here is to give a detailed overview and a solid base on frugal innovation. The section is divided into four parts; the first outlines and provides some definition of the topic, while the second one depicts the three fundamental characteristics in order, for an innovation, to be defined as frugal; the third part is more theoretical and describes the development of a frugal innovation by a company, finally, the last part provides some practical cases of the phenomenon.

1.1.1. Definition of frugal innovation

This part of chapter one deals with the definition of frugal innovation; before moving into a review of the existent arguments of many scholars, it is necessary to understand the semantic of frugal innovation, which is composed of two words: innovation and frugal. The most exhaustive and widely accepted definition is given by the Oslo Manual, that refers to innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organisation or external relations". The word frugal instead, is an adjective, coming from Latin,

that means being economical in use, prudently saving, not wasteful, thrifty, careful and saving use of resources, and some of the antonyms are wasteful and opulent.

The definition of frugal innovation proposed by Brem and Wolfram (2014) is one of the most comprehensive and does not get too far from the roots of the topic: frugal innovation is "a derived management approach, based on *jugaad*, that focuses on 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". Thus, from this first conceptualization, it is possible to affirm that frugal innovation is a means and ends to do more with less for more people.

As the economy becomes every day more interconnected, emerging markets are gaining attentions like never before; they are characterized by underdevelopment, resource constraints, institutional voids, and very low purchasing power. Probably driven by these limitations, the phenomenon of frugal innovation was born exactly in those countries, from the exigency to cope with resource constraints and to satisfy the needs of the people at the BoP, and is now gaining broader attention also in the developed countries, thanks to its no-frill, cost-cutting, and resource-saving nature. In fact, the idea that innovation is conceived in a different way in or for emerging countries with respect to developed ones is pervading significantly the last studies. Some businesses, that wanted to reach disadvantaged population, focused on the essential features of the product or service, thus simplifying it and minimizing the use of resources, and achieved to develop affordable frugal innovations for the majority of people in the emerging markets.

The most successful case is Tata Nano, the cheapest family car (US\$2000), by Tata Group.

As explained in detail later, although there are many definitions of frugal innovation, it is possible to identify the following peculiarities: frugal innovation focuses on fundamental and core needs, by eliminating unnecessary functions; it has no-frills, it is easy to use and affordable; it struggles to reduce costs and save resources during the whole production process; and then it adapts to harsh environments, especially in the developing countries.

A particularly interesting idea is proposed in the work of Watson et al (2013), that tackles the topic of frugal innovation as the result of the mix of already existing ones: Schumpeterian innovation, institutional innovation and social innovation.

All authors define frugal innovation in a different way, some give an explicit definition, some only mention a few characteristics, and some refer to definitions of other authors. Generally,

we refer to frugal innovation with the sentence doing more with less, because the main features identified in the inventions or approaches are simplicity, affordability and functionality. This comes from the idea that frugal innovation has to be something new, with a higher degree of simplicity in order to better adapt to local conditions and needs, affordable to give the possibility to a large number of people, especially those at the base of the pyramid, to benefit and take advantage of them, and functional, that means with core features specifically designed for the needs that have to be satisfied.

In the following table (table 1.1.) we collected the definition of frugal innovation given by the most relevant authors. The first thing that is possible to highlight is that frugal innovation, according to the different authors, is not conceived in a univocal way: it is described as product or a service (Zeschky et al., Weyrauch and Herstatt), as an outcome of a process (Bhatti et al., Basu et al., Radjou and Prabhu), as an approach (Agarwal, Brem et al.) and finally, in a more comprehensive way, as a product, process or marketing and organizational method at the same time (Tiwari and Herstatt).

Almost all the authors stressed the economic aspect and the importance of creating something affordable, cheap (that does not mean bad quality) and that implies a cost reduction.

Only a few times is precisely specified the location and the market addressed, which usually is constrained-based and of an emerging economy; an alternative view is proposed by Agarwal. He argues that frugal innovations should serve also the low-growth stuck Western market. Also other authors support this view, listing all the motivations that shall induce developed countries to adopt frugal innovations; slow growth of developed economies, environmental constraints, aging population are only some reasons that lead to an increase of the demand of frugal innovation and frugal models of production and consumption (Bound et al., 2012).

Albeit the definitions have some common features, it is not clear if frugal innovation should be considered as an output (products and services) or as an approach/mindset. An important insight is given by Brem and Wolfram (2014) with their definition; they argue that frugal innovation is an "approach 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". Hence, frugal is something related to the whole innovation process and to the product's features that can be applied in different types of innovations.

Rao in a recent study (2017) analyses how advanced sciences and technologies have an impact on creating cheap but sophisticated products. Hence, he identifies an evolution of the frugal innovation, a new class, the ones so denominated Advanced Frugal Innovations (AFI). The

main characteristics are the following: low cost as a direct consequence of their frugal nature, employment of workers with high specialization and advanced education in order to understand and conceive AFI and leveraging the progresses in science and technology since the beginning of the process, for example adopting both product frugal design and product frugal engineering.

To sum up, what frugal innovation is, a useful definition, that does not limit the phenomenon to specific markets, geographical areas or income group and at the same time ensures good quality standards and compliance with the legislation, is proposed by Tiwari, Fischer and Kalogerakis (2016).

Frugal innovations are said to be aimed at creating an attractive value proposition for their targeted consumers by focusing on core functionalities. In this way, the use of financial and material resources is minimized; there is a substantial reduction in the costs of usage or ownership while respecting or even exceeding the required quality standards. From the broad view of this notion, we can affirm that frugal products and services i) can be created and be suitable for any group of consumers through their increased affordability and openness to a new segment (BoP); ii) are “responsible innovations” because of their sustainable component deriving from reduction of production materials; iii) they embed a principle of sharing economy.

Table 1.1: definitions of frugal innovation

Author	Definition of Frugal Innovation
Agarwal, Brem, et al. (2012)	“Frugal innovations have been proposed as potential approach for serving resource-constrained consumers in emerging and developing markets as well as in the low-growth stuck Western markets, due to their notion of affordability, good (enough) quality, and no-frills structure”.
Basu et al. (2013)	“Frugal innovation is a design innovation process in which the needs and context of citizens in the developing world are put first in order to develop appropriate, adaptable, affordable and accessible services and products for emerging markets”.
Bhatti (2012)	“It is not simply about reducing costs, but can also involve increasing the affordability power of the buyer through income generation, saving, [...], the outcome involves [...]. sustainability”.
Radjou and Prabhu (2015)	“Frugal innovation is the ability to ‘do more with less’- that is, to create significantly more business and social value while minimizing the use of diminishing resources such as energy, capital and time”.
Tiwari and Herstatt (2014)	Frugal innovation can be characterized as “new or significantly improved products (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 with the objective of significantly reducing the cost of ownership and/or usage while fulfilling or even exceeding certain pre-defined criteria of acceptable quality standards”.

Weyrauch and Herstatt (2016) “We propose that innovations are frugal if they simultaneously meet the criteria of substantial cost reduction, concentration on core functionalities and optimized performance level”.

Zeschky et al. (2014) "Frugal innovations are not re-engineered solutions, but products or services developed for the very specific application in resource constraint environments".

1.1.2. Three criteria at the base of frugal innovation

As outlined in the previous sections, frugal innovation is gaining increasing attention and many different definitions have been proposed, but what is missing are some clearly defined criteria to identify frugal innovation. In this respect, the following part will be illustrating the three core features of frugal innovation, according to the researches of Weyrauch and Herstatt.

These are substantial cost reduction, concentration on core functionalities and optimised performance level; innovation can be defined as frugal only if meet all the criteria simultaneously; in the event that also other characteristics are observed, the innovation remains a frugal one, unless it does not satisfy anymore the requirements earlier mentioned.

I. The first criterion is cost reduction and, only to clarify, it embraces similar concepts and synonyms like minimizing the use of material and financial resources, affordable, much lower price, substantial cost reduction or considerably lower initial cost. In effect, in almost every case, frugal innovations are described as having a considerably lower cost than the common product or service, but it is not clear if it is from the consumer’s or producer’s point of view. Considering that firms always pursue minimization of costs, the requisite of cost reduction has to be intended from the customer's perspective or as a reduction of the total cost of ownership, thus including both positions.

Lower prices measurements are rarely reported, so it is difficult to understand what is the threshold to satisfy the criteria. Rao (2013) conducted a study on this topic and found out that usually, the decrease is between 58% and 97%, with the majority of cases around 80%; so, in broad terms, the cost reduction has to be at least a third.

II. The second criterion is the focus on core functionalities and, as before, it includes the words user-friendly, easy to use, essential functions, core benefits and reduced functionalities.

From the literature, it distinctly emerges the effort of frugal innovation to focus on the most important and fundamental characteristics in order to give the highest benefit to people and efficiently satisfy essential needs. Concentrating on core functionalities means eliminating useless frills, meeting a specific lifestyle and making a product or service easier to use, thus saving natural and financial resources and having a positive impact on the environment.

III. The third criterion is optimised performance level; this concept contains many attributes such as robust, easy to use, acceptable quality standards, reliable and high-end technology, only to cite some. Differently to the two previous criteria, in this case, it is more difficult to identify the optimum performance of an innovation in order to be defined as frugal; it is not easy to understand the right level of performance and quality required, because it is strongly correlated with the context. For example, construction equipment developed in high-income countries usually struggles in meeting this condition, because it is over-engineered and articulated, with respect to the global building market that look for instruments technically simple, robust and that allow the do-it-yourself reparation. In other cases, instead, the conventional quality is not enough for frugal innovation and the performance has to be of better quality than usual; for example, Indian people, when driving, tend to abuse of cars' horns much more than in other countries; thus a higher performance level of this tool is necessary if you want to have success in the Indian market. From this, it is possible to conclude that the performance level has to satisfy the purpose, while adapting to the specific conditions of the environment.

Aligning on these criteria in the definition of frugal innovation is fundamental, giving that studies are still evolving, and necessary in order to gain a solid background to really understand frugal innovation.

1.1.3. Development of a frugal solution by a firm

Looking at the current economic and social tendencies, in the future, traditional companies should adopt flexible strategies in order to be still competitive; in particular, this includes also the creation of products, specifically designed for emerging countries, characterized by affordable prices, good quality and suited for the targeted context. In this section, a step forward in analysing frugal innovation is done, by exposing the modular-based approach for frugality; this was developed in the context of the European project “ProRegio” and it could help firms in the process of definition and development of frugal products or services.

Looking at frugality as an objective, a company should adopt a modularity approach in order to achieve it. Modularity basically means decomposing a system into independent parts, the modules, so that they could be considered units per se (Jiao et al. 2007). Combining frugal innovation requirements and modularity implies the adoption by the firm of the practices described below.

One of the first action to take is the increase the product variety in order to better adapt to regional differences; from the basic modules, through their different combinations, it is possible to offer a variety of configurations, keeping the development cost limited. A second aspect is the improvement of product development by means of modularity; in fact, using this approach the development process could be significantly simplified and the creation of a new version can be obtained, in a short time and with limited resources, through the adjustment of existing modules. The last practice that should be systematically incorporated in firms' strategies is the involvement of customers also in the development and implementation phase. In this way, their needs are better known and easier to satisfy and in addition, their specific needs can support also products in an initial phase of conception but destined to markets with similar customers.

The modularity approach is useful in representing the variety and complexity of information related to the customers. In order to facilitate the whole process, since the principle, the company should identify the product functions, choose the appropriate structures and modules and identify the most suitable production system and network configuration; subsequently, it should study alternative product structures, resulting from combination of modules, and relate them to production capabilities and limits. Finally, to build an effective and useful global network, the company should list all the suppliers and possible actors involved. To sum up, following frugal innovation principles, the modular approach facilitates the interpretation of people's needs and the detection of the right modules to be considered.

In this section some aspects of a possible future approach have been described; its main strength consists of the close relationship between the customers, the product development phase and the network. It is precisely this interaction that allows the achievement of frugality solutions.

1.1.4. Examples of frugal innovation: A Liter of Light and the ChotuKool

In this last part, some cases of idealization and development of frugal innovations are introduced, in order to better understand the theoretical definition proposed above.

In the first case is presented the frugal innovation named "A Liter of Light", a solar bottle bulb created to address the electricity problem in the Philippines, where energy's prices are the highest in Asia. There, lighting is still a luxury for a big portion of the population, houses are built without windows many times and so close to each other that they are not reached by sunrises not even during the day. This situation forces people to rely on illegal electric systems, with terrible consequences, for example fire accidents. Driven by this social issue, the no-profit MyShelter Foundation was established, with the objective to bring lighting solutions in people's life. The name of the project is "A Liter of Light" because the frugal solution is derived by a recycled plastic bottle, filled with bleached water and put through a hole in the house's ceiling. The solar bottle bulb cost less than US\$1, has a very simple technology, takes less than five minutes to assemble and creates the equivalent of a 55-Watt light bulb. This solution was initially ideated in Brazil by Alfredo Moser and then developed by the Massachusetts Institute of Technology (MIT) that adapted it to the needs of the Philippines population. This frugal innovation is having big positive impacts; in fact, the solar bulb is diffused in more than 28.000 houses in the city of Manila, the capital of the Philippines (MyShelter Foundation, 2012); and in 2015 it reached more than 350.000 families across fifteen countries.

The electricity problem affects also India, where the supply of energy is limited, unstable and costly for many people. The illustration of the second case is also moved by this problem and it regards the ideation of frugal refrigerator as solution. In this country, less than 18% of families have a refrigerator in their house, due to the lack of stable energy supply and the prohibitive price, especially for people living in rural areas, of the furniture; however, the hot and humid Indian climate makes the refrigerator even more essential than in other countries. For these reasons, an Indian home appliances company, Godrej, decided to create a solution in order to satisfy the need and capture the big potential market, estimated to be around 8.5 million per year (Economic Times, 2011). The firm decided to send some employees to rural villages with the goal of understanding the characteristic of the need and of the specific context. They discovered that the normal family does not need a big refrigerator for two reasons: the first one is that it is only used to contain few products, mainly vegetables and milk, and the second reason is that, being the houses constituted of one room, the refrigerator cannot occupy a lot of space. Moreover, they found out that families migrate often for job or financial and resource problems and every time that they move it is not possible to bring with them a big refrigerator; so it has to be small and portable. Based on these observations, the company created the "ChotuKool", a portable refrigerator. It is very small, around 46 cm tall and 60 cm wide, light, only 7.2 kg, it has two handles to move it, it opens from the top to save better cold air and it can work also

with a battery. This frugal solution costs only US\$70 and it is affordable for a significant portion of people living in rural areas; it is composed of only twenty parts (a normal refrigerator counts at least 200 components) and this characteristic permits a big saving in the material and financial resources used. Thanks to the frugal innovation "ChotuKool" now many people in India have increased their living conditions.

1.2. Historical perspective of frugal innovation

This part of chapter 1 aims to provide a historical perspective of the concept of frugality, in order to identify elements that could explain the presence and acceptance of frugality in modern society. This section is structured as follows: the first part focuses on the historical perception and relevance of frugality, in both Western and Eastern societies, with the objective to understand its current relation with topics such as innovation, progress and sustainability; the second part instead, provides a real case of frugal approaches in the past.

1.2.1. The notion of frugality in history

Although, at the time, not associated with innovation, the notion of frugality has its roots in the ancient past, especially in philosophy and religion. Some cultures, like Greek and Roman ones, relied on this ideology and promoted it through values of temperance, moderation and self-restraint. Both epicurean and stoic philosophy highlights the benefits of a frugal life, characterized by limitation of desires, abolition of luxury and moderated lifestyle. Cicero and Seneca, two of the most famous representatives of stoicism, stressed the importance of a way of living based on austerity and voluntary restraint.

The word itself comes from the Latin term *frugalitas*, that literally means useful result. In particular, one of the first statements regarding frugality is by the Roman writer Varro. In his treatise about property management, "*De rustica*", he illustrates how a more frugal manor, in the meaning of simpler, sober, more efficient and production-oriented, should be preferred to a more luxury one, only intended for material things' enjoyment.

In the eastern countries, frugality and material simplicity are considered virtues, since they are connected with principles of Buddhism and Neo-Confucianism, two of the most diffused religions. Lao-Tzu, the founder of Daoism, inter alia, is especially known for his writings on frugality and simplicity (Low, 2009).

Later, also in the 18th century, it is possible to track down many reflections on frugality. With the coming of Enlightenment, industrialization and mercantilism, discussions around self-control, moderation and passions were very popular. The middle class, mainly French and

British ones, conditioned by enlightenment's theories of civilization and progress and at the same time by the ancient thinking of some Greek philosophers, used to really take into account the concept of frugality and to consider it as one of the fundamental pillar of their lives (Koselleck, 2014). These ideas grew up strongly also with the contribution of the philosopher Adam Weishaupt; he argued that, in the future, our planet will be fully populated, and it will be imperative for the society to be based on frugality and moderation, the only two conditions that can guarantee peace and social stability (Neugebauer-Wölk, 1996).

The German philosopher Immanuel Kant identifies different kinds of frugality, based on rational thinking, and explains that the individual that is satisfied because he does not comprehend amenities of life is a man of simple frugality, while the one who knows but voluntarily avoid them due to the fear of consequences, is an individual characterized by wise frugality (Munzel, 2012). Adam Smith, known as the father of economic science, also participated in the debate over frugality, considering it as a form of virtuous behaviour; he idealized the concept of "frugal man" in the books "Theory of Moral Sentiments" and "An Inquiry into the Nature and Causes of the Wealth of Nations". According to Smith, frugality has its origins in saving, so he thought that being frugal in private and everyday life can bring to a capital's growth and to national wealth's increase. Also the neoclassical economist, Alfred Marshall, looked at frugality as a positive characteristic; for him frugality, thrift and industriousness are the keys of success (Marshall, 1890), even if he considered welfare policies, taxation and poor laws negative incentives for a frugal way of living.

The attention over a frugal way of living lost its significance at the end of the 19th century, especially with the Congress of Vienna, and even more in the 20th century with the emergence of tendencies such as consumerism and a marked increase of the quality of life. In fact, in this century, frugality assumed a negative connotation, given that the rapid economic growth was promoting values such as abundance, opulence and the aspiration that everything had to be "bigger and better" (Tiwari et al., 2016).

As it will be explained in the second part, only with the advance of World Wars, some values related to frugality have been rediscovered with the objective to cope with resources' scarcity and austerity concerns. In that period, the philosophy "doing more with less" was the base of many frugal solutions adopted for daily problems in a resource-constraint context.

In the last century, instead, the topic of frugality has been highlighted in conjunction with the new attention towards sustainability and the relationship between economics and ethics. So, frugality is seen as appropriate use of resources, avoidance of waste and ethically conscious

choice. In particular, Bouckaert et al (2008), in their work “Frugality: Rebalancing Material and Spiritual Values in Economic Life” point out as frugality is often conceived at the opposite to economic growth, but actually frugality is “a necessary condition for global sustainability and international justice”, thus promoting it as an ideal.

From this brief historical digression, it is possible to notice how the concept of frugality has always been present in religion, philosophy and ordinary life, all around the world. We now move to the presentation of a practical application in the past to show through which behaviours frugality was achieved.

1.2.2. Historical examples: British fashion in 1941

During World War II, many countries had to deal with resource constraints and austerity measures in order to assure as many resources as possible for the war; in practical terms, this is translated mainly with the rationing of food, goods and services for the civilian population and had as main effect of increasing prices. In this regard, governments, worried about possible societal inequalities and low public morale (essential to win the war), came up with some schemes such as CC41 in Britain, DIY (Do It Yourself) in United States System D in France and some other frugal innovation to cope with the current context. For example, the American entrepreneur Benjamin Franklin to solve everyday problems invented the Franklin stove, a metal-lined fireplace, bifocal lenses and lightning rod.

A particularly interesting case are the measures and inventions adopted in Britain during World War II, commonly known as CC41 scheme. In 1941, the British Board of Trade decided to introduce CC41 scheme, which stands for Civilian Clothing 1941, in order to ensure to costumers that, in such a difficult period, goods were of quality and at affordable and reasonable prices. The CC41 was first applied to clothes and then, once frugal practices had been learnt, also to furniture and other goods. For example, during the production process, it was prohibited to use more inputs than the bare essential or certain materials, such as wool, that was needed for military uniforms. At the base of these restrictions, there was a frugal, "make do and mend" mentality where everything as to last as long as possible and waste were not allowed; all had to be done and produced in order to have more resources to be addressed to the War, with the only purpose of winning.

Austerity regulation had very strict rules; some examples are the followings: no more than two pockets, five buttons, six seams in a skirt, two inverted or no more than four pleats; they were all limitations regarding the use of materials; in fact, with regard to design and fashion style, there were no constraints, on the contrary, it was promoted in many ways. For example, in 1942,

The incorporated Society of London Fashion Designers created a collection of Utility Clothing with 34 items, top designers were commissioned by the government to create year collections and in the television were transmitted films on how to make old items into new ones. So, women started to create small beds for babies from old sacking, ladies' dresses from men's ones and patchworks of different textiles in order to lengthen children's clothes. It was the art of frugality and improvisation. Other times, instead, alternative materials were used, such as cork for shoes' soles, since leather and rubber were destined to war's equipment.

The short-supply of chemicals and other products had an impact also in the beauty routine of women, who used burnt matchstick as an eyeliner, beetroot or cherry juice on the cheeks as blush or on the mouth as a lip gloss to appear rosier and healthier, or used teabags to paint their legs, because stockings were not produced given that nylon and silk were needed to make parachutes.

This new way of getting dressed was not discriminated, instead, it became so renowned and socially accepted that in 1942, British Vogue referred to it as "the clean elegance of a style stripped of all superfluities" (Mendes, 1999); it was the consecration of CC41 style.

In a second moment, the English government decided that CC41 scheme has to be applied also to household goods, the furniture had to be of good quality and affordable. Thus, the design commenced to be standardized, produced in a modular way and sold to the consumers half completed but provided of assembly instructions. This has given to the birth of the discipline of industrial design and the DIY (Do It Yourself) philosophy, still present today and one of the major strengths of the Sweden furniture giant, IKEA.

In that historical period the British economy was characterized by resource constraints in many parts of the value chain, from accessibility of raw materials to skilled labours, from the designing point of view to the finances of the final consumers; nevertheless, they achieved in adding value to the products with a frugal mindset, by turning the problem into an opportunity and changing the way of considering the entire production process, by thinking of it in a very innovative way.

From the history case explained above, it is possible to observe how some kinds of frugal products and processes have always existed and are usually adopted in a resource-constrained context. This successful case is the demonstration that doing more with less does not mean offer a poor product or service doomed to fail. In this historical moment, of global economic crisis, what frugal scholars are studying and trying to understand is how to work in a context characterized by fast changes, lack of resources and skills and at the same time offer good and

affordable solutions that meet population's needs. Is it a situation so far from the one described in the case of British fashion in 1941?

1.3. A constellation of notions around frugal innovation

Around the main topic of frugal innovation, many concepts and types of innovation have been studied, creating some misaligning and confusion, since that often there is an overlapping of some aspects of the different notions. The first part of the section describes all concepts in order to gain a common understanding, while the second part provides a framework to classify the terms.

1.3.1. Explanation of the notions

As already pointed out a common definition of frugal innovation is still under debate, as the different concepts related to it. Hence, this part aims to clarify and explain them, in particular Jugaad, Gandhian innovation, frugal engineering and constraint-based innovation, catalytic innovation, indigenous innovation, grassroots innovation and reverse innovation.

To conclude, an extensive understanding of these concepts is necessary to better understand the phenomenon of frugal innovation.

Jugaad

The term *jugaad* has Hindi origins and has been many times roughly translated as creative improvisation because it reflects the creativity and ingenuity of some cultures living in poor areas to adapt to the scarcity of resources by using them in a creative and improvisational way, in order to create solutions to solve everyday problems. The word is usually associated with the common expression *kabaad se jugaad*, which indicates the conversion of waste into something useful and beautiful.

This notion has its roots in the Indian rural areas, where farmers are used to adopt improvisational and spontaneous approaches to solve the problems of the community in which they live, at a low cost and in a short time. This mentality is mainly diffused all over India, especially at the Bottom of the Pyramid (BoP), where people learn to be self-reliant due to the scarcity of all kinds of resources. BoP is defined as one of the largest and poorest proportion of the world's population that lives with less than US\$2 per day and is estimated to be more than four billion human beings in the developing world; this market is volatile and characterized by high uncertainty and significative institutional voids. From this last aspect, it is possible to deduce another peculiarity of jugaad: the absence, partially or totally, of taxonomy or discipline; the direct implication is that some jugaad inventions might not meet high-quality standards and

norms. In these contexts, jugaad is almost seen as a way of survival and fundamentally is a result of poverty and exigency.

Jugaad solutions are often based on imaginative problem solving, rather than technological inventions; the standard process approach where input, conversion and output are defined a priori and some product's requirements are achieved, here is completely overturned, in fact, in this conception, the input of the creation process is not the product, but the problem to be addressed. Therefore, jugaad innovations have some features that completely revolutionize the standard model of innovating, usually characterized by high costs and intensive activities of research and development; in fact these kinds of innovation have birth without a studied and well-defined project, moreover, they are low cost and made of poor materials, thus incorporating a sustainable and environmental aspect, because with respect to traditional product development, jugaad takes fewer resources and uses them in a more efficient way.

In Indian rural areas everyday farmers come up with jugaad solutions: for example, because a seed drill is too expensive, a motorbike can be properly modified in order to allow it to sow the fields and an old pan can be rearranged and hung to the wall or ceiling of a house, to then become a boiler for the shower.

Gandhian innovation

The term Gandhian innovation appears for the first time in the literature in 2010, with the work of Prahalad and Mashelkar; they argue that it is similar to jugaad innovation for some aspects such as the caring for the community or local raw materials adoption, but it is moved by different motivations, being based on Mahatma's conceptions. Concerning innovation, the two most important Gandhi's assumptions are "I would prize every invention of science made for the benefit of all" and "Earth provides enough to satisfy every man's need, but not every man's greed". From these two quotes, it is possible to sum up that Gandhian innovation is a type of innovation mainly developed for the Indian market and based on the two Gandhi's assumptions regarding affordability and sustainable development (Prahalad and Mashelkar, 2010). This type of innovation is addressed to people at the bottom of the pyramid and aimed at simplicity and affordability.

Moreover, in analysing innovation's path in Indian enterprises, the authors discovered that Gandhian innovation could be of three types, thus adding a further characterization. The first type is the technology-driven innovation, in which the firm creates new business model taking advantage of western technologies, especially in the IT sector; the second type is the capability-driven innovation that involves a creation of new internal capabilities (ex. technical expertise, design) in the enterprise in order to solve problems, where collaborations with other firms are

R&D centres are very common; the third type instead, is the creation or acquisition of new abilities, through combination of external technologies and internal capability approach with the objective to achieve good products lowering the production costs.

To conclude, it is appropriate to affirm that, even if Gandhian innovation was born in India, it could have a big impact all over the world because, to some extent, the innovation process is based on philosophical cornerstones. In this respect, Prahalad and Mashelkar also stated five "cardinal principles" that each entrepreneur should adopt; they are the followings: i) inclusive growth is my goal; ii) my vision has to be unequivocal; iii) I should adopt flexible objectives; iv) I have to learn how to innovate in a resources constrained environment and v) the focus is on the people.

The supreme example of Gandhian innovation is the well-known Tata Nano, the car specifically created for the Indian market that, with all its appropriate components, costs less than US\$2.500; Tata Motors, the enterprise, projected it collaborating with many advanced companies, such as Bosh and Johnson Control.

Frugal engineering and constraint-based innovation

Our society is characterized by scarcity in all its forms, that is the quality of something unavailable or insufficient. For this reason, studying how innovation arises and takes place in a resource-constrained context is gaining increasing attention among scholars. The creation of products or services in scarcity conditions requires major efforts in the planning of the business model as well as in the development, production and sales phases. Emerging and developing countries are one of the best examples of resource-constrained environments, that's why is so important to study innovation in these contexts.

Frugal engineering is the science of decomposing complex products and processes in order to identify the core and the fundamental components and then recreate them in the most economical way as possible (Weigl et al., 2012). In this way, it is possible to obtain a significant costs' reduction in a product that still maintains good quality.

Constraint-based innovation is a broad concept and, in a similar way, is defined as "the ability to absorb, adapt and build upon the technologies imported from abroad rather than produce completely novel technologies, to reduce total cost, accelerate product development and deliver value for money" (Brem and Wolfram, 2014). Resource-constrained innovation is driven by the necessity to focus on frugality and costs' reduction; its fundamental aspects are the following: reduction of R&D costs by relying on existing technologies and modularity for design, abolition of the frills, exploitation of local talents and establishment of good relationships with local firms and entrepreneurs in order to obtain low-cost supply chain.

So, the main point of the two notions just exposed, is the importance of consciousness and a mental approach when developing something in a restrictive context (Sharma and Gopalkrishnan, 2012).

A successful case born from this approach is C-DoT (Centre for Development of Telematics), an Indian technology and development centre. Established in 1984, it is recognised as the major contribution of the development of the telecommunication sector in India and its diffusion in the mass market.

Catalytic innovation

Inclusive growth has been defined by the Asian Development Bank as a growth that creates new economic possibilities, while ensuring equal access to these opportunities for all the segments of society, especially poor ones (Ali e Son, 2007). Sharing this vision and moved by other social goals, Christensen et al. decided to expand the theory of disruptive innovation, through the introduction of the concept of catalytic innovation.

Catalytic innovations are a subset of disruptive innovations, i.e. those innovations that challenge the existents player in the market by offering alternative solutions, with a primary focus on social changes; they are solutions that address social issues and can bring benefits to more people, by serving the need of customers who are not targeted yet, because of their strong financial constraints. According to Christensen et al. (2006), an innovation to be classified as catalytic should have the following features: first of all, it has to push social changes in a systematic way through economies of scale and replication; second it has to address a need that is badly or not served at all (the existing solutions are too expensive or complex than what is required); moreover, catalytic innovation could be a product or service simpler and cheaper, with fewer functionalities but still perceived as adequate for its intended use and it often exploits unusual resources, such as volunteers' work, donations and grants in a manner that is seen as unattractive by incumbent players; finally catalytic innovations are often underestimated or ignored by competitors who are not able to see in them a profitable and successful business model. It is worth to observe that usually, the initial actors of these new kinds of inventions are new players, not existing firms. The catalytic approach switch from premium pricing and opulence to affordability and sustainability, by creating products and services for a large number of people worldwide; in fact, the social entrepreneur, engaged in a catalytic innovation, is moved by the desire to enhance the social wealth of poor customers through a sustainable and system-changing solution. In this way, the social impact that this type of innovation could generate is huge and might be bigger and better than the one currently created by established

firms. The main difference with the concept of frugal innovation is that catalytic one highlights the aspects of small and unnoticed competitors and social change.

One of the most famous cases of this phenomenon is the Grameen Bank of Bangladesh, that with its microfinance business loans helps small entrepreneurs at the BoP, usually ignored because they do not own any collateral for the loan. Surprisingly, Grameen Bank's default rate is below 3%, while the default rate of credit card issuer in the USA is 5% (Mohan and Potnis, 2010).

A less known case, but really interesting, is the Mexican social firm Iluméxico, that has the goal to furnish electrification through solar energy to low-income communities. At the present time in Mexico there are more than 640.000 houses without electricity and the government is not interested in addressing this need. Iluméxico's project consists of the distribution of simple and cheap solar cells in order to allow internal activities even with the dark or bad weather, thus enhancing life's conditions of those communities. The firm is not considered as a threat by the big electric companies because they do not see any source of profits in providing electricity to rural areas.

Indigenous innovation

At the current time, little researches have been undertaken to define what indigenous innovation means, and despite the multiple real cases presented, a well-structured and clear definition does not exist, so it is a phenomenon in its early stages of the study.

That being said, indigenous innovation could be described as a value-oriented process that integrates internal and external resources under an open innovation model. Indigenous innovation originates in developing and new industrial countries. One peculiar aspect, commonly recognized, of this type of innovation, is its objective to arrive at the core technology or intellectual protection in order to create an indigenous brand and in the end achieve sustainable competitive advantage. Nevertheless, it encompasses also non-technical factors, such as management, strategy and business models (Zheng, 2009). To better understand the concept, it is of great help to look at the suggestions of the World Economic Forum, that depicts indigenous innovation with three features: i) ability to innovate, ii) technology transfer from abroad and iii) overall technological capabilities. According to Chen (2005), expert scholar of this subject, indigenous innovation is a process aimed at exploring potential markets through R&D activities and acquisition of external knowledge. In creating a successful indigenous innovation, it is important to take into account different elements: entrepreneur's motivation and objective, the central role of the firm, technological strategy, technology hub and environment and resources related to the innovation. To achieve indigenous innovation

adopting a total innovation management approach is fundamental, in order to give birth and establish core competencies, idiosyncratic capabilities and a strong innovative strategy.

China is the leader country for indigenous innovation and its government considers it of fundamental importance, since it is the central factor of their economic strategy. A good illustration of this concept is the history of Haier Group. In 1984, it was a small collective factory, stuck in its debts and without a real and own design process. During the last years, Haier Group achieved exponential growth thanks to the strategy of “importing-absorbing-secondary innovation-indigenous innovation”; it was accumulating its intellectual rights and standards and concurrently it was building foreign factories to learn local designs, production processes and sales methods. This case is so successful and effective that it is considered as a model for implementing indigenous innovation strategies.

Grassroot innovation

According to Seyfang and Smith (2007), grassroots innovations are defined as “networks of activists and organizations generating novel, bottom-up solutions for sustainable development; solutions that respond to the local situation and the interests and values of the communities involved”. Grassroots innovations are not profit-motivated, instead, they are driven by social and sustainability concerns and usually carried out by communities of people. In fact, grassroots innovations lead to new products or services that address social needs in order to create a more sustainable, unified and inclusive society.

The Grassroot Innovations Approach (GIA) identifies the main features of this kind of innovation. First of all, grassroots innovation is not market or technology-driven, instead it arises to satisfy a real need; for this reason, usually ideas have their roots in a local context and the design is based on local experience and knowledge. Another characteristic is that grassroots solutions, when successful, are easily accepted and then copied by local communities. Finally, the process that leads to a grassroots innovation does not have well-defined stages and directions, it is based on improvisation, in fact, many times, the developers are people at the BoP without a high level of education (Jiang and Kandachar, 2009).

Grassroots innovations are characterized by social integrity, collaboration of poor people and use of available resources. It could appear similar to jugaad, but it embraces the additional aspects of networking and sustainability. A good and efficient network is of fundamental importance, since an intensive communication between people is necessary for the development and diffusion of what is called "little science", that means all those non ordinary inventions that arise in rural areas where science, technologies and policies are missing (Gupta, 1999). Moreover, grassroots innovations are ignored and not supported by governments and policy

makers, because they are developed by powerless and non-business actors, and due to that, many times, the potential of this type of innovation remains unexploited. Furthermore, in grassroots innovations is present a significant ecological aspect aimed towards sustainable development and consumption.

One of the first examples of grassroots innovation is the Honey Bee Network. Established in 1986 and nowadays diffused worldwide, the Honey Bee Network is composed of voluntaries aimed at promoting and diffusing both innovative ideas and traditional knowledge produced at the grassroots level. Another example of a grassroots invention is a simplified computer, made of an old TV and a second-hand self-learning device, diffused in the village's school in rural areas of Guizhou (China), created to help students in learning some computer skills.

Reverse innovation

The attention on this phenomenon at the beginning was coming from the press and only later scholars started to focus on it; in fact, in 2009, *The Economist* roughly identified reverse innovation as the process in which products for the emerging markets are created but then sold also in the developed countries. Now, reverse innovation is defined as “the development of new products and services in and for the emerging markets that are then introduced to industrialized market if demand is identified” (Brem and Wolfram, 2014). So, in this new disruptive tendency emerging countries are playing a central role, since they are the laboratory of the global economy; innovations are starting to be first developed in emerging countries and then exported and introduced to the developed world. The superpower old countries have, to some extent, already lost their supremacy in the research capabilities. Indeed, in the developing markets, R&D is gaining increasing importance for global competition and in this way, the traditional value creation approach and value chain are turned upside down. There is in place a transition from glocalization strategies, where products are conceived in a centralized way in the developed countries for all the world, to strategies where the product development relies on the developing countries, as well as the sales and support strategies. Low and middle-income countries are fertile soil for the development and establishment of reverse innovation processes, given that their markets are characterized by low barriers to entry, lower costs and a huge market base. The fact that these innovations come from low-income countries does not imply that they are with a poor quality and a low technological level; in fact, especially multinational companies, first they introduce and commercialize the product in the developing countries, and then, only if it is successful and with some performance improvements, in developed countries. In this respect, General Electric, that is strongly benefiting from its subsidiaries located in emerging countries, developed in India a portable electrocardiogram, the MAC 400, that adopts

a common printer system, like the one used in the bus, to imprint the medical record (Ramdorai and Herstatt, 2015).

1.3.2. Evaluation according to a common framework

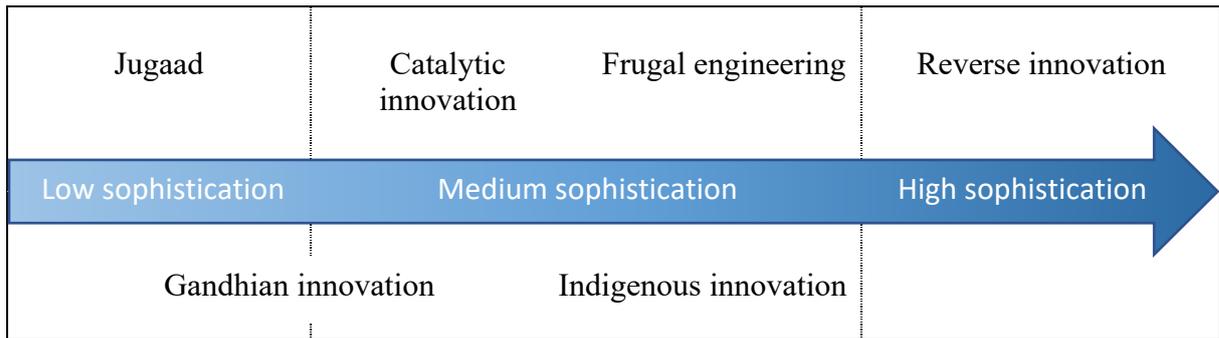
In order to understand the differences between all the concepts related to frugal innovation in a common framework, some standard attributes are necessary: they are sophistication, sustainability and emerging market orientation; the terms are classified according to them.

The classification used in the following analysis has been adapted from the one presented by Brem and Wolfram (2014) in their research on product development in emerging markets.

The degree of sophistication of something is usually evaluated depending on the complexity of the underlying process and the level of interaction between all the elements and actors involved. With reference to the different types of innovations, the sophistication can have a low, medium or high level. A low degree means that the output is created without a systematic coordination, communication and planification; jugaad and grassroots innovation are characterized by a low degree of sophistication, since they are based on improvisational, intuitive, creative process in achieving the need's satisfaction, even if in both cases usually it is possible to observe some kind of communication and interactions, but only between narrow groups of actors. Catalytic innovation, frugal engineering and indigenous innovation instead, fall within the medium degree, which occurs when there is a minimum level of communication and coordination between the actors involved, in order to achieve the desired solution. The main feature of these innovations, in fact, is the flow and the transfer of knowledge from developed to emerging markets, during the development and production process; they exploit external technologies and spillover effects, and especially for indigenous innovation the whole procedure is quite complex. Gandhian innovation is located somewhere in the middle between low and medium degree, since it is possible to encounter cases where complexity is quite good and other cases where communication and coordination are not present at all. Finally, there is a high level of sophistication that implies excellent and sophisticated practices of coordination, information transmission and high complexity in all the phases. In this degree only reverse innovation can be included, given that it is a well-defined and studied approach of product development from emerging economies to developed countries.

In figure 1.1., all the concepts are positioned in the same line from the lowest degree of sophistication to the highest one.

Figure 1.1. Classification in sophistication

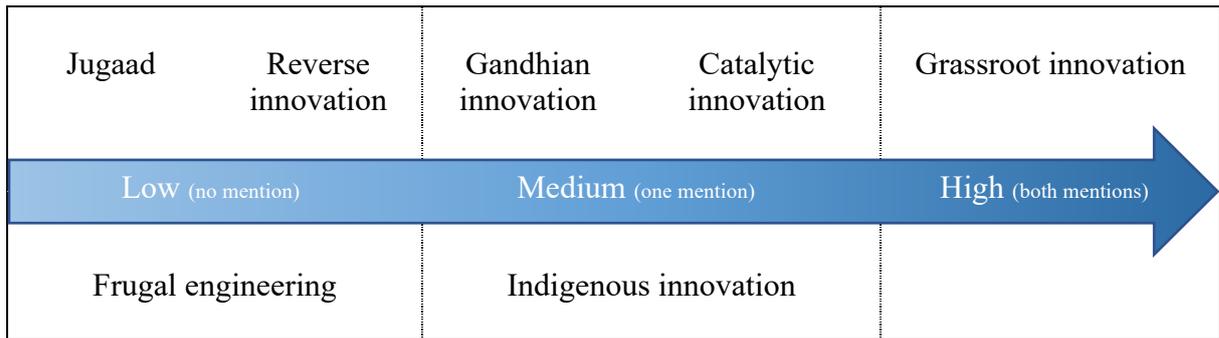


Source: own elaboration based on Brem and Wolfram (2014)

The second attribute for which the various concepts have been evaluated is sustainability, that, for the purpose of this classification, involves only the ecological and social aspects, while it excludes the economic one. Also here, it is possible to evaluate the measure of this attribute, according to three levels: low, medium and high. The degree is considered to be low if there is no mention at all of the sustainable aspects; this is the case of jugaad, reverse innovation and frugal engineering. In fact, the focus of the first approach is on the creation of a solution that satisfies the need, and environment or society are not taken into account; the latter two instead concentrate all the efforts mainly on economic and technical characteristics of the innovation. The sustainability degree is judged as medium when at least one between the ecological and social aspects is mentioned. Falling in this level there are Gandhian innovation, catalytic innovation and indigenous innovation, since the majority of times, they deal with social problems of emerging markets. The final degree of sustainability is the high one and it occurs only when both social and environmental sustainability is discussed. In this level only grassroots innovation can be included, because it is the only type that involves in the whole development and adoption process the community and the social network, always stressing the importance of a green and positive impact for our planet; sustainability in its forms is one of the main characteristics of grassroots innovation.

In figure 1.2., as before, all the types of innovations are located along this line that describes the sustainability aspect, from low to high.

Figure 1.2. Classification in sustainability

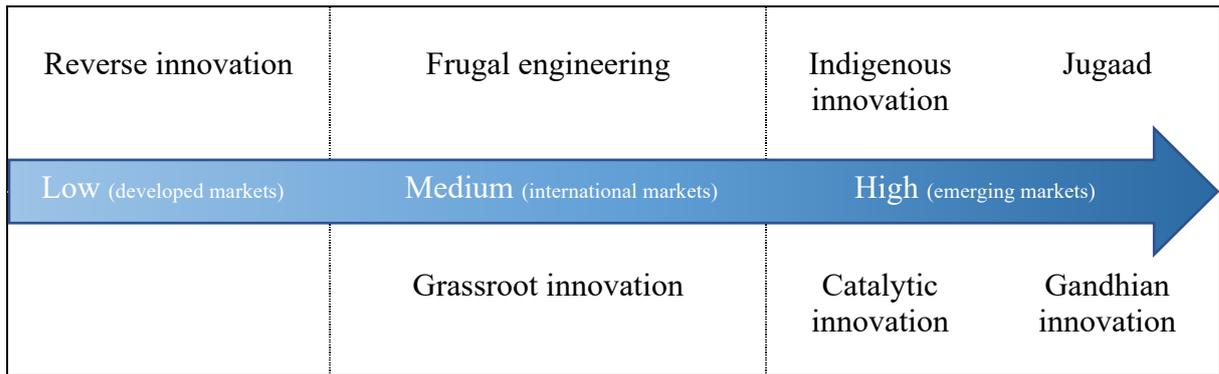


Source: own elaboration based on Brem and Wolfram (2014)

The third and last characteristic is the orientation towards emerging markets and a subdivision of this variable can be achieved with the identification of three degrees of direction: low, medium and high. Contrary to what the word suggests, the lowest level of emerging market orientation occurs when only developed countries are served, thus the real focus is not on the emerging markets (the aspect that is taken into account by the attribute). This is the case of reverse innovation, that has the objective to sell in developed markets and emerging economies and BoP are only used as the source and test of innovation. The medium level is a tendency towards international markets: it addresses indiscriminately emerging and developed countries and it includes innovations that are conceptualized in emerging markets specifically for people at the base of the pyramid or without a clear market targeted. In this medium level are placed frugal engineering and grassroots innovation; in fact, their initial focus is on low and medium-income economies, but are also distributed by companies in developed countries. The highest level of emerging market orientation is considered the one in which this kind of market is the only targeted. Falling in the last level there are jugaad, indigenous innovation, catalytic innovation and Gandhian innovation, all characterized by the high involvement from development to adoption of the local population.

In figure 1.3., all the different notions are positioned in the line according to the level of emerging market orientation, starting from low to high.

Figure 1.3 Classification in emerging market orientation



Source: own elaboration based on Brem and Wolfram (2014)

To conclude the analysis, it is worthy to analyse also frugal innovation according these three categories and surprisingly it emerges that frugal innovation has a medium level of sophistication, since it is still in its first stage and there is not yet a systematic approach; a medium level of sustainability, because environmental or social aspects are always mentioned and it is possible to affirm that likely they will acquire more importance in the future; and it is also characterized by a medium level of emerging market orientation, given that frugal innovation is diffused around the world but it is not addressed to developed countries.

1.4. Frugal innovation and actual trends

This section is aimed at investigating the current perspective of frugal innovation, by observing the actual trends of this phenomenon and identifying future advancements that could affect the global economy and the whole society. The first part deals with the ecosystem of frugal innovation: the institutional and social context in which it is developed, the actors involved and their relationship. The second part instead, deals with the topic from the sustainable point of view, analysing the relation of frugal innovation with economic, environmental and social sustainability.

1.4.1. Ecosystem of frugal innovation

One of the open aspects in the existing literature on frugal innovation regards the explanations of the conditions and ecosystems in which frugal innovation arises. A theoretical foundation may offer interesting insights. For this reason, Hoskisson et al. (2000) believe that the resource-based view is useful to investigate the phenomenon. Barney's (1991) resource-based view states that a firm's sustainable competitive advantage derives from the exploitation of its idiosyncratic resources and capabilities.

Despite this, it has been found out that the majority of frugal innovations born in emerging economies, characterized by environments' lack of resources. So, it is possible to affirm that a constraint-resource based environment stimulates frugal approaches, that typically are adaptable, simple, inclusive and resilient. Asian countries, in particular India and China, can be considered lead markets for this type of innovation. The concept of lead market was theorized by Baise, stating that driven by the country-specific advantages on cost, transfer opportunities, demand and market structures, such markets become leaders in developing new products with global dominant design. Usually, these lead markets are the first that feel the need for specific innovation, so they push (also indirectly) firms to experiment with new features and a simplified innovation development process. For example, the large diffusion of Indian innovations such as Tata Ace (mini truck), Tata Swach (non- electric water purifiers) and Vortex Gramateller (ATM for rural areas), are a clear signal of India's huge lead market potential, derived from its large volumes, dynamic market, strong technical capabilities, global linkages and aspiring population. In this type of market, customers look for good-enough, affordable products or services without all the frills associated with the goods typically designed in developed countries.

A significant role in the development and promotion of innovation is played by institutions. Unfortunately, in the developing countries, capital, labour and information market do not operate in the same way as in the developed markets; instead, there is the presence of institutional voids (Khanna and Palepu, 2010). They are due to the missing of intermediaries and their direct effect is an increase in transaction costs and underdevelopment of the countries. These emerging markets are called "transaction arenas" because buyers and sellers are not easily or efficiently able to come together. These inefficiencies, of course, limit the development of formal innovation, but at the same time, they favour informal and frugal innovation. In fact, it has been discovered that frugal innovation may not occur in environments where there is a strict legal and social regulation (Radjou et al., 2012), but instead it proliferates, and it is encouraged in economies where institutional intermediaries are weak or missing.

A particular role in the development and diffusion of frugal innovation is also played by the social context. As we already reported, the majority of these types of innovations see their born in India and China, that according to Hofstede's dimensions have a culture characterized by collectivism and high tolerance of uncertainty. A collectivist culture from one side presents a bigger resistance to changes and novelty, but from the other side commonly accept the improvisational approaches, that in a lot of cases are the starting point of frugal innovation. In

a connected way, tolerance for ambiguity and uncertainty means that people are more willing to accept good-enough solutions, instead of world class ones.

In this context, some authors proposed a very interesting definition of frugal innovation focused on the resource-constrained ecosystem. For example, Zeschky et al. (2014) reached the conclusion that frugal innovation is a product or service based on a new product architecture that is often quite disruptive for new customer groups located in resource-constrained environments. Chuna et al. (2013) studied product innovation in resource-poor environments and conceived frugal innovation, from companies' point of view, as a product innovation when wealthy customers are scarce. In fact, frugal innovation aims to satisfy, in an efficient way, essential needs mainly but not only of poor people (Hart, 2005; Prahalad, 2012). Another similar definition is proposed by Agarwal who stressed the focus on needs' fulfilment of resource-constrained consumers.

Moving into the economic environment, the literature is mainly focused on the following actors: multinational companies and their subsidiaries in emerging countries, local firms, institutions and customers. Concerning the last two players, they have already been analysed previously: customers are poor people or those living at the bottom of the pyramid, unable to afford standard prices and not interested in unessential functionalities; institutions and the related regulations instead, are missing, weak, and not well-structured. Multinational companies, coming from developed countries and used to design advanced products and services for the wealthiest at the top of the pyramid, struggle to adapt and successfully survive in this kind of context. In the first period of observation and learning, multinational companies have to rely on partnerships with local firms and academic centres, in order to acquire the specific resources and capabilities needed; otherwise, they could decide to invest in the local research industry. In the case of a multinational's subsidiary, things are slightly different: in fact, the firm is already embedded and aware of the local ecosystem, so it only needs to acquire new capabilities and set a new strategy, in order to develop a frugal innovation. Unfortunately, this innovation process might enter in conflict with the dominant vision of the parent company, its research agenda and the headquarter might be forced to add an extension to its structure; these aspects lead to a consideration by multinational of frugal innovation more as an outcome to achieve, rather than as a frugal process and mindset. Obviously, the economic actors in the most favourable position are domestic firms, because they are perfectly aware of environment and customers' needs, moreover, during years they acquired the specific skills, including soft ones, and capabilities required by the context. Also for local enterprises innovating remains still high-risk, but they

are more inclined to be part of social networks, that lower uncertainty and facilitate the flow of relevant information.

To conclude, as evidence shows, in emerging countries multinational companies and their subsidiaries struggle more in the frugal innovation process, thus they tend to be more oriented towards the creation of frugal products; domestic firms instead, are successful in both achieving a frugal process and mindset as well as frugal goods and services.

1.4.2. Frugal innovation and sustainability

Back in 2002, the UN World Summit on sustainable development referred to it as "economic development, social development and environmental protection as interdependent and mutually reinforcing pillars". So, sustainable development aims to achieve growth and progress in the world and in our lives, basing itself on the balance between economic, social and environmental aspects. Often in the literature, the term frugal innovation has been associated to inclusive and sustainable growth, inclusive and social innovation or empowerment; other times, it is conceived as a way of "doing more with less". Underlying these connections, there is the idea that frugal innovation has a direct impact on the environment, on the quality of life of people and in general on society and on the economy. Frugal innovation is having every day a great impact on society because many times it solves urgent societal problems through simplicity and low-cost, generating revenues at the same time. Through frugal innovation, economically disadvantaged communities and people at the BoP are able to find solutions to problems related to health, energy, education and at the same time increasing their quality of life.

Now we are going to analyse in a more detailed way the impact of frugal innovation on the three different aspects, but first we have to define them. Economic sustainability is generally defined as the ability of an economy to sustain an economy's long-term growth, without compromising or damaging the environmental, social or cultural aspects of human beings. Environmental sustainability instead, refers to the protection and maintenance of the environment, its resources and products for the long term. Finally, social sustainability could be seen as the maintenance and improvement of the well-being of present and future generations and it is focused on the development of programs that promote social interaction and cultural enrichment.

From the environmental point of view, the analyses conducted by Rosca et al. show that, in general, there is a decrease of resources and materials used in the production and realization of the product or service needed, thus reducing the consumption of energy and water and the

emissions. Other environmental-sustainable techniques adopted in frugal approaches are the usage of waste and renewable materials in the production process, or alternatively the adoption of local resources and natural processes, or privileging sharing and commonality rather than ownership.

Examples of these innovations are the \$4 handmade bamboo microscope made of fast-growing bamboo, the solar bulb, made of a used plastic bottle filled with water liquid bleach and then fixed in the ceiling or EnviGreen bags, made of a combination of natural starch (potato and tapioca) and vegetable oils, completely degradable in a short time and edible.

A positive ecological impact is also created by frugal innovation through the engagement of local communities in education and awareness campaigns regarding renewable energies or products. These approaches contribute to a sustainable impact on the environment by reducing the use of materials, production resources, energy, water and emissions, and by creating in many cases collaborative and inclusive value chains (even if informal) and ecological value.

From the economical perspective of sustainability, it is possible to evince that frugal approaches may give birth to new businesses that generate employment for local people. In general, all the frugal enhancements and novelties introduced into education, training, access to knowledge have a spillover effect on the economy; in fact, people become more productive, prepared and well trained. Moreover, the hiring of women by local entrepreneurs free them from hard work in agriculture and generates their empowerment. For example, two doctors Aravind and Narayana take young women from remote villages and train them to perform basic tasks in the hospitals. In remote locations, spillover effects have even a much greater impact. Particularly interesting is the indirect effect on health industry; in fact, many of these frugal inventions have a positive impact on the health and well-being of the population, thus reducing mortality, illnesses and fetal death rate; in the long run this impact productivity of the workforce and the cost of the healthcare sector.

The social perspective is one of the widest, that involves a multitude of aspects from work creation to empowerment of disadvantaged classes, from education to improvement of living standards. In this light frugal innovation can be thought, not as an output, but as a process that puts the needs of the citizenship ahead of everything else in order to solve some pressing societal problems. One of the basic reasoning is that products that are cheap or low-cost become affordable for a larger number of poor people that can spend the saved money on other essential goods or services. For the same reason, the development of cheap medical devices in the hospitals has granted medical care to a big portion of people that previously were excluded

because not able to pay them. For example, in India was developed and then adopted, the Jaipur Foot; this is a prosthetic foot, created using rubber, wood and tire cord, that costs less than US\$45 and it is specifically tailored for poor who otherwise could not have access to it. For people at the BoP, losing a limb is even worse than in the developed countries; in fact it impacts the ability to provide subsistence for them and their families. This frugal innovation has the characteristics of empowering poor and marginalized people by allowing them to participate in the society and labour market, regardless of their physical limitations. Moreover, as already said, many of these new frugal businesses have women as the central actors; their employment improves their social status and empowerment in general.

Frugal innovations have a lot of potential for their implication in the society; it can create opportunities for people to escape from poverty and deprivation and make them real and fundamental customers for the firms (Prahalad, 2010), it can reduce the distances between rich and poor and it can deal with social inclusion, social justice and equity. Obviously, this does not mean that frugal innovation will resolve all the problems related to social sustainability, but of course, it does have positive effects on society.

1.5. Research questions

An appropriate understanding of frugal innovation is of fundamental importance for scholars, policy makers and experts, because of the wide range of disciplines that this phenomenon embraces and because in the future it can have big impacts on the world and significative and disruptive consequences in our lives. The studying of this topic, being in the first stages, is facing some limitations and encountering some gaps to be answered in future researches.

From the previous discussion, it emerges clearly that there is not yet a study with a rigorous and structured analysis aimed at building a theory or a framework and for this reason a boundary of the notion does not exist and many times we encounter overlaps with related innovation concepts, such as reverse, disruptive, catalytic, only to cite some of them. Moreover, frugal innovation, as underlined by many authors, is a notion relatively new that is still in constant development and evolution. Furthermore, it is worth to observe that when a case study is presented it is used merely for an illustration purpose and not to add valuable or case-related characteristics to the notion of frugal innovation. Hence, the necessity to find and study the main attributes that characterize frugal innovation. They have to be relevant, complete, clear and updated to the latest discoveries. In addition, it will introduce a quite innovative way of conceptualizing frugal innovation; the definition will be built, mostly but not exclusively, on

the empirical analysis of a quite important, for dimensions, database of frugal innovation case studies.

The second aspect discussed in the previous sections is the ecosystem in which frugal innovation has its roots and the aspects that drive it. From the observations, it emerges that a resource-constrained environment, preferably in emerging markets, characterized by institutional voids and weak protection of intellectual property rights and with a collectivist society able to well tolerate high uncertainty, tend to favour frugal approaches and innovations. The main limitation of these findings is that they are focused only on emerging economies and developed ones are not taken into account. Moreover, a more defined framework of the actors that are involved in the development and adoption process of frugal innovation is missing almost entirely. Moving from these findings, the work presented in the following sections aims to fill these gaps and investigate it not only in emerging and developing countries but also in the developed ones, because the comprehension will be the starting point to correctly address the challenges of the future. Absence of institutions has been mentioned: an interesting point that will be studied is the relationship between the innovator (MNE, local firm or institution) and the surrounding partners and actors, such as companies' organization, universities, communities, both in the development and adoption phase of frugal innovation.

The last topic, maybe the most articulated, handled in the prior discussion of the literature review is the impact that frugal innovation can have on sustainable development. Sustainable development is the balance between economic, environmental and social sustainability and in all these cases frugal inventions have an impact and it is possible to observe the direct consequences. Looking at the effects without being able to measure them is quite useless and a little bit dangerous for the future because it does not allow us to forecast possible tendencies. Many papers focus on the sustainability aspects of frugal innovation and affirm that it can improve society and help our planet, but none of them even mention the measurement of impact. So, in the following analysis, there is a need to focus on the measurement of economic, environmental and social impacts of frugal innovation, and verify if they can lead to an enhancement of humanity's and Earhart's conditions.

To sum up, it is now evident there has been significative growing attention towards frugal innovation, especially at BoP and emerging economies, to try to understand the phenomenon, but literature in this field is evolving rapidly leading to confusion and fragmented visions, given that a theoretical and consolidated framework is missing.

Therefore, this work is aimed at I) investigating the main characteristics of frugal innovation in order to define it more clearly, II) analysing drivers, collaborations and relationship that push its development and diffusion and III) understanding the impact of frugal innovation through measurements. For all the reasons outlined previously, the following analyses aim to fill these gaps and answer to the subsequent questions:

- What are the characteristics that define frugal innovation?
- Which elements are necessary for the development of frugal innovation and what kind of relationships exist between actors involved?
- How is frugal innovation measured? What are its economic, social and environmental impacts?

2. RESEARCH METHODOLOGY

The aim of chapter two is to report methodology of the further analysis on frugal innovation. The research methodology is presented in the third section, since it is preceded by an explanation of what systematic literature review is, and why is needed in the studying of frugal innovation. The methodology used is at the base of the work and gives consistency and reliability to the findings outlined in the next chapter.

2.1. What is a systematic literature review?

In the last decades, systematic literature studies have increasingly emerged as a method to condensate evidences and then ultimately to allow researchers to achieve a common understanding of the status of the studies. The need for a systematic review arises from the requirement of scholars to summarise all the existing information about some phenomenon in an unbiased manner. This may be aimed to obtain more general conclusions than with respect to individual studies or may be done as a preliminary activity to further researches.

According to Fink's (2015) definition, a systematic literature review is "a systematic, explicit, comprehensive and reproducible method for identifying, evaluating, and synthesizing the existing body of completed and recorded work produced by researchers, scholars, and practitioners". A slightly different definition is provided by Cochrane (2014) who consider systematic literature review as "a review of a clearly formulated question that uses systematic and explicit methods to identify, select, and critically appraise relevant research, and to collect and analyse data from the studies that are included in the review. Statistical methods, such as meta-analysis, may or may not be used to analyse and summarise the results of the included studies". Irrespective of the specific definitions given, the focus is on the systematic nature on the overall review; in this context systematic means being consistent, widely accepted and characterized by a rigorous methodology, that has to focus on quality issues, such as bias replicability and credibility.

A systematic literature review is primarily aimed to define and describe the state of the current research through the definition of a particular problem or topic, to identify relations, gaps and contradistinctions in the literature and to investigate the reasons behind them, for example proposing a new conceptualisation; then it formulates a general statement or overview in order to give a relevant contribution, by commenting and evaluating the findings. In doing these things, implications for practice and policy are provided, as well as directions for future research.

A systematic review synthesises existing work in a manner that is fair and seen to be fair. For example, systematic reviews must be undertaken in accordance with a predefined search strategy. The search strategy must allow the completeness of the search to be assessed. In particular, researchers performing a systematic review must make every effort to identify and report researches that does not support their preferred research hypothesis but at the same time they have to identify and report researches that support it. A systematic review, according to Pittway (2008) must be characterised by transparency, clarity, integration, focus, equality, accessibility and coverage.

Conducting a systematic literature review is a complex, intense and articulated work, that each time slightly differs according to the topic, the case and other contingencies. Nevertheless, it is possible to identify some general steps, common to the majority of systematic literature reviews. In the next paragraph, is provided a description based on Durach' studies (2017).

The first step of a systematic literature review is the definition of the research question, in order to justify the review for its relevance and to highlight the contributions of the SLR; the second step consists in the determination of the required characteristics of primary studies and it is carried out by defining inclusion and exclusion criteria, such as research method, study focus and language used. These two steps are followed by a third one, aimed at establishing a sample of potentially relevant literature (called baseline sample), that is formed by applying search procedures and keywords. The fourth stage is named "synthesis sample" and it selects the pertinent literature, through the application of inclusion and exclusion criteria; the fifth step, indeed, synthetizes the literature, by applying coding schemes to extract relevant information from the literature and summarizing and integrating the different findings across the primary studies. Ultimately, the last step reports the results from the review, providing a descriptive overview and discussions.

The advantages of a systematic literature review are the following:

- it is less likely that the results of the literature are biased, due to the strict and well-defined methodology, even if there may be bias in the primary studies;
- a systematic review outlines information about the effects and implications of some phenomenon across a wide range of setting and empirical methods. The systematic review provides evidence that the phenomenon is robust and transferable if studies give consistent results; in the opposite case, the sources of variation can be;
- in the specific case of quantitative studies, it is possible to combine data using meta analytic techniques; this increase the probability to detect real effects; this is not possible with small individual studies.

A systematic literature review differs from the traditional literature reviews because it is based on well-defined search strategy that aims to investigate as much of the relevant literature as possible; in addition to that, it allows to report in a detailed manner the search method so that readers can assess the rigour, objectivity and repeatability of the process and to include explicit inclusion and exclusion criteria to assess each potential primary study; furthermore a systematic literature reviews specify the information obtained in each primary study, including some quality criteria to evaluate them. A systematic literature review provides a way to evaluate the quality level and magnitude of existing evidence on a certain topic and it offers the broadest and the most accurate level of understanding with respect to the other types of reviews, thanks to the incorporation of multiple viewpoints. As a general rule, a systematic review adopts standardized methodologies and guidelines in the searching, filtering, reviewing, critiquing, interpreting, summarizing and reporting of findings from multiples publications. It also assesses the quality of individual studies, in order to eliminate low-quality ones; moreover, a well-conducted SLR can be replicated and verified because it reports in a detailed manner all the steps, methodology and documentation. The value of conducting a systematic literature review is really appreciated because it is solid and with the highest level of rigour. For all these reasons, it is possible to conclude that a systematic literature review is the most robust level of evidence available on a topic or question of interest.

2.2. The need of a systematic literature review on frugal innovation

Frugal innovation is a quite novel topic and discussions on it are still in their primary phase. As already declared, the aim of the overall work is to understand what frugal innovation is and to identify the possible future directions of its development. In the attempt to contextualize the phenomenon, in order to gain a better comprehension, the subject of frugal innovation was first analysed from a theoretical point of view. With the purpose of identifying the current state of art of the researches, all the most relevant papers dealing with the topic have been examined. The relative literature sample includes only English-speaking studies, covering the period from 2012 to 2018; on the whole, 14 papers have been identified, collected over eleven different sources, among which six are journals. The detailed list of papers, as well as their source, distribution, key words and main topic, is reported below in table 2.1. Subsequently, the sample of literature review papers on frugal innovation have been in-depth read and analysed, and some interesting and challenging observations have emerged. First of all, as it possible to evince from a first look to table 2.1., even if theoretical, not all the most relevant works are systematic literature reviews; the direct implication is that, especially for case studies and conceptual papers, a rigorous and well-defined approach is missing. Furthermore, in some cases research

methodology is absolutely not mentioned, while in others, even if adopted, it is only briefly described; due to this absence, the findings are not highly reliable and robust, because it is not possible to reproduce the review process in order to verify or explore in a more exhaustive way a particular aspect. A limitation encountered in the literature papers lies in the modality in which case studies are showed: they are only presented through a description and every time in a different manner, thus not bringing relevant insights in the studying of frugal innovation. Another limitation of the sample is due by the fact that frugal innovation is often associated with another topic, such as sustainability, environment, disruptive innovation, reverse innovation, as it emerges from the keywords in table 2.1. These kinds of associations tend to focus more on the relationship between the two topics, than on the definition and outlining of the phenomenon under review. As a result of the arguments abovementioned, it is possible to affirm that a defined, standardized and rigorous method to study the subject is missing; therefore, it emerges the need of a systematic literature review on frugal innovation. As exhibited in the previous section, a systematic literature review is the most robust and reliable method to understand, investigate and discuss a certain topic and it is exactly what is needed to proceed in the studies dealing with frugal innovation. A theoretical approach, deriving from a well-structured and accurate study, and leading to the formation of a common framework on the topic under review, will be exposed and discussed in the following sections of the work.

Table 2.1. Source, keywords, methodology and main focus of papers under review

Reviewed papers	Source¹	Key words	Methodology	Focus/Main topic
Rosca et al. (2017)	JCP	Business model, frugal inn, reverse innovation, sustainability, archetypes, BoP	Case study design	Promotion of sustainability through frugal and reverse innovation and business models
Agarwal et al. (2017)	IEEE TEM	BoP inn, bricolage, disruptive inn, indigenous inn, reverse inn, catalytic inn.	Systematic literature review	Definition and analysis of the constraint-based innovations
Albert (2019)	JCP	Frugal inn, sustainability, connection, potentials, threats, literature review	Systematic literature review	Potential and threats of frugal innovation for sustainability

¹ Notes: Legend of sources - CIM Creativity and Innovation Management; EJDV The European Journal of Development Research; IEEE TEM IEEE Transaction on Engineering Management; JCP Journal of Cleaner Production; JES Journal of Economic Surveys; JIBR Journal of Indian Business Research; JPIM Journal Product Innovation. Management; MDPI Multidisciplinary Digital Publishing Institute; TIM at HUT Technology and Innovation Management at Hamburg University of Technology; TS Technology in Society

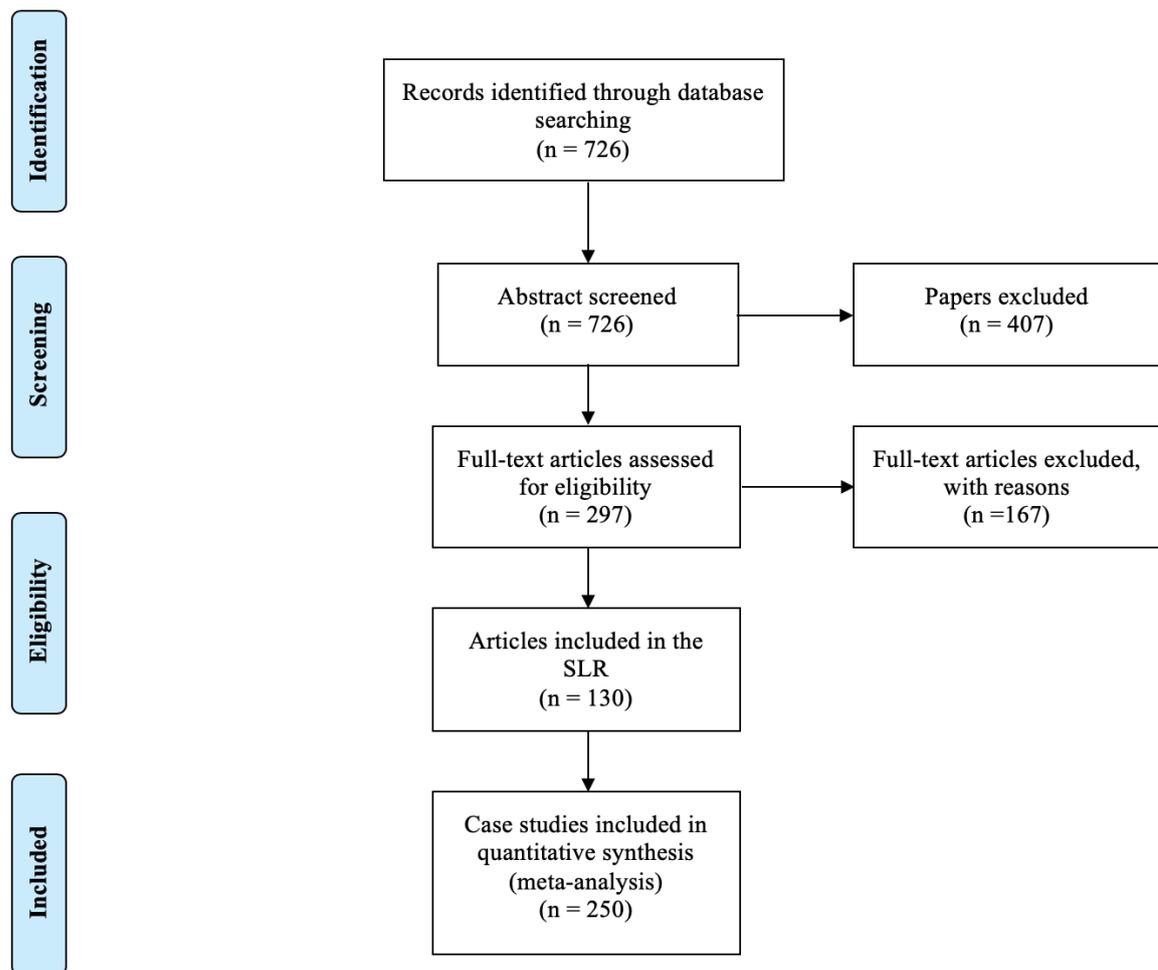
Corsi and Di Minin (2014)	CIM	Not reported	Literature review	Innovation at the BoP, disruptive innovation, reverse innovation and their partial overlapping
Hossain (2016)	JCP	Grassroots inn, cleaner production, community, diffusion, sustainable development, niche	Systematic literature review	Theories, characteristics, diffusion and implications of grassroots innovation
Hossain (2017)	TS	Frugal inn, reverse inn, affordability, low cost	Systematic literature review	Mapping of frugal innovation across sectors
Khan (2016)	MDPI	Social sustainability, frugal inn, practice, sustainable development goals	Literature review	Impact of frugal innovation on social sustainability
Pina et al. (2013)	JPIM	Frugal innovation <i>and</i> new product development, BoP	Literature review	Impact of scarcity in the product inn. process and focus on bricolage, frugal inn and improvisation
Pisoni et al. (2018)	JCP	Frugal inn, resource constrained inn, systematic literature review, expert survey	Systematic literature review and qualitative analysis	Development of concept of frugal innovation in the years
Rosca et al. (2017)	EJDV	Frugal inn, sustainability, inclusive development, BoP, sustainable development	Systematic literature review	Frugal innovation and sustainable development; approaches of MNEs and local initiatives in addressing economic and social issues
Tiwari et al. (2016)	TIM at HUT	Frugal inn, frugality, thrift, responsible inn, sustainable growth, competitiveness, international business, emerging economies, industrialized nations	Literature review	History of frugal innovation, definition and possible impacts through a workshop
Tiwari and Kalogerakis (2016)	TIM at HUT	Frugality, frugal innovation and synonymous	Bibliometric analysis	Frugality in the context of innovation management
Zanello et al. (2016)	JES	Development, diffusion, inn, low- and middle-income countries	Systematic literature review	Creation and diffusion of innovation in private sectors of developing countries
Soni and Krishnan (2014)	JIBR	Innovation, Resource based view, institutional theory, new institutional economics, economics of location	Conceptual paper	Description of frugality as outcome, process, mindset; innovators of frugal innovation

2.3. Methodology

2.3.1. Papers' selection

The next section describes the overall process adopted in order to conduct the further systematic literature review on frugal innovation. To outline the methodology, we followed the 2009 PRISMA checklist. The whole search and selection process is summarized in the following PRISMA flow diagram (figure 2.1.).

Figure 2.1. Paper selection process



In order to build the literature sample some selection criteria have been established: the sample has to include only English-speaking papers on frugal innovation, with a publication year up to 2018 and including, in the title, abstract or key terms list, at least one of the keywords reported in table 2.2., such as indigenous innovation, frugal innovation, frugal engineering, grassroots innovation,.. The structured keyword search was carried out in the major databases and library services: Scopus, Springer, Emerald and Google Scholar. Then all the titles of the papers

identified have been read and checked in order to ensure the absence of duplicates in the sample; in case of doubles presenting slightly differences in the judgements, the more relevant and optimistic paper has been preferred (i.e. high instead relevance). The initial sample consisted in 726 papers.

Table 2.2. List of keywords

Keyword	#	Share on total
Indigenous Innovation	178	24.5%
Frugal AND Innovation OR Engineering	145	20.0%
Grassroot Innovation	129	17.8%
Inclusive Innovation	90	12.4%
Base of The Pyramid AND Innovation	85	11.7%
Reverse Innovation	82	11.3%
Low Cost Innovation	36	5.0%
Innovation for Inclusive	25	3.4%
Jugaad AND Innovation	23	3.2%
Pro Poor Innovation	10	1.4%
Catalytic Innovation	9	1.2%
Resource Constrained Innovation	8	1.1%
Trickle-Up Innovation	4	0.6%
Total	726	100%

Subsequently different processing steps were needed to ensure that the identified papers are appropriate to the purpose of the work and a first screening was conducted: by reading the abstracts, we considered appropriate to create three categories: high relevance, medium relevance and low relevance and assigned each paper to one of the three groups. Only high and medium relevance studies were taken into account while low relevance were excluded from the further analysis because they would not have brought a useful and interesting contribution to the work. In total, 319 papers were considered valid, 100 for the high relevance category and 219 for the medium one. A detailed statistic of valid papers is reported in table 2.3.

Table 2.3. Statistics about relevant papers

Keywords	Total selected papers	
	#	%
Base Of The Pyramid AND Innovation	38	29.2%
Frugal And Innovation And Engineering	23	17.7%
Reverse Innovation	20	15.4%
Jugaad AND Innovation	11	8.5%
Inclusive Innovation	10	7.7%
Grassroot Innovation	9	6.9%
Indigenous Innovation	7	5.4%
Low Cost Innovation	5	3.8%
Innovation For Inclusive	3	2.3%
Catalytic Innovation	2	1.5%
Pro Poor Innovation	1	0.8%
Resource Constrained Innovation	1	0.8%
Total	130	100,0%

The next step was to download all the relevant papers and catalogue them, in order to create our own database; all the items have been registered by indicating a progressive number, the surname of the author/s and the date of publication, for example 105-Agarwal N., Brem A., 2012. Altogether 319 papers were detected but only 297 were available for consultation and so downloaded (95 high relevance, 202 medium relevance). The following phase consisted in creating a file with all the papers and the relative identifier number, keywords, author/s, title, date of publication, journal, methodology (conceptual, case study, meta-analysis...) and industry.

Then a second screening was conducted, aimed at ascertaining that selected papers really deal with the topic of frugal innovation. All the abstracts and keywords were read and depending on the type of information provided, the papers were included in the next stage of analysis. In particular, two inclusion criteria were established for the papers collected: the focus on innovation (does it focus on innovation?) and the empirical nature of it (is it empirical?); if the paper has a positive answer to both conditions, then it was included in the second step of analysis. So, the final sample consists in 130 papers to be analysed that include 250 real cases on frugal innovation.

2.3.2. Bibliometric analysis of the sample

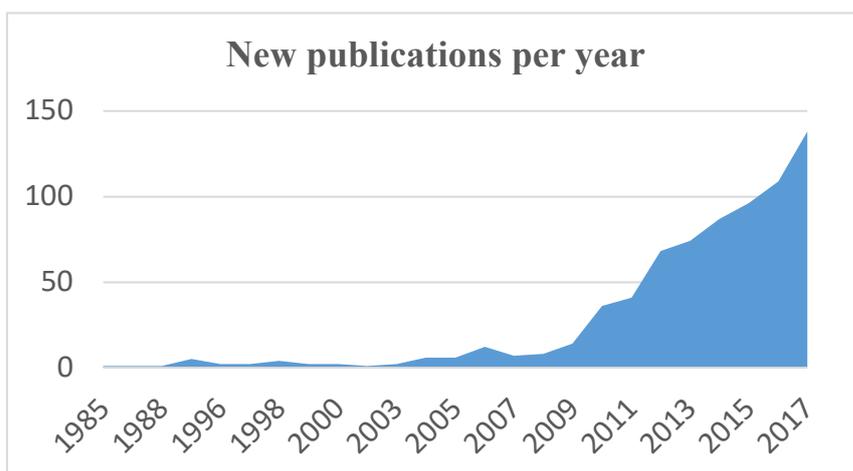
As already reported, the original sample consisted of 726 papers, covering two decades, from 1997 to 2018. As it emerges from figure 2.2., frugal innovation is an increasing and debated

topic for scholars and practitioners. Until recently it was an unknown phenomenon that gained attention in a relatively fast period of time; in particular after 2009 (when the topic of frugal innovation appeared in the economic mass press for the first time) it is possible to observe an exponential increase in the number of new publications per year. In our sample, the most frequent authors, those who wrote more than one articles, are Seyfang G. (16 papers), Smith A. (12 papers) and Fu X. (7 articles); a more detailed analysis of the contributions by authors is given in table 2.4.

Table 2.4. Top authors in the sample

Top Authors	Num of papers	Share on total
Seyfang G.	16	2,5%
Smith A.	12	1,9%
Fu X.	7	1,1%
Longhurst N.	5	0,8%
Hielscher S.	5	0,8%
Harris M.	5	0,8%
Halme M.	5	0,8%
Gebauer H.	5	0,8%
Feola G.	5	0,8%
Chen J.	5	0,8%
Baekelandt J.	5	0,8%

Figure 2.2. Representation of new publications per year

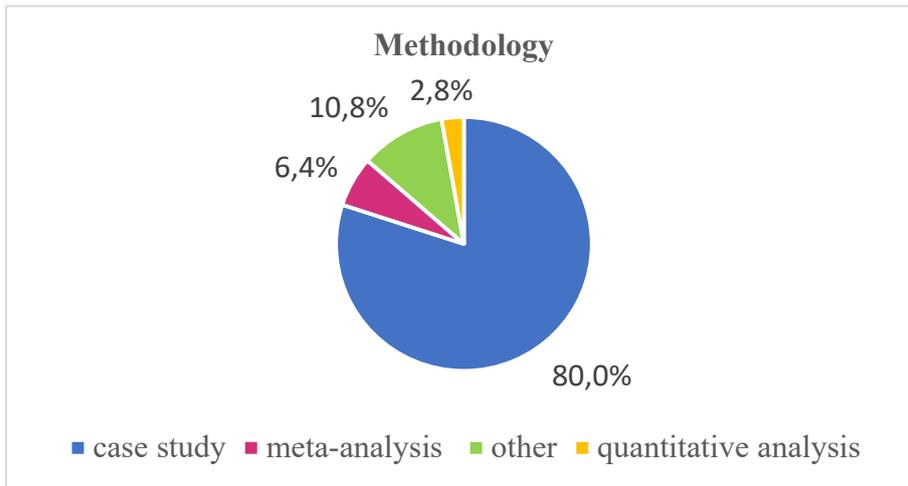


So, the final sample consists in 130 papers to be analysed that include 250 real cases on frugal innovation. Among them, as it possible to observe from pie chart, the major contribution is given by case studies. A detailed distribution of the methodology encountered in the papers is reported below (table 2.5., figure 2.3.).

Table 2.5. Distribution of methodologies in the sample

Methodology	cases	%
case study	200	80%
other	27	10.8%
meta-analysis	16	6.4%
quantitative analysis	7	2.8%
Total	250	100%

Figure 2.3. Representation of methodologies' distribution



2.3.3. Method for the meta-analysis

Finally, the selected papers on FI have been in-depth read and the content analysed according five main categories: i) FI context; ii) FI (frugal innovation) development; iii) FI implementation, adoption, diffusion; iv) FI characteristics; v) FI impacts. A detailed list of the variables analysed for each category is given in table 2.6., and between brackets are indicated the values that the variable could assume.

Transparency and replicability are ensured by the documentation of the entire research process. The results are presented and discussed in the next chapter, aiming at providing some guidelines for future frugal innovation researches.

Table 2.6. Variables analysed for each category

Category	Variables included
FI Context	<ul style="list-style-type: none"> -Country where developed/adopted; -World Bank classification; -Continent classification; -Geo (rural, peri-urban, urban) -Industry; -Key focus (inn dev, inn adopt, econ out, social out)
FI development	<ul style="list-style-type: none"> -Who developed; -Engaging local actors² (high, med, low, not reported); -Engaging foreign actors³ (high, med, low, not reported); -Motivations of developer/other actors (profit motivated, social oriented, both);
FI implementation/ adoption/ diffusion	<ul style="list-style-type: none"> -Engaging local actors¹ (high, med, low, not reported); -Engaging foreign actors² (high, med, low, not reported);
FI characteristics	<ul style="list-style-type: none"> -Innovation type (product, process, business model); -Group targeted (poor, emerging middle class); -Simplicity (high, med, low, not reported); -Functionality (high, med, low, not reported); -Affordability (high, med, low, not reported); -Social goal;
FI impacts	<ul style="list-style-type: none"> -Economic impact (positive, negative, not reported); -Environmental impact (positive, negative, not reported); -Social impact (positive, negative, not reported); -Economic measurement (yes/no); -Environmental measurement (yes/no); -Social measurement (yes/no);

² Local actors include firms, NGOs, governments, firms' associations, research centres/universities; community/consumers.

³ Foreign actors include institution/university, firms, NGOs.

3. ANALYSIS OF FRUGAL INNOVATION

The purpose of chapter 3 is to present the analysis with the relative results on frugal innovation. In order to gain a clear vision of the work conducted, the chapter has been divided in six sections; the first one describes the context in which frugal innovation takes place, the second the characteristics of the phenomenon; the third and the fourth ones respectively present the actors that are involved in the development and the beneficiaries of frugal innovation, while the fifth part explores all the collaborations and relationships between developers and actors; to conclude, the last section provides some insights on the measurement of frugal innovation's impacts.

3.1. Empirical setting

In order to gain significant insights and deeper knowledge regarding frugal innovation, it is necessary to contextualize the empirical setting of the phenomenon, where it arises, where it is adopted and the main features of the background. We start by analysing the countries where frugal innovation is developed to then explore where it is adopted; this can be done by classifying them according to their geographical location or their income-class.

As it emerges from figure 3.1., a central role is played by the Asian continent, in fact on 232 valid observations, more than 52% report of frugal innovation developed in Asia, followed by Africa with 16,4% of total cases; this is coherent with the idea that frugal innovation usually arises in constrained base environments. In table 3.1. are reported the ten countries that bring major contributions in the development of frugal innovation; India (70 cases), China (32 cases) and Kenya (13) on their accounts for almost half of the observations. In fact, the first and the most known case of frugal innovation, Tata Nano, comes from one of these countries.

What is interesting to observe is the quite relevant position occupied by Europe, with more than 10% of cases; furthermore, as it emerges also from table 3.1. Sweden and Netherlands are ranked between the top 10 countries in the development of frugal innovation. In the literature analysed previously this aspect is never highlighted or taken into account, but it is significant for its implications. The fact that frugal innovation is developed in these modern countries, USA and United Kingdom included, does not automatically mean that it is also adopted there, but instead that MNEs are starting to invest in this kind of innovation, as we will illustrate later. The category multiple instead represents situations in which the development occurs, simultaneously or not, in more than one country and/or continent; it includes relationships between states located close each other, such as India and China, or between Europe and Asian or African countries, that are part of international projects.

Figure 3.1. Countries where developed (grouped by area)

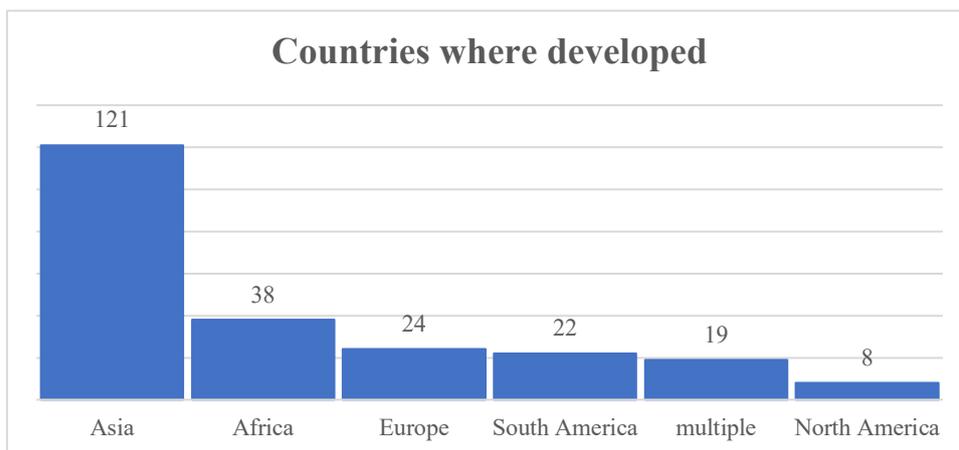


Table 3.1. Top 10 countries in the development

Country	cases	%
India	70	28.0%
China	32	12.8%
Kenya	13	5.2%
South Africa	12	4.8%
Brazil	9	3.6%
United Kingdom	7	2.8%
USA	6	2.4%
Netherlands	6	2.4%
Sweden	4	1.6%
Philippines	4	1.6%

Moving to the adoption side of frugal innovation, from figure 3.2., it emerges that Asia and Africa are still the leading continents, covering about 67% of the total cases, while Europe and North America have an even less significant role, with only 11 reported cases (0.8%). What it is worthy to observe is the presence of the category "global", that stands for some frugal innovations that are already spread all around the world, such as the model of Grameen Bank, initially conceived in India. Differently from the development side, here emerges clearly the role of South America, in particular of Mexico and Argentina, not even present in the previous part and now ranked between the top 10 adopters (table 3.2.). As before, all the continents above mentioned are, many times, characterized by resource-constrained environments, instability and significant institutional voids; so we can affirm that frugal innovation usually originates and develops in these type of contexts; this is confirmed also by other studies, such as the one of Soni and Krishnan (2014), previously analysed in the literature. In order to gain a more detailed overview, we can look at table 3.2. - representing 70% of cases - where are reported the top 10 countries in the adoption of frugal innovation; here again the major contributions are

given by India, China and Kenya, but with respect to top developers rank, it is not possible to identify any countries located in the European and North America area; this implies that even if they are interested in the phenomenon and they are investing on it, the population does not feel the necessity or does not have the right mindset to adopt frugal solutions. This last aspect is reflected also in the literature, focused on the study of Asian and African dynamics, mainly, and completely ignoring the few cases reported in the wealthier part of the world.

At a closer look, it is worthy to notice that the general trends that emerged from the adoption perspective, are the same ones highlighted in the analysis of development's context; so usually frugal innovations are adopted in the same place or area in which they are also conceived. This fact is confirmed by a further analysis, that compares, through a dummy variable, the place where the innovation is developed and the one in which then is adopted; on a sample of 241 cases, we found out that in the 58.4% of cases there is total correspondence, in 14.8% partial match (i.e. a solution created in Brazil and then spread in Brazil and India) and only in 26.8% no correspondence at all. The most likely explanation is that frugal innovation does not arise from intensive R&D efforts, but instead, has its roots on the existence of unsatisfied needs in that area.

Figure 3.2. Countries where adopted (grouped by area)

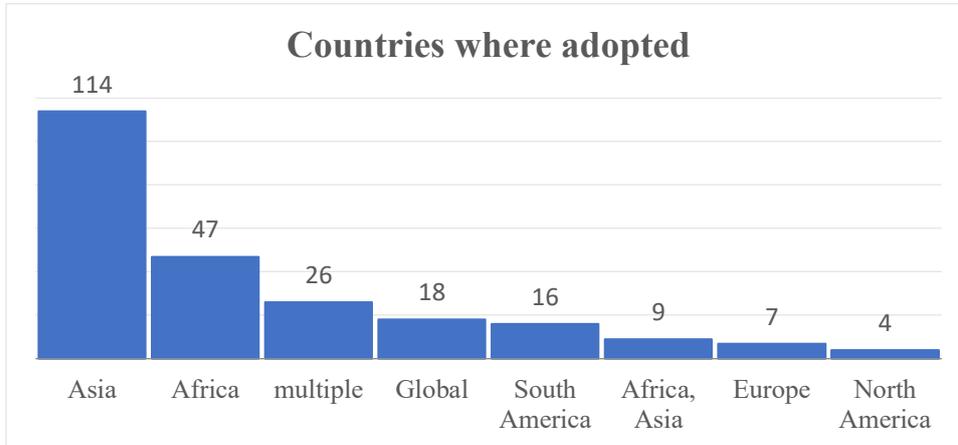


Table 3.2. Top 10 countries in the adoption

Country	cases	%
India	67	26.8%
multiple	28	11.2%
China	25	10.0%
Kenya	20	8.0%
Global	15	6.0%
Mexico	5	2.0%
South Africa	4	1.6%
Indonesia	4	1.6%
Argentina	4	1.6%
South Africa; South East Asia	3	1.2%

In order to better understand the phenomenon, we analysed the context of development and adoption also according to the income of the different countries reported, using the World Bank Classification; in particular, the financial institution divides the World's economies into four income groups: high, upper-middle, lower-middle and low. Usually, this economic aspect is not really taken into account in the studies, given that the focus is more on cost features of frugal innovation, but as it emerges from figures 3.3. and 3.4., this aspect can provide interesting insights. In fact, frugal innovation tends to occur mainly in lower-middle and upper-middle income countries, with respectively 101 and 63 observations on a valid sample of 232 cases and covering together with 65.7% of the total. What is even more surprising is the role played by high-income countries with respect to low-income ones; the first ones represent 20.7% of cases, while the latter only 2.2%.

From the adoption perspective, this scenario is even more accentuated; with lower-middle income accounting for 44.4% (106 cases) and upper-middle income for 17.4% (42 cases). Again, the wealthiest nations see the diffusion of frugal innovations more than the poorest ones (22 vs 14 cases); thus, low-income countries have no access to knowledge and remain every day more underdeveloped. These data highlight the need of a certain amount of financial resources in order to develop a frugal innovation; so only at a first sight this kind of innovation seems to be addressed to the poorest, but it would be more appropriate to conclude that frugal innovation arises in not excessively poor contexts.

Figure 3.3. Countries where developed (grouped by income)

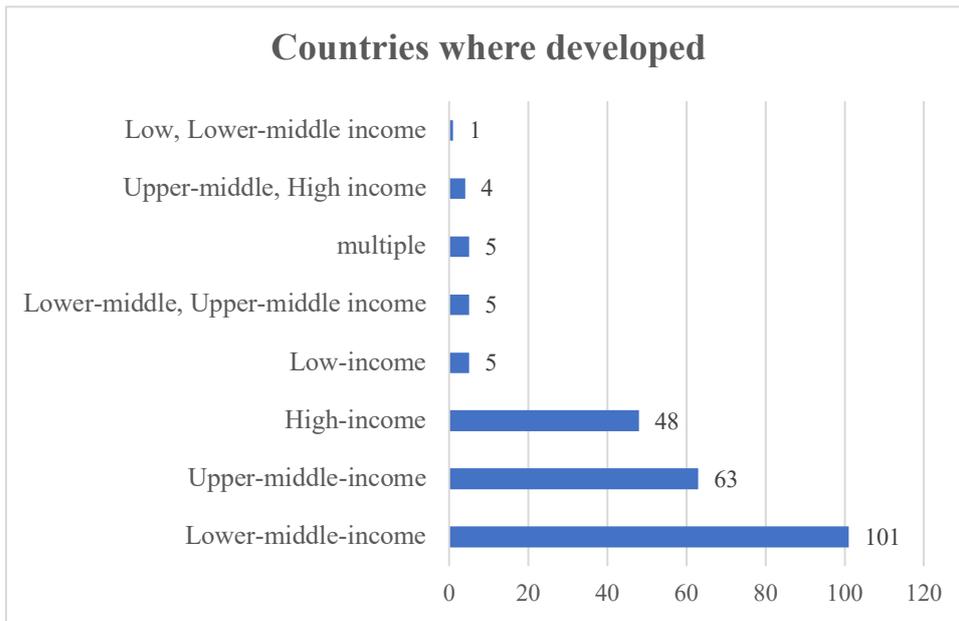
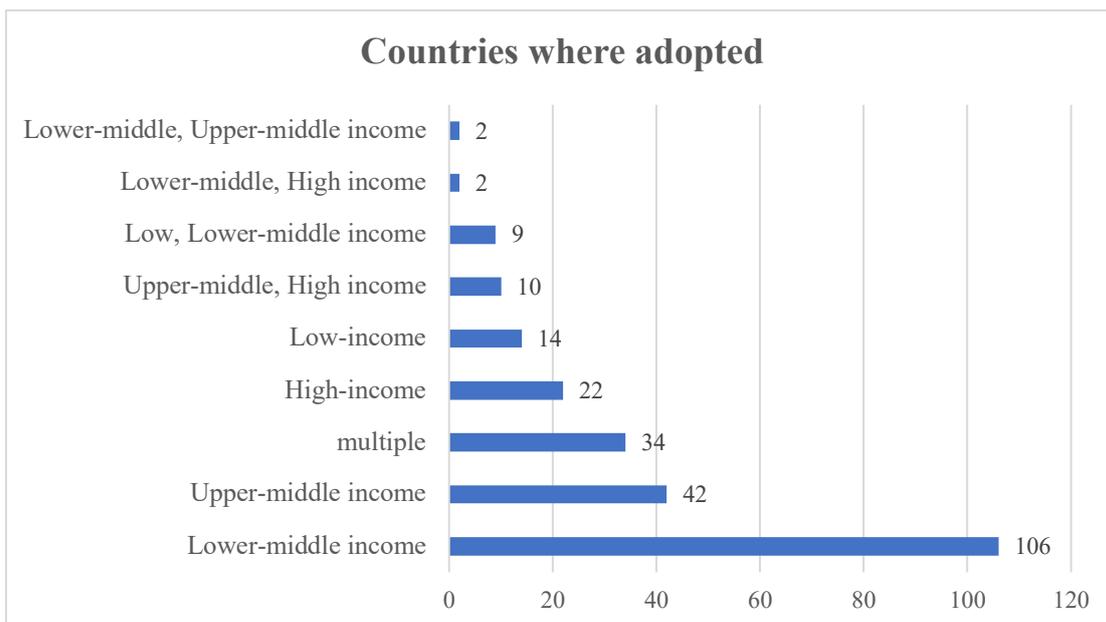


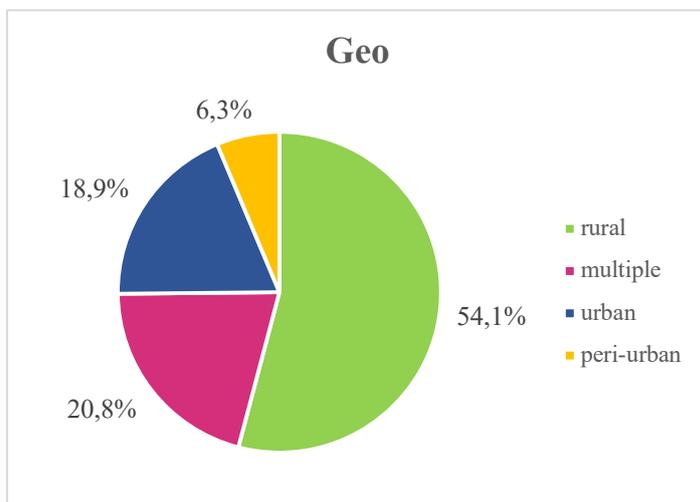
Figure 3.4. Countries where adopted (grouped by income)



Proceeding in the analysis, the phenomenon has been investigated again from the geographical perspective, in order to understand if frugal innovation is more diffused in urban, peri-urban or rural context. The pie chart (figure 3.5.) clearly illustrates the preponderance of countryside: the rural context, in fact, accounts for more than the half with 54.1% (86 cases), followed by situations of multiple contexts (20.8%), urban ones (30 cases) and 10 cases of peri-urban. Again, it can be observed how frugal innovation arises from resource-constraints context, where underdevelopment, poverty and unsatisfied needs are, many times, the drivers. With respect to the previous analysis, here there is a high number of "not reported" cases, 91 out of 250; this

could be directly linked with the fact that the majority of times, frugal innovation is developed in poor, rural and non-institutional contexts, where is difficult to report and document the context, the processes and the findings in a methodological way.

Figure 3.5. Geo of frugal innovation



Moving towards a sectoral analysis of the phenomenon, this has been conducted in two levels: first according to the belonging sector and then to the industry; the sectors identified are the following: agriculture, manufacture, services and advanced services; while the list of all the industries has been determined according to "COFACE country and sector risks handbook 2019". Although the rural context is typical in the development of frugal innovation, there is a strong predominance of service-related innovation, with 131 cases for the class "services" and 15 cases for the one of "advanced services" (figure 3.6.). Manufacture and agriculture instead account for 48 and 39 cases respectively. Looking more in depth, in table 3.3. it emerges that the majority of observations reported concern healthcare, agriculture/food and energy industry, covering together 138 cases on a total of 246. This is not causal, instead it is related to the type of innovation developed, usually is a new product or methodology, and with one of the main aims of frugal solutions, such as improving the population's lives. Many times, the three industries abovementioned are strongly connected to each other. For example, due to energy lack, people living in African villages set outbreaks in their houses to cook, warm-up and enlighten; this is dangerous because it might lead to wildfires but also because of the dust coming from the burning process has really negative consequences on health. Providing them with electricity not only improves their living condition, but also their health status.

What is interesting is also the data related to the ICT sector, accounting for 6.1%; in fact there is an increasing trend to adapt the latest technologies to emerging countries conditions in order to satisfy their financial needs, such as the case of the bank in India that provides microloans to

the population through an app. Unexpectedly, embedding frugal innovation into a social aspect, the field with fewer cases, only one reported, is the charity one.

Figure 3.6. FI diffusion among sectors

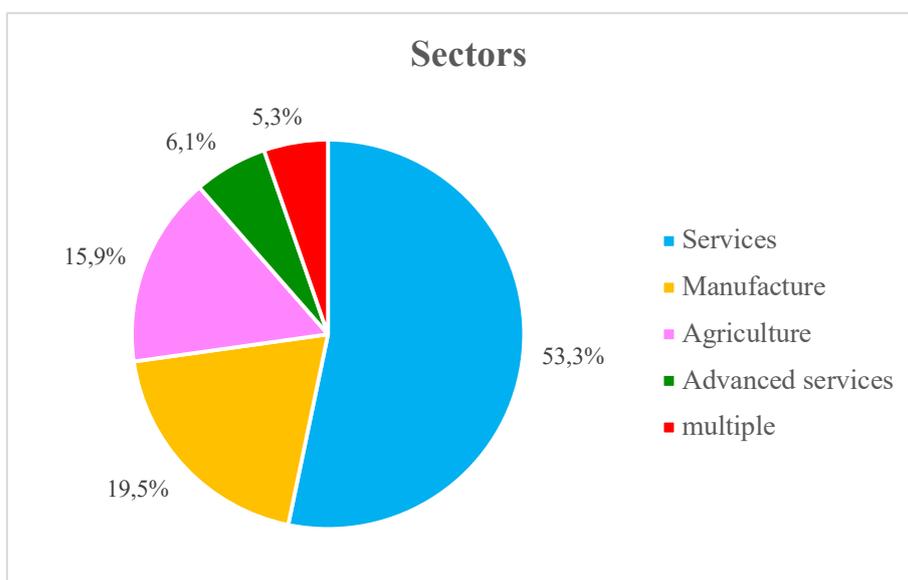


Table 3.3. FI diffusion among industries

Industry	cases	%
healthcare	61	24.8%
agri-food	39	15.9%
energy	38	15.4%
automotive	23	9.3%
ICT	15	6.1%
manufacturing	15	6.1%
multiple	13	5.3%
finance	10	4.1%
transport	10	4.1%
education	5	2.0%
pharmaceuticals	4	1.6%
technology	4	1.6%
construction	3	1.2%
textile	3	1.2%
retail	2	0.8%
charity	1	0.4%
Total	246	100%
not reported	4	1.6%
Total valid observations	250	

3.2. Characteristics of frugal innovation

The following section aims to investigate the characteristics of an innovation that has been classified as frugal; aspects such as innovation type, key focus and typical features are going to be analysed. Before moving to this, general exploration of the various definitions of frugal innovation has been conducted, to understand the current theoretical state.

Even if a generally accepted definition of frugal innovation is missing, 162 out of 250 cases of the sample report some sort of it to identify the phenomenon. All the descriptions have been collected and used to form a word cloud with the objective to highlight the most common words. As it emerges at a very first sight from the word cloud (figure 3.7.), usually frugal innovation is described as simple, low cost and functional and the main related words such as easy, cost-saving, good enough, value and resource-saving are also present; this is coherent with the most relevant definitions that have been studied in chapter 1. Great attention is also put towards the context in which frugal innovation is embedded, in fact, words such as local needs, BoP and poor are highlighted. Another feature that emerges clearly is the role of community and institutions; usually this aspect is not really taken into account in the researches, but we can affirm that it has a relevant impact in the development and adoption of frugal innovation and, with this aim, we are going to investigate it in the next sections.

Figure 3.7. FI word cloud



In the literature, scholars generally identify three main types of innovation: product innovation, process innovation and business model innovation; in our analysis of frugal innovation, we consider appropriate to apply the same theoretical categorization. As it is possible to observe in table 3.4., product innovation has a strong majority over the rest, representing 49% of total

cases, while business model innovation and process innovation are almost in the same position, with respectively 58 and 52 cases. There is also a portion of the sample, the 6.8%, that involves a mixed situation.

Table 3.4. Innovation type

Innovation type	cases	%
product	122	49.0%
business model	58	23.3%
process	52	20.9%
mixed	17	6.8%
Total	249	100.0%
not reported	1	0.4%
Total valid observations	250	

Moving to the key focus of frugal innovation, in the description of the cases analysed in the sample, there is always a focus and particular attention towards one of the following aspects: the innovation development, the innovation adoption, the social outcome or the economic outcome. As it emerges in table 3.5., more importance is given to the development of frugal innovation rather than to its adoption, in fact, they respectively account for 149 and 48 cases. This is probably due to the fact that the researchers are still in the primary phase of the phenomenon's study, so it is more relevant to gain knowledge first on all the aspects that deal with the development and then to the adoption. It is also possible to observe how frugal solutions are addressed more towards the achievement of a social outcome rather than the economic one; in particular, we reported 34 vs 11 cases. These data are coherent with the nature of frugal innovation that many times stresses the importance of social impact and improvements of living conditions, but it seems to be not in line with the normal objective of some MNEs that have already started to develop frugal innovation such as Tata Motors, GE and Nokia.

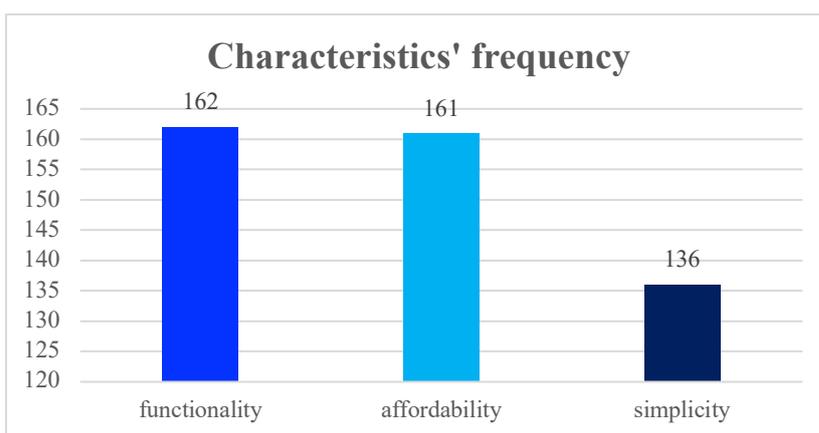
Table 3.5. Key focus of FI

Key focus	cases	%
Inn. Dev	149	60.3%
Inn. Adopt	48	19.4%
Social out	34	13.8%
Econ. Out	11	4.5%
multiple	5	2.0%
Total	247	100%
not reported	3	1.2%
Total valid observations	250	

We now proceed in the investigation of frugal innovation, by analysing in depth three characteristics: functionality, affordability and simplicity. The features identified derive from the general definition of frugal innovation given by Weyrauch and Herstatt (2016) that states "innovations are frugal if they simultaneously meet the criteria of substantial cost reduction, concentration on core functionalities and optimized performance level". So, the variable affordability mainly refers to a cost reduction, in order to offer the necessary product or service affordable to the targeted costumers, that usually belong to the bottom of the pyramid. Functionality instead, is related to the features of the frugal solution that have to be suited for the particular context in which they are located and for the satisfaction of different needs. At last, simplicity means creating something that has only what is essential, and it eliminates all the frills and non-necessary features. All the variables just mentioned can assume three different values: high, medium and low.

A general investigation was first conducted, to understand if at least one of these features was reported, and then we analysed them in detail and also in a relationship with the type of innovation. On a sample of 250 cases, 80% cites at least one characteristic, while the remaining 20% does not mention anything at all. In particular, as reported in figure 3.8., functionality is the most frequent characteristics, reported 162 times, almost even with affordability 161 times, and followed by simplicity, expressly mentioned 136 times. This difference could derive from the fact that simplicity is more difficult to be defined and identified with respect to the other two characteristics.

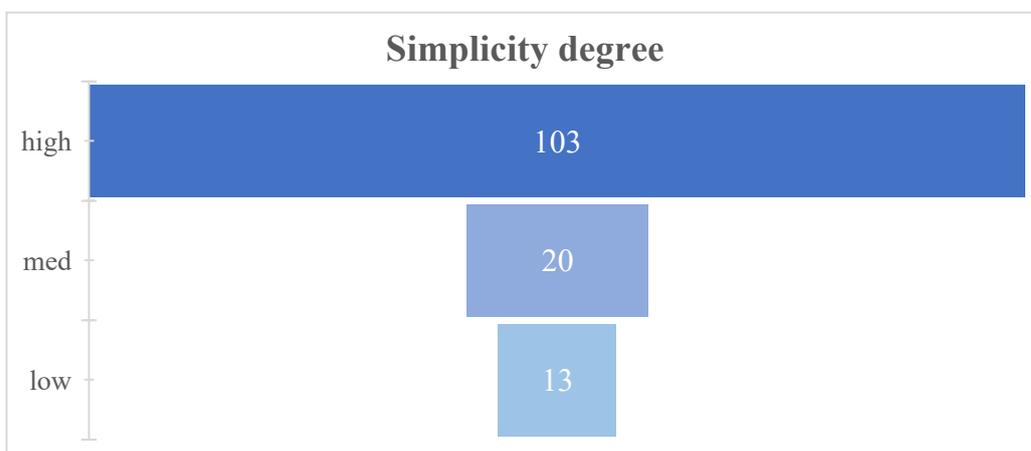
Figure 3.8. Characteristics' frequency



We now look to the measurement of the degree (high, medium or low) separately for each characteristic. A general problem that has emerged is the high number of “not reported” cases, due to some difficulties in the collection of data and results. It seems that features are measured and reported in the cases only if their level is high, and thus easily observable; from that, we could assume that a standard measurement process is missing.

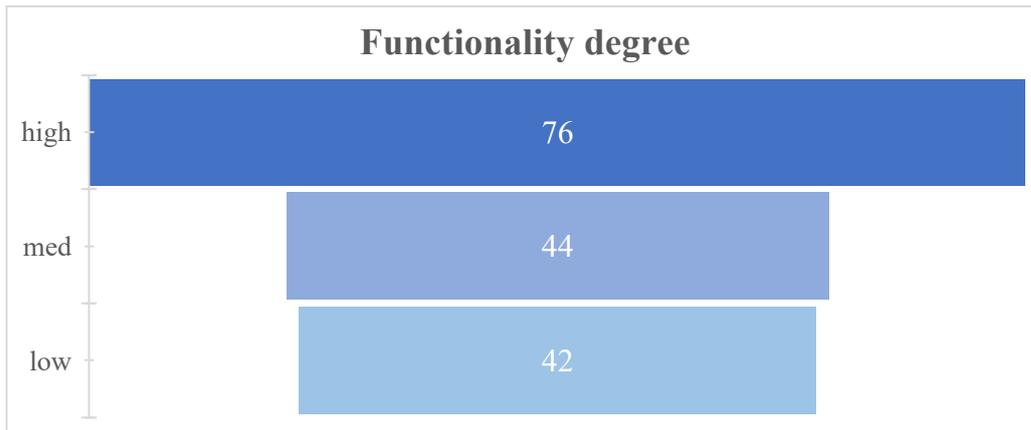
We start by analysing the simplicity degree, graphically illustrated in figure 3.9. On the total sample of 250 cases, the number of "not reported" reached 45.6%. Despite this, in the 75.7% of cases, simplicity has a high degree, in the 14.7% a medium degree and in the 9.6% a low one. This means that in general frugal solutions are simpler compared to standard products and services and lacking all the unnecessary frills and components. Even if it is not highlighted in the literature, simplicity has a strong relationship with affordability. In fact, keeping everything simple and using alternative components allow a relevant reduction in the cost of the final product or service; such in the case of an ECG device that uses a normal ticket printer to give the clinical result. Frugal innovation is usually addressed to consumers at the BoP, so it has to satisfy the specific need but essentially it has to be simple and cheap.

Figure 3.9. Simplicity degree of FI



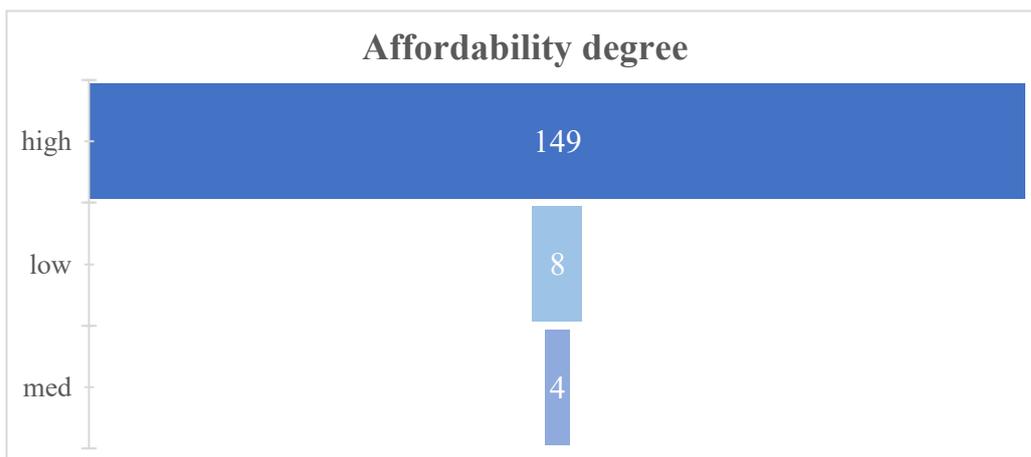
In figure 3.10., instead it is possible to observe the functionality degree, again it can assume the value high, medium and low. Here the "not reported" cases are less, but still accounting for 35.2% of the total. This reduction is mainly related to the fact that in presenting a new frugal product or service, describing the features is essential in order to understand it, so it is easier to deduce the functional aspect. In this regard, the three degrees of functionality are uniformly distributed; in fact, we have a high degree for 46.9% of cases, a medium one for 27.2% and a low one for 25.9%. This better distribution is due to the fact that a low degree of functionality does not correspond to a frugal solution that does not work properly. In fact, in many products or services the common functionalities are not present because they are substituted with other ones, better suited for the context; for example in India has been developed a mobile phone, without apps and camera, because these tools would have been unnecessary for the farmers, instead this phone is not ruined by dust and soil and it has a charge much more powerful than our mobile phones, to deals with the lack of electricity in rural areas.

Figure 3.10. Functionality degree of FI



Finally, the third characteristic examined is the affordability degree, which basically results in a relevant cost reduction and a low-cost product. A high affordability degree means that the price is significantly lower than the standard one, a medium degree indicates the same price with respect to the common solution, while a low degree stands for a more expensive product. For these reasons, 92.5% of total cases report a high degree of affordability, while low and medium account together for 7.5% (figure 3.11.). This is not surprising, given that one of the main objectives of frugal innovation is creating a good-enough solution at an affordable price; the idea of developing something more expensive than usual is quite in contrast with the definition itself and with the whole literature. One of the most outstanding cases is the creation, by the Indian company Cipla, of the cheapest anti-retroviral medicinal for AIDS.

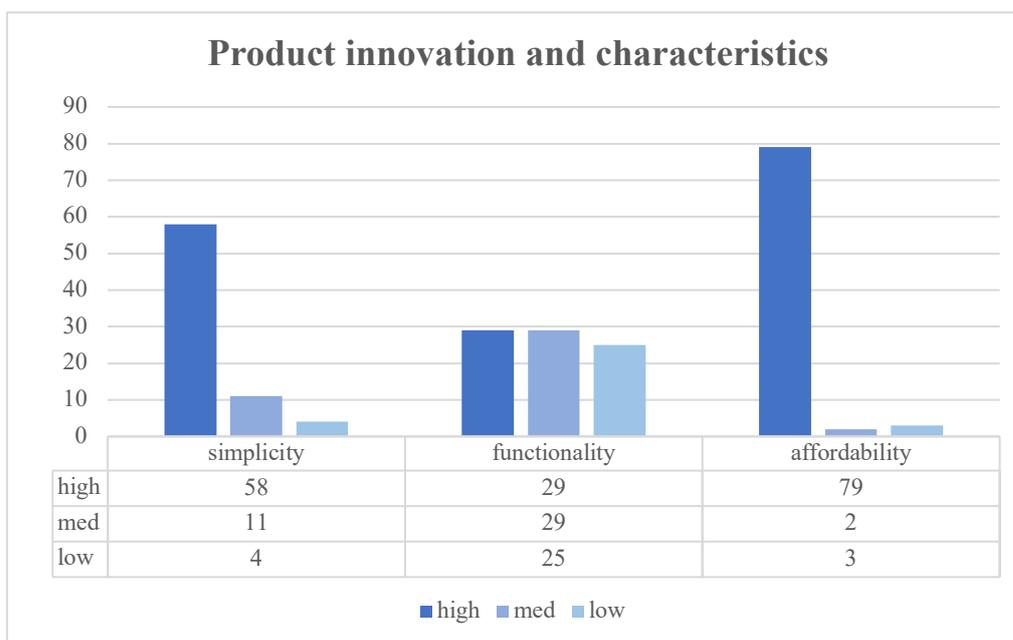
Figure 3.11. Affordability degree of FI



In the following part, an analysis of the different types of innovation related to the basic characteristic is presented. We start from product innovation; the overall situation is depicted in figure 3.12. As it is possible to observe, the general trends of the three features are the same described before. In fact, there is again a high degree of simplicity and even more of affordability, while the medium and low degrees have a less relevant impact. Functionality

instead, shows an almost equal level for the high, medium and low degree, with respectively 29, 29 and 25 cases reported. This means that in the development of a frugal product, all the efforts are towards the creation of something low-cost, with only basic features. So far, intermediate solutions, for example, upgrading of frugal products more complex and a little bit expensive, have not been explored yet. As already pointed out, we are still in the initial phase of this phenomenon, so firms and MNEs in particular, probably have not acquired yet the necessary skills to offer a "not basic frugal product".

Figure 3.12. Product innovation and its characteristics

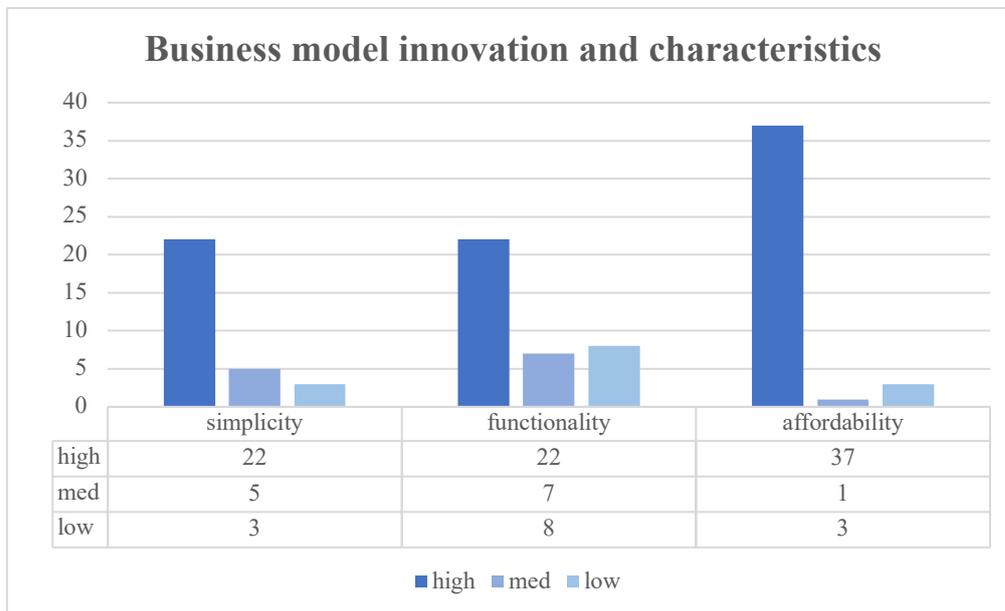


In figure 3.13. is shown the relationship between the business model innovation and its characteristics. Again, there is a strong predominance of a high degree of affordability, in fact, 37 cases are reported, versus 1 and 3 of medium and low degree. With this type of innovation, this trend is observable also for the simplicity and functionality variables. Differently than the product innovation, in the business model innovation, the functionality characteristic tends to assume more the high value; but this is probably related to a risk avoidance factor. As a general note, innovating the business model is more complex and difficult than doing it for a product, given that it requires more knowledge, a predefined strategy and clear procedures. At the current state, this is more complicated to achieve, because frugal innovation is still strong characterized by improvisational approaches and many informal aspects and actors.

An interesting frugal business model has been developed in the Chinese health sector: due to the huge population and the lack of resources, a mobile health application has been introduced: the app allows to book medical examination through SMS, receive the results and gain

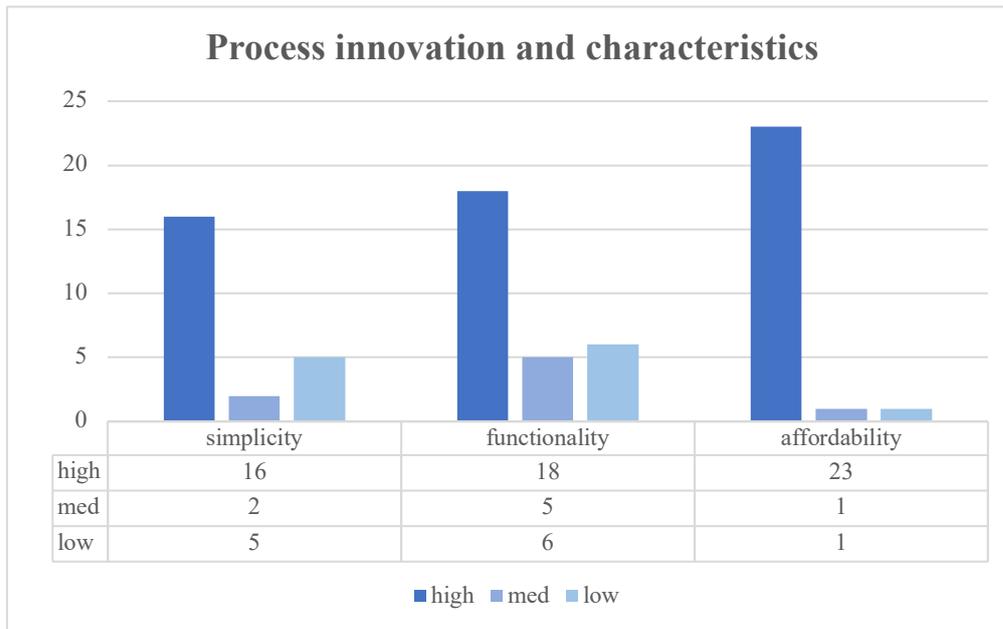
information about the hospital and the doctors. This new frugal business model is also one first step in creating a central database.

Figure 3.13. Business model innovation and its characteristics



The last part is examined the relationship between the process innovation and its characteristics. First of all, it is worthy to notice that process innovation accounts for fewer cases with respect to the previous two types of innovation. The hypothesis here is not that in the reality there are effectively fewer cases of frugal process innovation, but instead that the process is not documented and reported, because it is still at an informal level. From figure 3.14, it emerges again a situation where all the efforts are towards complexity and cost reduction. In fact, simplicity, functionality and affordability present a significative high degree, with respectively 16, 18, 23 cases reported; while medium and low degrees have an impact that may be ignored. In the frugal process innovation, a particularly important role is covered by the simplicity variable; in fact, facilitating the overall process leads many times to cost reduction and thus, to a less expensive process and to a more affordable frugal product or service.

Figure 3.14. Process innovation and its characteristics



3.3. Actors

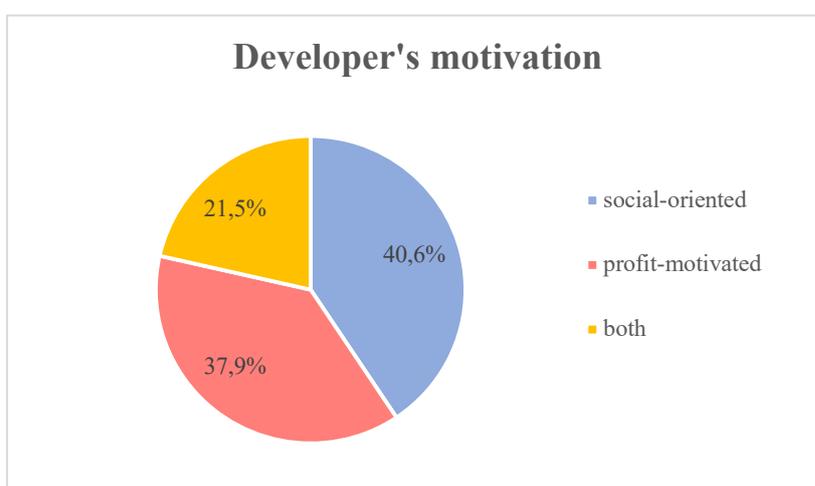
The aim of the third section is to investigate the actors that are involved in the development and adoption of frugal innovation and the different motivations that drive them. From the studies examined in the literature review conducted previously, and in particular in the study of Soni and Krishnan (2014), it seemed that the main actors involved in the creation and diffusion of frugal innovation are multinationals, local subsidiaries of multinational and enterprises; but if we look at the table 3.6., the situation is quite different and characterized by a multitude of different actors. In particular, it is possible to encounter firm, non-firm, MNE, informal firm and institution, both at a local and at a foreign level. Table 3.6. reports a detailed list of all the developers involved and their importance and presence in relation to the sample of cases on frugal innovation. The major contributions are given by local firms (23.4%), local non-firms (20.9%), foreign MNEs (13.8%), local subsidiaries of foreign MNEs (11.3%) and local MNE (10.9%). Except for the voice "foreign MNE", it emerges clearly the presence of a local context; as outlined previously in the word cloud and in the literature, thus one of the main drivers of frugal innovation is the surrounding environment and the specific needs of the local population. If we look also at the final part of table 3.6., where the actors involved are small informal firms and institutions, there is still a significative presence of the local context. Thus, it is possible to assume a strict relationship between the latter one and the development of frugal innovation. It emerges only here, and not in the previous literature, the role of local institutions (7.1%) and their possible relationships with community, firms' associations and individual entrepreneurs.

Table 3.6. Developers of FI

Developer	cases	%
local firm	56	23.4%
local non-firm	50	20.9%
foreign MNE	33	13.8%
local subsidiary of foreign MNE	27	11.3%
local MNE	26	10.9%
local institution	17	7.1%
foreign non-firm	16	6.7%
multiple	8	3.3%
local small firm (informal)	6	2.5%
Total	239	100%
not reported	11	4.4%
Total valid observations	250	

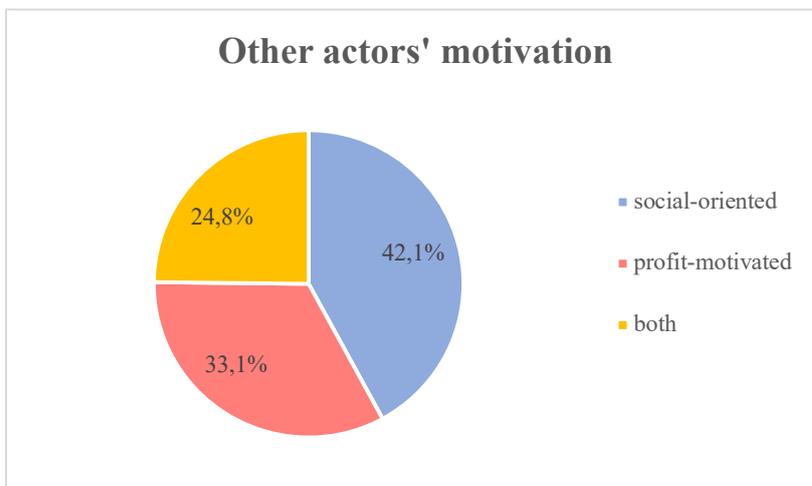
It has been observed that in the development and adoption phases there is the main developer, the ones abovementioned, but also other actors are involved through formal and informal collaborations. For example, the developers could be a foreign MNE that has strong linkages with a local institution. These kinds of relationship will be explored in the next sections, now we are going to analyse the motivation of both the developer and the other actor/s involved. In developing frugal innovation there might be plenty of motivation, but these can be attributed to two main categories: social-oriented and profit-motivated ones. In the pie chart below (figure 3.15.) developer's motivations are represented. It emerges the prevalence of social-oriented cases over the profit-motivated ones, in fact, there are respectively 89 and 83 cases reported. This might be related to the fact that frugal solutions many times are developed by actors, such as non-firm and institutions, that not being firms do not have profit as the main objective.

Figure 3.15. Developers' motivation



In figure 3.16., instead are depicted, through a general overview, the other actors involved. The social focus is still predominant with respect to the profit one (42.1% vs 33.1%), but what is interesting to observe is the elevate number of "not reported" cases, 105 out of 250 of the total sample. Many times, this aspect is not reported because the relationship between the main actor and the other ones is not always clear or formalized. In any case, social motivation is the most relevant, indicating that who collaborates in the development of frugal solutions is not interested or attracted by the possibility of making profits; thus, again the social nature of frugal innovation emerges.

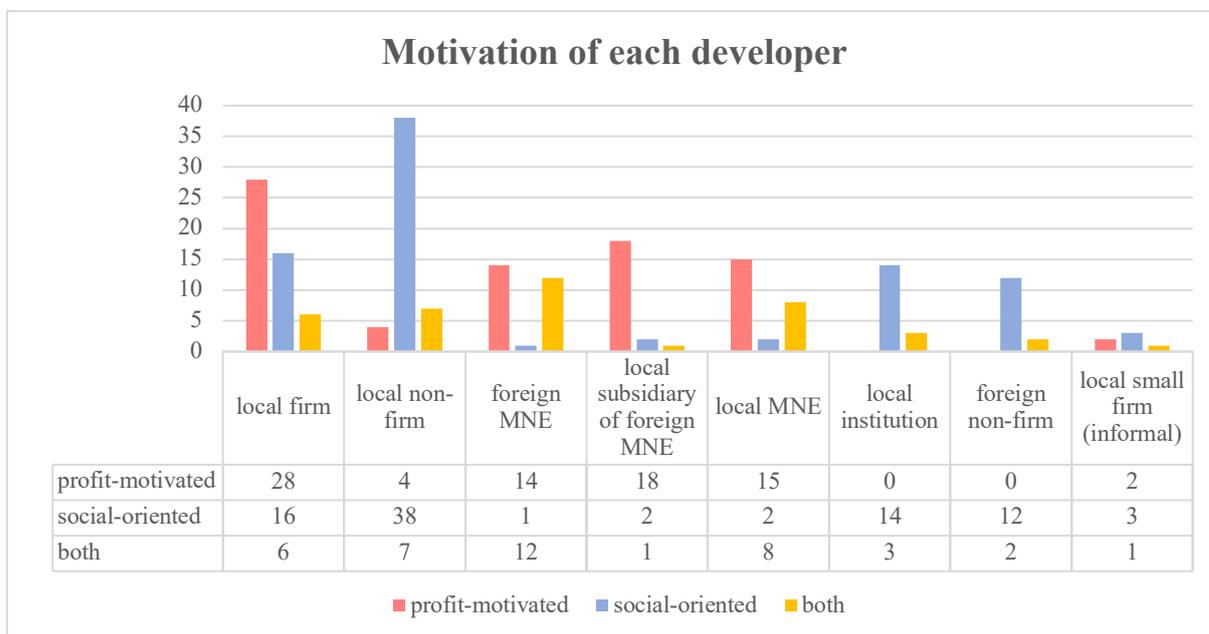
Figure 3.16. Other actors' motivation



We proceed in the analysis of motivations, examining in a more detailed way the motivation that drives the different actors (figure 3.17.). Irrespectively of the total observations available for each category, it emerges clearly the distinction between the actors that are profit-motivated and those who are socially oriented. In particular, it is possible to observe how local firms, foreign MNEs, local subsidiaries of foreign MNEs and local MNEs are driven by profit objectives. For examples, if we compare local firm and local non-firm (actors for which we have the highest number of valid observations) it emerges how the first accounts for 28 cases in which achieving a profit was the main goal in the development of frugal solutions, while the latter only reports 4 cases. This kind of actors has also a higher number of the value "both", meaning that sometimes they combine the profit goal with the social one. On the contrary, it is also possible to note how local non-firm, local institution, foreign non-firm and local small firm (informal) stress more the social perspective; in some cases, the profit aspect is not even taken into accounts, such as the case of local institution and foreign non-firm. Another interesting aspect is that when dealing with actors that are not companies, data are more difficult to be

obtained; this might derive from the fact that frugal process is not formalized and so there might be a lot of cases of frugal innovation that are not taken into account in the studies.

Figure 3.17. Motivation of each developer



3.4. End users and beneficiaries

This section is aimed at exploring the social context in which frugal solutions are spread, by investigating the goal pursued and the different social classes targeted, in order to gain detailed knowledge about the end-users and the beneficiaries of frugal innovation.

Every case in the sample has been analysed to understand the social goal of the related frugal product, business model or process. Needless to say, the objectives pursued differ from case to case, but we decide to classify them according to the categories presented in the table 3.7. From the table it appears that the two most common goals are health and energy; they account respectively for 33% and 20.1%. These data exactly reflect the same trend that has been pointed out in the analysis of diffusion of frugal innovation among sectors, where the top positions belong to energy and healthcare industries (see table 3.3.); thus, we can affirm that the social goal is deeply influenced by the industries that are more able to comprehend the unsatisfied needs. Given the social nature of frugal innovation and its intrinsic aim of improving people's living conditions, the social goal should not be conditioned by the industry. Nevertheless, some goals reported, such as empowerment, poverty, water and education indicate that there is a wish to have a positive impact on society and improve the general quality of life. These goals, with their related industries, are maybe the less attractive from a company's point of view because they do not bring huge profits; moreover, they are not usually highlighted in the literature, but

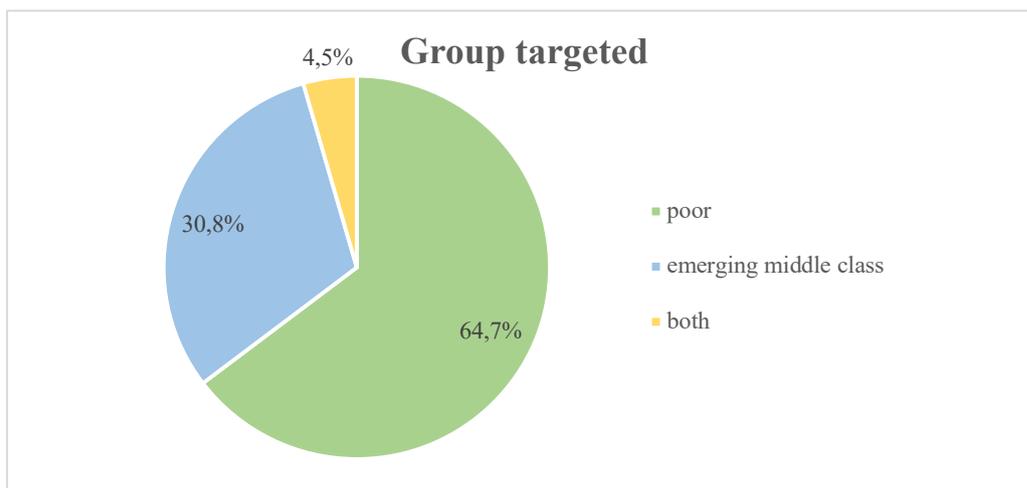
as it emerges from table 3.7. they have a significant role. It is worthy of precision that the category empowerment stands for the general improvement of life's quality and major emancipation, but it poses particular attention to the role of women in society. Finally, the environmental social goal even if reported it is not particularly significant, accounting for only 1%, but again in the previous literature and analysis we have emphasized how frugal innovation has a positive environmental impact, so we have reasons to believe that in the table this aspect does not stand out because of a lack of measurements.

Table 3.7. Social goal of FI

Social goal	cases	%
health	64	33.0%
energy	39	20.1%
empowerment	27	13.9%
agro-food	22	11.3%
poverty	20	10.3%
water	13	6.7%
education	4	2.1%
multiple	3	1.5%
environment	2	1.0%
Total	194	100%
not reported	56	22.4%
Total valid observations	250	

We now move to the investigation of the various social classes targeted; as already explained frugal innovation reaches unsatisfied needs of poor, in particular, those at the bottom of the pyramid. In fact, as it emerges from the general overview of the groups targeted in figure 3.18., the wealthiest and richest class is not even included, because, in the sample of cases, all the solutions were addressed to poor or emerging-middle class. The main focus is on the poor class, which accounts for 130 cases out of 201, while the emerging middle-class reports 62 cases. Only 9 times the frugal solution was considered appropriate for both social classes; the underlying reason can be identified in the economic gap between the two classes. In fact even if the emerging middle class is considered as low or lower-middle income, it has the financial resources to afford some purchases, people at the BoP, instead, living with less than US\$2 per day, do not have financial resources almost at all; so it is difficult to develop a frugal solution able to cope with these two very different conditions.

Figure 3.18. Group targeted (general overview)



Subsequently to the general overview of the different groups targeted, we have explored in detail the social classes that each actor intend to address; in doing so, they have been divided into four categories: i) foreign firm, that comprehends foreign MNEs and their subsidiaries; ii) local firms, that includes local firms, local MNEs and local small firm (informal); iii) foreign non-firms and iv) local non-firms, that embrace also local institutions. Looking at figure 3.19., it emerges that in the majority of cases, the main group targeted is the poor one, except for the foreign firms that aim to reach primarily the emerging middle class. Multinationals, in fact, being interested mainly in making profits, tend to focus more in the middle class, which has a certain purchasing power and disposable income, and only after they are interested in the poor one. Local firms instead, target largely the poor class with respect than the middle one (44 vs 23 cases); the possible underlying explanation is that they are more social-oriented, less interested in making profits and more importantly they own the necessary skills to survive in the local context and they have knowledge of the unsatisfied needs of people at the BoP; with respect to MNEs the latter reasons mentioned are important sources of competitive advantage and are the aspects in which big foreign companies usually struggle. Local non-firms focus even more on the poor class, given that they are not interested in earning money and that they are aware that targeting poor people can not be their main source of revenue, probably they act only aimed by a social motivation. In effect, the gap between the two groups addressed is the widest reported, with 48 cases of poor class targeted and only 12 for the emerging middle one. Concerning foreign non-firms, such as universities, research centres and governments, there is a lack of valid observations necessary to deduce valid results; in any case, it appears again the major interest to poor ones. As already mentioned previously, studies on frugal innovation are still in their primary phase, so it might be possible that foreign non-firms are still understating how to deal with the new phenomenon and they have not realized yet the importance that it is

gaining. In the following pie charts, the relationship actor-group targeted is presented individually. In particular, on a sample of 41 cases, foreign firms targeted the emerging middle class 53.7% of times, while the poor one 46.3% (figure 3.20.). In the case of foreign non-firms, the poor class accounts for 71.4%, the emerging middle one for the 14.3%, while the remaining cases, 7.1%, are addressed to both classes (figure 3.21.). Moving to local firms, on a sample of 74 cases, in 59.5% of cases the poor class is targeted, in 31.1% of cases the emerging middle one and in 9.5% both classes are targeted (figure 3.22.). To conclude, in figure 3.23., it is possible to observe how local non-firms are addressed for 78.7% to the poor, 19.7% to the middle class and 1.6% to both classes.

Figure 3.19. Groups targeted by actors

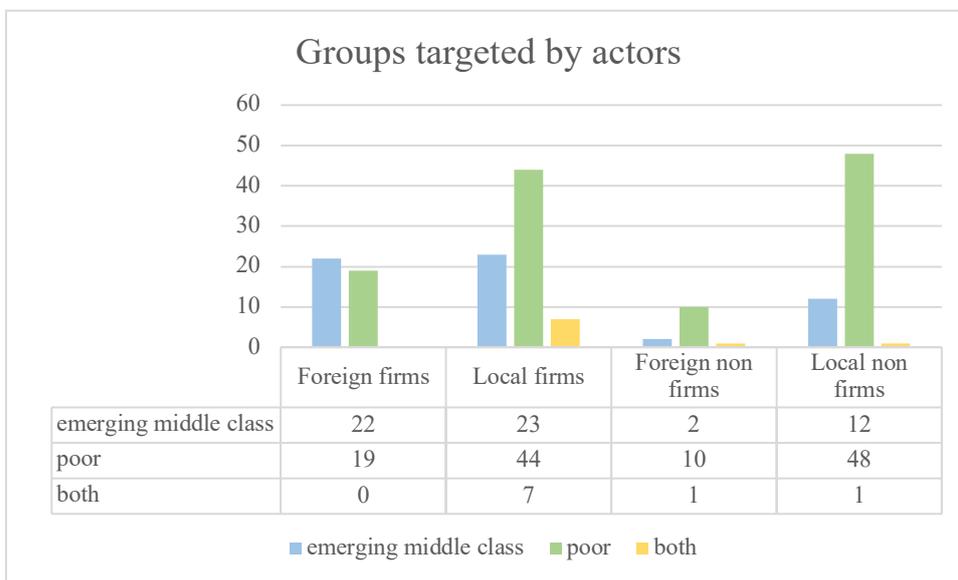


Figure 3.20. Group targeted by foreign firms

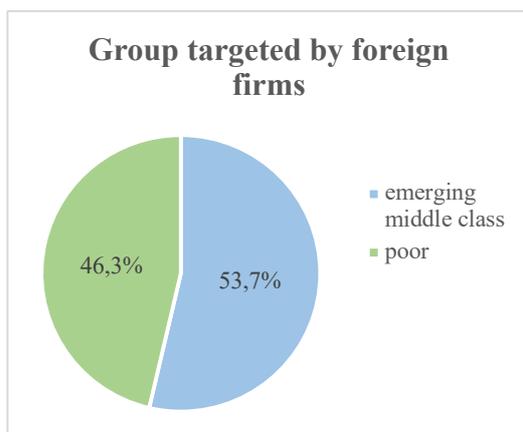


Figure 3.21. Group targeted by foreign non-firms

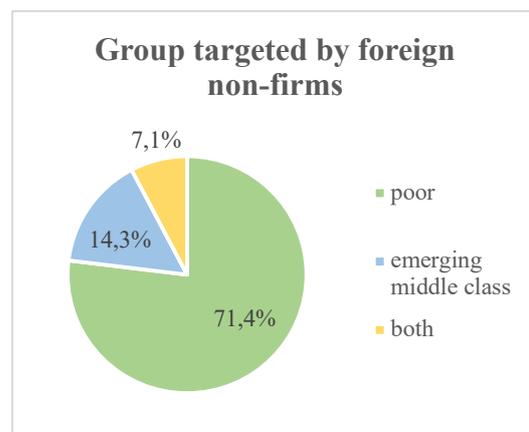
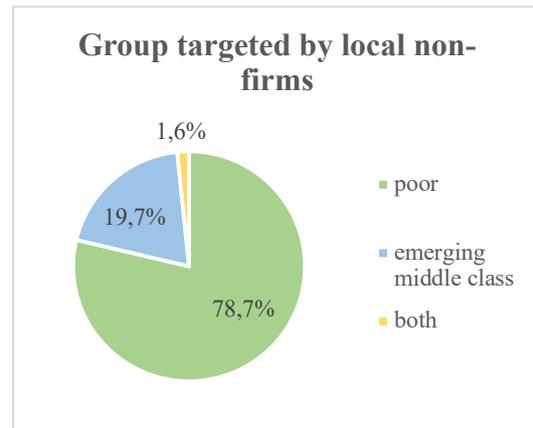


Figure 3.22. Group targeted by local firms



Figure 3.23. Group targeted by local non-firms

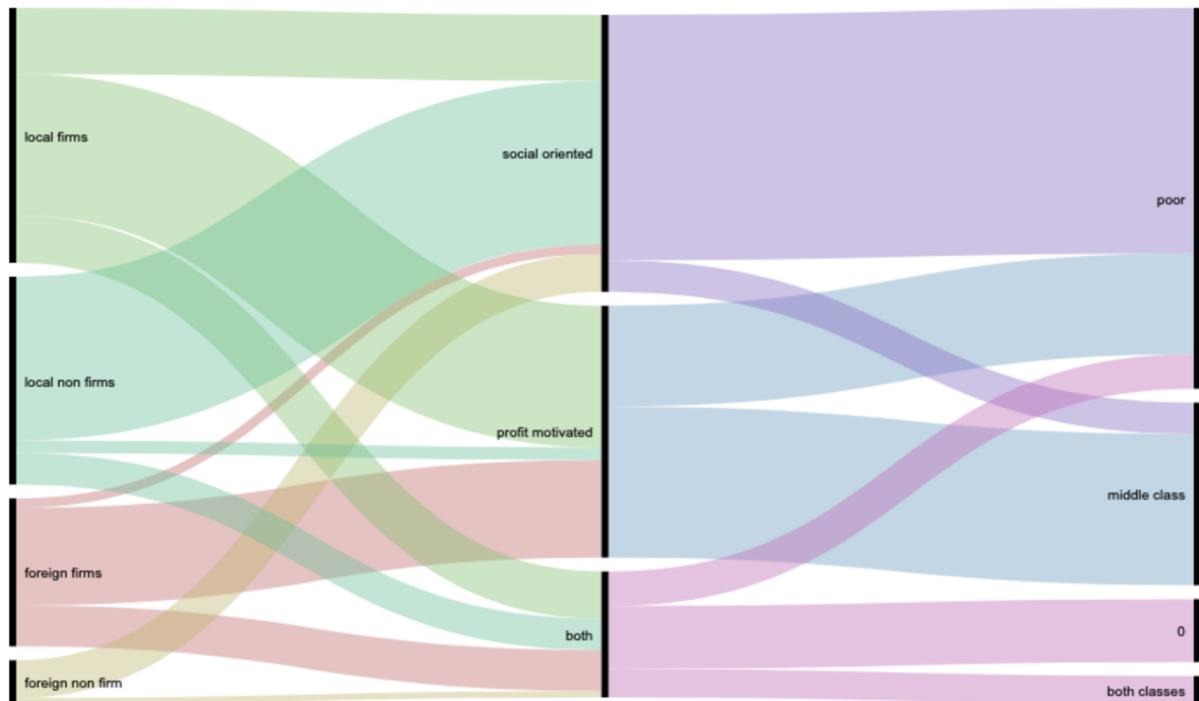


The analysis proceeds presenting an interesting relationship between the actors, the motivation that drives them and the group that they effectively target. The results are shown in table 3.8. and in the alluvial diagram (figure 3.24.). Foreign firms - MNEs and their subsidiaries – in the 66.7% of cases are profit motivated, in fact, their main group targeted is the middle class; also in the alluvial diagram it is possible to observe the red stream that goes toward profit-motivated section and then move to the emerging middle class. Local firms are driven by a profit motive in the 55.6% of cases, but they desire to address mainly poor class, but the middle one still has importance; in the alluvial diagram local firms are represented by light green and it emerges how the main stream goes to profit-motivated section and then to middle class, but there is also a relevant portion of the stream addressed to the social-oriented section and to the poor class. Foreign non-firms instead are mainly social-oriented and not at all profit-motivated (85.7%. vs. 0% of cases) and their main group targeted is the poor one; indicated by beige colour foreign non-firms' stream is directed to social-oriented section and then to poor, while little attention is given to the emerging middle class. Local non-firms, indicated by dark green, follow the same trend. Thus, thanks to this analysis it is possible to affirm that there is a certain degree of coherence between the objective that the actor pursues and the social class that is targeted.

Table 3.8. Relationship actor-motivation-group targeted

	Motivation						Group targeted					
	profit-motivated		social-oriented		both		middle class		poor		both classes	
	#	%	#	%	#	%	#	%	#	%	#	%
Foreign firms	32	66.7%	3	6.3%	13	27.1%	22	53.7%	19	46.3%	0	0%
Local firms	45	55.6%	21	25.9%	15	18.5%	23	31.1%	44	59.5%	7	9.5%
Foreign non-firms	0	0.0%	12	85.7%	2	14.3%	2	15.4%	10	76.9%	1	7.7%
Local non-firms	4	6.1%	52	78.8%	10	15.2%	12	19.7%	48	78.7%	1	1.6%

Figure 3.24. Relationship actor-motivation-group targeted



3.5. Engagement and relationships

The following section, as the title suggests, is aimed at exploring relationships and collaborations between the actors involved, and in particular between the main player and its partners. The principal actors are those identified in section 3.3., but we considered appropriate to focus the analysis on local firms, local non-firms, local MNEs and local subsidiaries of foreign MNEs; this choice has been strongly influenced by the elevate number of "not reported" cases for the minor actors, so including them would have implied obtaining non-significant results. Collaborations have been investigated according to two phases: the development phase of frugal innovation and the implementation, diffusion and adoption phase of frugal innovation,

both times the analysis has been conducted at a local and foreign level. The actors involved in the development are firms, NGOs, firms' associations, universities and research centres and communities/consumers for the local level, while for the foreign level they are institutions/universities, firms and NGOs. In the diffusion, adoption and implementation of frugal innovation instead, at a local level, there is the engagement with firms, governments, NGOs, firms' associations, universities/research centres and communities/consumers, while at the foreign level the actors identified are institution/universities, firms and NGOs.

The investigation of collaborations has been conducted following a funnel approach, starting from the general towards the more specific cases. In the sample of 250 cases, 23 times there is no collaboration at all, while 227 times at least one collaboration is reported; among these 227 cases, the 47.1% regards local collaboration, only 6.2% foreign collaboration and in 46.7% of cases we have some sort of relationship both at the local and foreign level (table 3.9.). Splitting the general overview in the two steps above mentioned, we observe that concerning the development phase in 195 cases there is at least one collaboration, while in 55 cases there is no collaboration at all; among the collaborations reported the 50.3% is at the local level, 8.2% at the foreign level and 41.5% of cases engage actors at both levels (table 3.10.). In the implementation, adoption and diffusion phase instead, the number of times in which at least one collaboration is reported is a little bit lower, in fact there are 177 positive cases and 55 negative; the first category is distributed as follow: 54.2% local, 4% foreign and 41.8% at both level.

Table 3.9. General collaboration at local/foreign level

Collaboration	cases	%
local	107	47.1%
foreign	14	6.2%
both	106	46.7%
Total	227	100%

Table 3.10. Collaboration in the development phase at local/foreign level

Collaboration	cases	%
local	98	50.3%
foreign	16	8.2%
both	81	41.5%
Total	195	100%

Table 3.11. Collaboration in adoption phase at local/foreign level

Collaboration	cases	%
local	96	54.2%
foreign	7	4.0%
both	74	41.8%
Total	177	100%

Proceeding in the analysis and with the funnel approach, the engagement between the different developers involved and other actors has been investigated, again at the local and foreign level and in the development and adoption phases. Table 3.12. collects an overview of the engagements by the different main actors. It emerges that local firms report the highest number of relationships (52 cases), while local subsidiaries of foreign MNEs the lowest one (26 cases). The actor that establish more relationship at the local level is the category of local firm, followed by local non-firm and local MNE, while subsidiary struggle a little bit in this activity, they respectively report 28, 22, 14 and 7 cases. But, on the other hand, local subsidiaries of foreign MNEs, given their international way of operating, are the ones who report the highest number of foreign relationships (15 cases). It is worthy to observe also how local non-firms perform better when they have to deal with local and foreign collaborations at the same time; this is probably due to their nature of institutions or non-profit entities.

Table 3.12. Engagement by developers at local/foreign level

Developer	local		foreign		both		Total	
	#	%	#	%	#	%	#	%
local firm	28	53.8%	6	11.5%	18	34.6%	52	100%
local non-firm	22	47.8%	0	0%	24	52.2%	46	100%
local MNE	14	46.7%	2	6.7%	14	46.7%	30	100%
local subsidiary of foreign MNE	7	26.9%	15	57.7%	4	15.4%	26	100%

Table 3.13. reports the relationship described above, but in a more detailed way; in fact, the local and foreign levels are analysed according to the development or adoption phase. It emerges that, irrespectively of the stage in which frugal innovation is, it is easier to establish partnership and collaboration at a local level than to foreign one. Again, the only actor that performs a little bit better when dealing with a foreign context is the local subsidiary of foreign MNE.

Table 3.13. Collaboration by developers at local/foreign level and development/adoption phase

Developer	Development phase		Adoption phase	
	local	foreign	local	foreign
local firm	37	17	40	10
local non-firm	43	23	44	24
local MNE	14	13	21	6
local subsidiary of foreign MNE	21	15	10	14
Total	115	68	115	54

The final level of investigation is reported in figure 3.25. and 3.26.: they represent in detail the engagement of each developer with every actor involved: firms, NGOs, firms' associations, governments, universities/research centres and communities/consumers.

Figure 3.25. regards the development phase and it emerges how the major collaborations are within firms or with communities, especially at the local level. This engagement with the local population, even if the sample is limited, appears to be very relevant; in fact, this aspect is often cited in the definitions of frugal innovation, but never supported by real data. Institution and universities are more involved at the local level than the foreign one; this aspect is quite surprising given that we would have expected a major contribution of foreign research centres and universities, because usually innovation has always been transferred from rich countries to poor ones, and as we already find out frugal innovation is developed in resource-constrained environments. On the contrary, NGOs are slightly more engaged at a foreign level.

Figure 3.25. Collaborations in the development

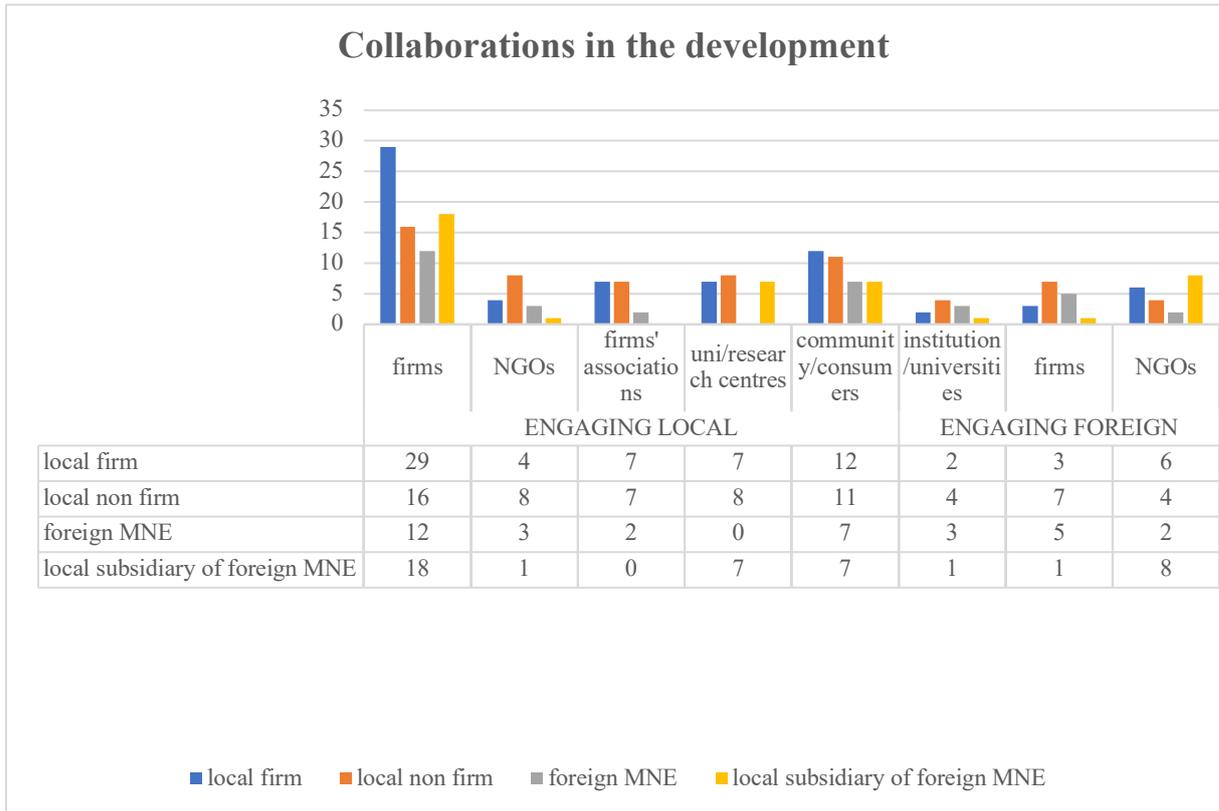
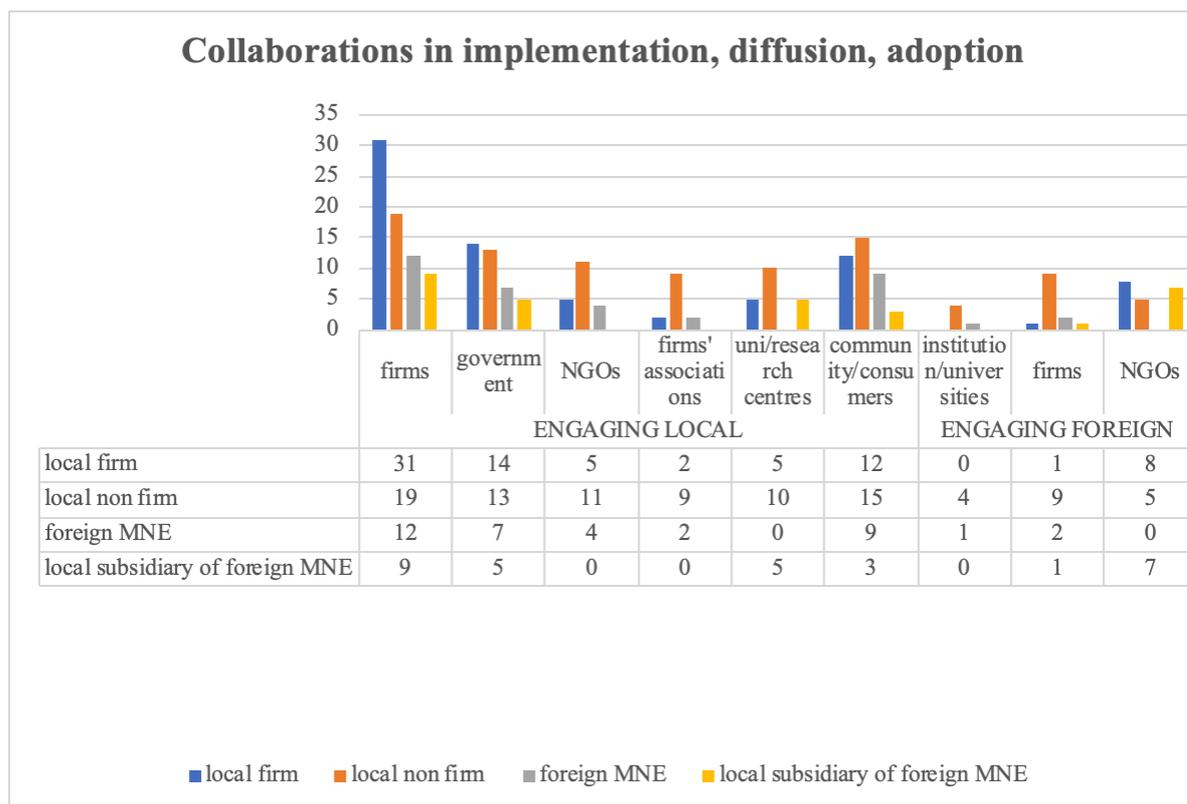


Figure 3.26., instead represent the collaborations of the developers with the other actors during the implementation, diffusion and adoption phase. It appears that the most relevant relationships are, again, within firms and with the local population, especially for local firms and not firms; this aspect regards more the local level. A significative role, not previously outlined, is played by local governments, probably interested in frugal innovation to create policies that can benefit the population. In this phase, the involvement gap between local universities/research centres and foreign ones is even more accentuated, NGOs instead, set more collaboration with respect to the development phase; the underlying explanation is that, being not profit organization, they are more interested in contributing in the improvement of people’s living condition, not in the research itself, so the logical consequence is the higher involvement in the adoption phase of frugal innovation.

Figure 3.26. Collaborations in implementation, diffusion, adoption



3.6. Outcomes

The purpose of this final section is to outline the outcomes related to frugal solutions. In order to evaluate and measure the impact of frugal innovation, three different aspects have been analysed in each case: the economic one, the environmental one and the social one. Contrary to the previous investigations, in the following analysis the “not reported” cases have been included, to understand if the findings can be considered valid or not. In exploring the outcomes, a funnel approach has been adopted, to first gain knowledge about the general situation and then about the particular aspects.

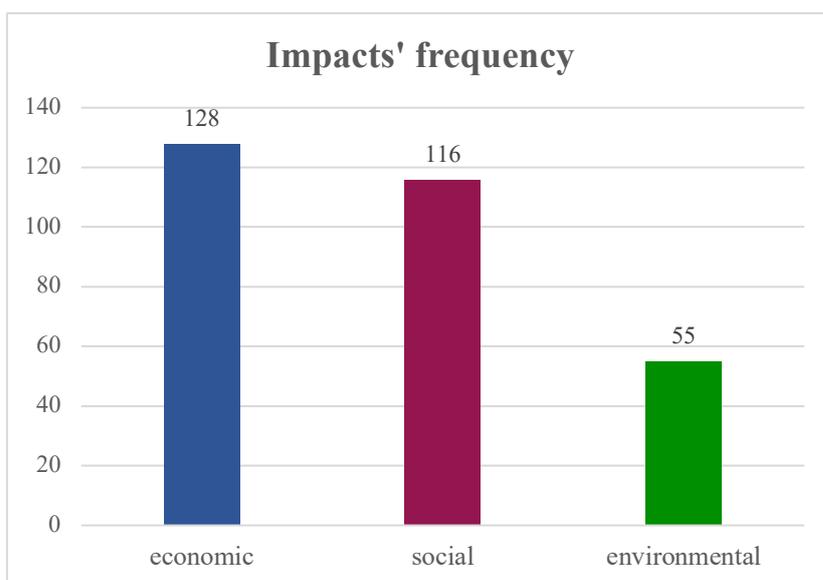
As already pointed out, the sample used to study frugal innovation consists of 250 cases, of which 170 (68%) report at least one impact, while the remaining 80 (32%) does not mention any frugal innovation's impact (table 3.14.). As it emerges in figure 3.27., they have different frequencies, but while the economic impact and the social one assume not so far values, there is a greater gap with the environmental aspect. The economic impact is the most reported, exactly 128 times, followed by social one, 116 times, and environmental, only 55 times. From these data, it emerges clearly the attention of frugal innovation towards cost-reduction, affordability, unsatisfied needs of BoP and improvement of living conditions, but it is highlighted also the impact the frugal innovation might have on our planet. Even though frugal

innovation is developed and adopted mainly in the energy sector, it is strange that the environmental aspect is not really highlighted.

Table 3.14. Type of impact reported

Impacts' report	cases	%
reported	170	68.0%
not reported	80	32.0%
Total	250	100%

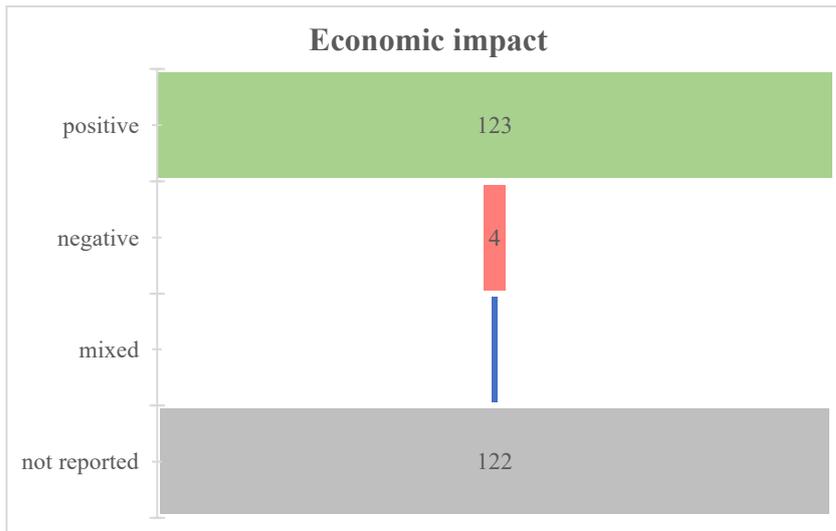
Figure 3.27. Impact's frequency



The following part of the analysis is dedicated to the exploration of the economic, environmental and social impact from an individual point of view.

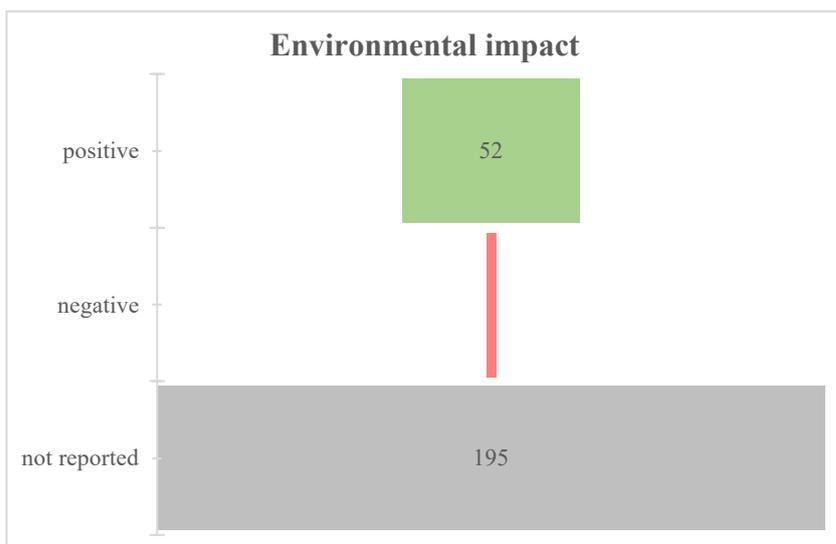
The first impact analysed is the economic one. As outlined before this is the category that accounts for most cases, because the economic impact is the easier to observe, describe and quantify; despite this, the number of "not reported" cases is high and accounts for 48.8% of the total, thus forming a valid sample of 128 observations. Among them, almost the totality, 96.1% reports a positive impact, the 3.1% a negative impact and only in one case the effect is blurred and embraces both positive and negative aspects (figure 3.28.).

Figure 3.28. Economic impact



Among the three categories identified, the environmental aspect is the one with the smallest valid sample; in fact, the "not reported" cases reach the 78% of the original total sample, allowing the analysis only on 55 observations. In 94.5% of cases, the environmental impact is positive, while only 5.5% is negative. As already noticed, it is strange to have such a quite small sample considering that frugal innovation is present in many fields related to the environment; it could be argued that there is not yet a sufficient sensibility and attention towards the phenomenon (figure 3.29.).

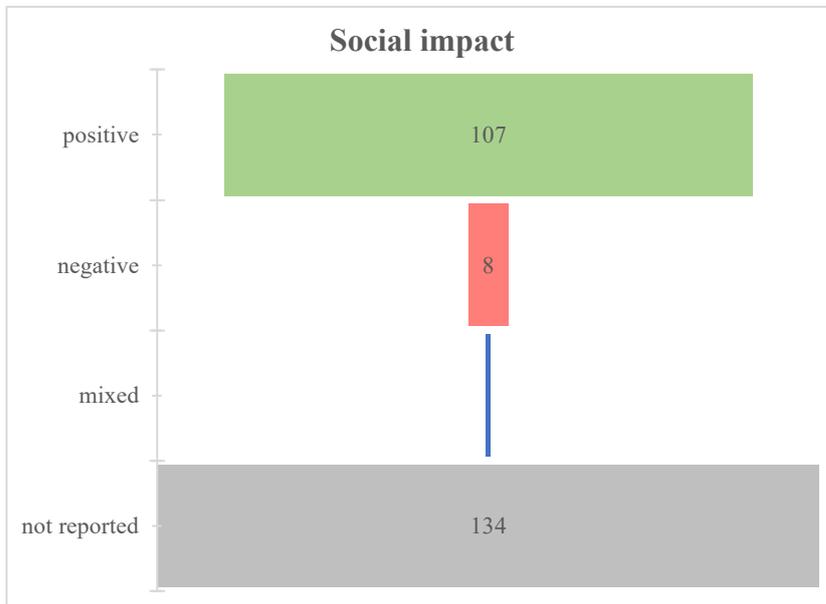
Figure 3.29. Environmental impact



The last aspect to be analysed is the social one; in this case, the "not reported" category accounts for the 53.3%, a little bit less than in the environmental case, this means that the social theme is taken into account more with respect to the environmental one. The valid sample consists of 116 observations, 92.2% refers to positive cases, 6.9% to negative ones and 0.9% to a mixed

situation. It is interesting to note, that in proportion to the sample and with respect to the other two categories, the number of cases in which the social impact of frugal innovation is negative is quite high (table 3.30.).

Figure 3.30. Social impact

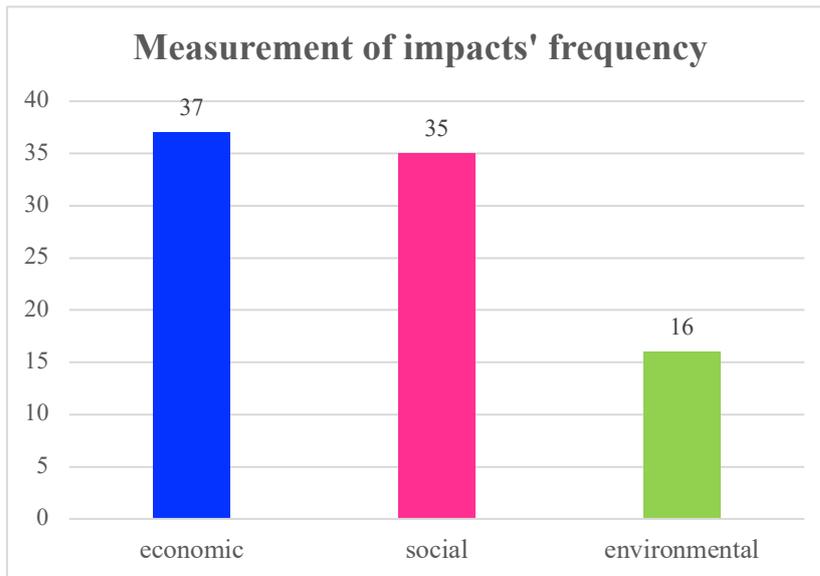


Proceeding in the analysis we have explored if the impacts mentioned have also some kind of measurement and the result is not the most satisfying one: in fact, only in 19.6% of cases at least one impact is measured and reported, while in the remaining 80.4% of cases impacts are only mentioned but not quantified (table 3.15.). The frequency of measurements is observable in the figure 3.31.: the economic effect is quantified in 37 cases, the social one in 35 and the environmental one only in 16 cases.

Table 3.15. Measurement of impacts

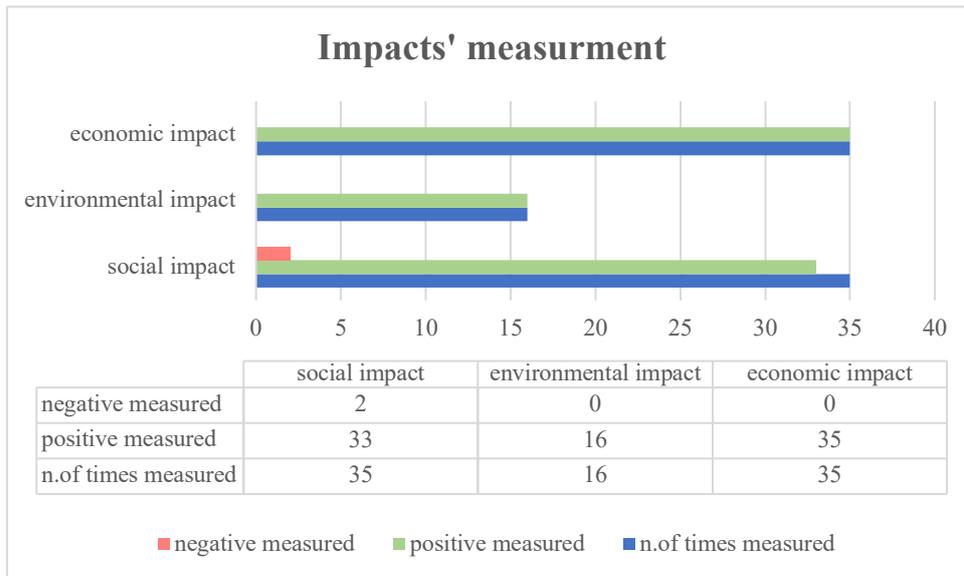
Impacts' measurement	cases	%
reported	49	19.6%
not reported	201	80.4%
Total	250	100%

Figure 3.31. Measurement of impacts' frequency



The following part of the analysis is dedicated to the exposition of results of the measurements in relation to the different types of impact (figure 3.32.). At a first sight, it emerges how the economic and the social aspect are quantified the same number of times, even if the economic impact is reported more times (see figure 3.27.); the environmental aspect instead is measured significantly in fewer cases. In particular regards with the economic perspective, we started with 128 valid observations, but we ended with only 35 measurements of the economic impact; among them, they are all positive. This means that, although it is the easiest to quantify, the economic impact is not usually measured, and this is done only if a positive effect is present; in fact, there are no measures of the negative effects. We encounter the same trend also in the environmental aspect, where among 16 valid measurements (the original sample consisted of 55 observations) they are all positive. Moving to the social perspective, the situation is slightly more equilibrated; in fact, it is possible to notice that in 35 cases the effects are quantified, but there is the measurement of both negative and positive effects, with respectively 2 and 33 cases. A general observation that emerges is the absence of a big number of measures, even if the initial sample was enough big and consistent. It could be argued that at the current time, there are not yet interests in quantifying frugal innovation.

Figure 3.32. Impacts' measurement



The final part of the section outcomes is aimed at exhibiting the relationship between developers and measurements of frugal innovation; this is done by presenting the results through figure 3.33. and through the alluvial diagram (figure 3.34.). Surprisingly, local non-firms, local institutions and local MNEs stand out among the other actor for the number of measures reported; followed by local firms and foreign MNEs, while the actor the minimum contribution in the quantification of frugal innovation is local small firm, probably due to its informal nature. In the majority of cases, the economic effect is the most evaluated, followed by the environmental and social one, except in the case of the local firm, where the social aspect is the most assessed, and foreign non-firm, that gives more importance to the environmental aspect. It is also interesting to note how the developers that give major importance to the environmental impact of frugal innovation are those present at a local level, probably interested in the consequences that it might have in their area; MNEs and their subsidiaries, both at the local and foreign level, tend to focus more on the economic measurements, since they are driven by the profit-making goal. Even though it is now clear that frugal innovation has a significative impact in our lives and in improving the living condition of the poorest ones, the social outcome is measured mainly by local firms and MNEs, while the other developers almost ignore it.

The alluvial diagram shown below represents the situation depicted above through streams: for each developer there are three streams, with different widths according to the number of cases reported, that link the actor with the section of economic, environmental or social impact measurement.

Figure 3.33. Developers' measurement

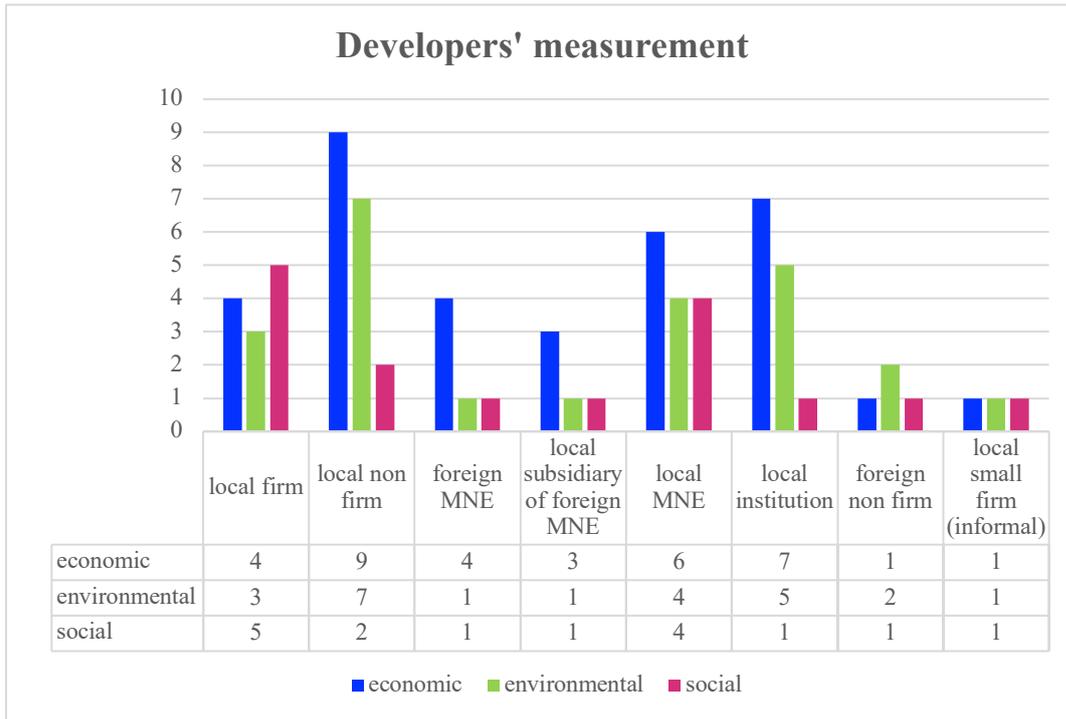
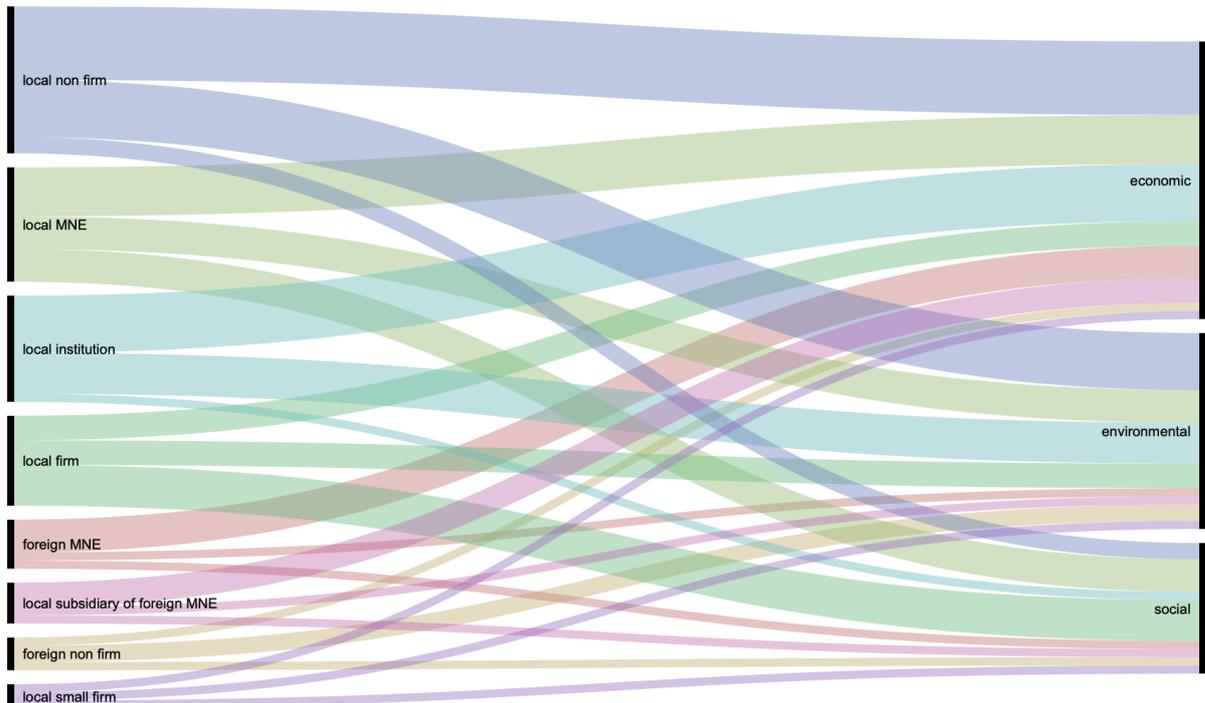


Figure 3.34. Developers' measurement (alluvial diagram)



4. GENERAL CONSIDERATIONS ON FRUGAL INNOVATION

The last chapter of this work on frugal innovation is aimed at exhibiting what has been discovered and at achieving an exhaustive comprehension of the phenomenon. The first part of the chapter explores the findings coming from the previous analysis with respect to the existent literature; the second section instead, deals with the limitations encountered during the investigation and the scenarios for possible further researches, finally, the third section provides a conclusion with some advice for our future.

4.1. Findings on frugal innovation

The analysis conducted so far had as objective the one of gaining knowledge about frugal innovation and its development. Tacking back the research questions proposed in the first chapter, we are going to display the main evidence regarding the phenomenon.

The definition of frugal innovation proposed by Agarwal, Brem et al. (2012) appears to be the most complete; they argue that frugal innovation is a potential approach to serve resource-constrained consumers in emerging and developing markets as well as the low-growth Western markets, given that it is affordable, with a good (enough) quality and a no-frills structure. From the examination done in the previous chapter, it is possible to affirm that innovation to be defined as frugal must meet the following features: affordability, functionality and simplicity and it can regard indistinctly a product, a process or a business model.

At the current time, the type of frugal innovation that is most diffused is the product one, even if also frugal business models and processes have a significative impact, not only in the literature, but also in everyday life. Probably the latter are less encountered because, differently from frugal products, business models and processes involve more risk and complexity, and to start this type of innovation a deeper knowledge and a clear strategy is necessary. It is worthy to notice that these elements are slightly in collision with the fact that frugal innovation many times is still characterized by improvisation, try and error and informality.

Being still in its initial phase, frugal solutions are mainly focused on their development rather than their adoption or implementation. In all the case studies, the three characteristics abovementioned assume the "high" value; this means that the frugal solutions developed are truly low-cost, affordable, with a strong focus on core functionalities and complexity reduction with respect to the common standard. The affordability feature, in particular, is stressed in almost every case, with a substantial cost reduction of 80% on the average. It is also deducible that, currently and mostly for the firms, the efforts are all focused on the creation of a basic

frugal product; so, intermediate solutions, still frugal, but a little bit more expensive and complex, have not been developed yet. In fact, cases with a medium degree of affordability, simplicity and high functionality are not reported in our sample. It has also emerged how affordability, simplicity and functionality are strongly correlated: in fact the creation of something simple, functional and focused on the essential features leads to a decrease of the resources, financial and not, in the production process and thus a significative reduction of the final price; from the other side, a decrease of cost combined with simple and working features brings to an optimized level of functionality. Apart from the relationship between the three characteristics, the findings just presented are often cited in the literature, so much that frugal innovation is roughly defined also as the ability to “do more with less”.

Moving to the context in which frugal innovation arises, some new and interesting aspects have emerged from the previous analysis. The phenomenon is mainly diffused in the Asian and African continents, in particular, India, China and Kenya, but also in some developed countries such as USA and United Kingdom, that are starting to show interest in this new type of innovation, probably driven by the economic crisis occurred in the last years. So, frugal innovation does not exclusively concern emerging and developing markets, as often reported in the literature. Moreover, through the analysis, it has been found out that usually frugal solutions are adopted in the same area in which they are conceived; especially for the developing markets. This means that the innovation does not come from developed market or intensive R&D efforts, but instead it arises in the local context, as it is proved by the frugal solutions presented in many case studies.

A particular condition that influences the development of frugal innovation, which poses interesting suggestions for future researches, has been discovered: the relationship between the country's income and the generation and diffusion of the phenomenon. The literature generally links frugal innovation with poor, emerging markets and the bottom of the pyramid context; this is only partially true. Through the categorization of countries where the phenomenon has been reported, according to income classes of the World Bank, it has been possible to gain insights with a certain degree of novelty. In fact, low-income countries report a few cases of frugal innovation, even less than high-income ones, while the main role belongs to those countries pertaining to the lower-middle, upper-middle income class. So, even if addressed to poor, in a context characterized by extreme poverty, frugal innovation struggles to develop and to diffuse; this implies that a certain amount of financial resources is fundamental in order to have access and to be able to develop frugal solutions.

Frugal innovation is usually associated also with resource-constrained environment and, when referring to them, rural and isolated areas mainly come into mind; in the analysis instead, it has been pointed out how the major degree of diffusion of frugal innovation occurs in rural context, even if also the urban and peri-urban ones have a significative impact. This shows how the phenomenon is not only limited to less developed places, but it is also diffused in the urban context and again, relates it with a certain purchasing power, usually higher in urban areas.

Frugal innovation has a strong social nature; originally it was born from unsatisfied needs of less developed countries, where the exigencies are basic and related to common matters. In fact, the sectors in which the phenomenon is most diffused are healthcare, agriculture and energy. Anyway, frugal innovation can be encountered also in other industries, such as finance, education and ICT, meaning that the phenomenon is gaining increasing importance and it is quickly evolving towards real applications in fields not related to primary needs. For example, the presence of frugal innovation in the education industry, in the developing markets, implies strong attention versus a social concern and a general improvement for all the society.

Proceeding in the exploration of the findings, we now move to the actors involved in the phenomenon under discussion. Differently from what is usually reported in the literature, the actors that participate in the development of frugal innovation are many, and even more, if we also consider those that have some sort of engagement with the main developer. In fact, in addition to the well-known foreign MNE, their subsidiaries and local firms, local MNEs, small informal firms, local non-firms, and local institutions have emerged as important actors in the development of frugal innovation. The phenomenon does not anymore pertain exclusively to local small actors, focalized on the resolution of context-based problems and needs; instead, it has penetrated also among big companies, both at the local and foreign levels. From that, we can deduce that frugal innovation is not any more simply related to a local context, but it has become a well-established way of innovating, spread all around the world and including many categories of actors. In supporting this view, a great contribution is given also by the motivations that push the development of frugal innovation; in fact, in the majority of cases there is still a social orientation, given the presence of many developers not interested in making money, such as institutions and small informal firms, but the cases where profit is the main driver for the main actor account for a relevant percentage; obviously MNEs and big companies, even if they can have some sort of social interests, have as the main objective profits. Thus, it is now clear how frugal innovation is a global phenomenon, not circumscribed to the resource-constrained environment; so, relating the phenomenon always with these kinds of context is not appropriate any longer. This idea is sustained also by the data on the social groups targeted; in fact, even if the main focus is on the poor class, a significant proportion of the cases is addressed

to the emerging middle class. In particular, foreign firms, especially MNEs, pose their attention almost exclusively to the middle class, being profit motivated, local firms also have interest in this group but they are driven as well by a social orientation, thus targeting the poor ones. Finally, the non-firms, both at the local and foreign level, tend to be focused only on the social aspect and they address the needs of the less privileged.

The analysis previously conducted, in order to gain a better comprehension of the environment where frugal innovation is developed, studied also the engagement between the actors. The topic was investigated both at the local and at the foreign level, in the development and adoption phases. Here, the actors involved, in addition to those already mentioned, are also universities, research centres, governments and NGOs. The results suggest that usually there is at least one kind of relationship; this means that frugal innovation is never created by a sole entity. In particular, collaborations between firms and the local communities have emerged as a central aspect of the phenomenon, especially when dealing with the local level. With respect to the existent literature, it has been highlighted the role of governments and NGOs, notably in the adoption and diffusion phase. The former in fact, is interested in shaping policies that can improve the country's economic conditions and general well-being of the population, while the latter is driven by social and humanitarian purposes. On the contrary, we would have expected a major contribution of foreign universities and research centres, both in the research process as well as in the implementation and diffusion one. This observation could be interpreted in two different ways: the traditional innovation path from rich to poor countries is not anymore, an always valid assumption, or they have not yet undertaken systematic research in the phenomenon.

The last part of the work investigated the outcomes of frugal innovation; this is a really interesting contribution to the field of research, given that usually impacts are only mentioned and there is never an attempt to quantify and measure the effects of new frugal solutions. This has been done considering three fields in which it is possible to observe an impact: the economic one, the environmental and the social one. The most cited and measured aspect is the economic, probably because it is the easiest to observe, describe and quantify, followed by the social and the environmental ones. Moreover, it has appeared that there is not a correspondence between all the times in which frugal innovation is associated with social and environmental issues, such as sustainability and life quality improvement, and its outputs' quantification. This might derive from a lack of a systematic procedure and method to detect the outputs or from a not enough yet developed interest in quantifying the phenomenon. As a general point, we have noticed how, even if starting from a significative sample, there is a limited number of measurements,

particularly for the environmental aspect. It has also been observed that outputs tend to be more reported and measured if they have a positive effect, while it seems that the negative ones are almost ignored.

Ultimately, we decided to relate the outcomes with the developers of frugal innovation and some interesting insights have emerged; local actors, including non-firms, institutions and MNEs, are the ones who report the major number of observations, while a less significant contribution is provided by foreign MNEs, and an almost null one by local small firms, probably due to their informal nature. Usually, the economic impact is the most assessed, except for local firms that give more importance to the social one, and foreign non-firms that highlight more the environmental one. It is also worthy to note how local actors have a major commitment toward their surrounding environment, being the most interested into the effects, and so measures, that frugal innovation could have in their area. Instead, MNEs and their subsidiaries, not surprisingly stand out for the measurement of the economic effects, connected mainly with the profit-making purpose. Thus, we can argue that, in scholars' studies, the outcome aspect is the less considered one and still more efforts need to be done.

To conclude, we consider proper to affirm that our findings offer some interesting consideration on frugal innovation with respect to the existent literature. We agree on the main features of this type of innovation, which essentially is functional, simple and affordable, but we also pointed out how in the future there could be an upgrading of the solutions. Frugal innovation can not be seen any longer as a phenomenon regarding only emerging countries and addressed to people at the bottom of pyramid. It has clearly emerged how it is a global phenomenon that involves, especially in the development phase, also the most developed countries and nowadays some frugal solutions are spread around the world. In contrast with the literature, it has been observed that the poor class is not the only one targeted; in fact, the emerging middle one also has a significant impact and we can hypothesize that it will gain more importance in the next decades. Moreover, in the analysis, it has been explained the relationship between the class of income and the development of frugal innovation and it came out that it tends to be more present in those situations where there is, even if minimum, a certain purchasing power. In the literature review, the phenomenon is often connected with an improvisational approach and informal situations; this aspect might be still valid in some cases, but the presence of many formal developers, in particular, MNEs, suggests that the ideation and creation process of frugal innovations is supported by clear and pre-defined strategies and systematic methods. Ultimately it is clear the frugal innovation, driven by both economic and social purposes, can have a great

positive impact on our society and our planet, thus the improvement of people's life quality and through the reduction of the resources used.

4.2. Limitations and further research

The analysis conducted so far has raised many interesting aspects, but it has also some limitations, that we are going to explore in this section.

The main limitation is related to the improvisational and informal nature that sometimes frugal innovation assumes and to the rural context in which is developed; for these reasons, in fact, many times it is not possible to obtain data and information, or the innovative solutions and processes are not even reported and so they are not suited to be studied.

Undoubtedly, the most evident limit lies in the number of valid observations in the report and measurement of frugal innovation's outcomes; as already hypothesized, this might derive from the lack of methodical procedures and assessment standards of the effects. However, it is possible to observe that some efforts towards the quantification of the impacts are already being performed, especially by formal companies. The shortage of quantitative data with respect to this aspect limits slightly the results, because, in this way, the impacts that frugal innovation has on our society and our planet can only be assumed from empirical evidence reported in the case studies, but a larger sample would be ideal. Thus, frugal innovation does have an impact, that in the majority of cases is positive, but there is not yet a theoretical basis that enforces the evidence presented in the case studies and in the literature analysed.

It is possible to identify the same limit also in relation to the engagement and relationship perspective, where the amount of variables with the value "not reported" is also high. This might be traced back to the reasons outlined at the beginning of this section. In fact, especially with regards to community and consumer engagement, it is clear that they have a significant role in the development of frugal innovation, but the missing of data probably leads to an underestimation of their importance.

Another limitation encountered derives from the existent literature on frugal innovation; in fact, as already highlighted, the phenomenon has always been related to emerging markets. The direct implication is the fact that, in this way, the phenomenon has always been studied and contextualized in those kinds of environments, but it is not limited to these areas. So, the results of the previous analysis are mainly based on cases coming from developing countries, but there might slightly differ if also developed countries are taken into account; probably there are other cases of frugal innovation in high-income countries, that have not been explored yet and so taken into account by researchers and scholars.

Lastly, it is possible to identify some other limitations that influence the final work, even if they are of less relevance. We have good reasons to argue that frugal innovation is still in its primary phase of the study because a theoretical framework is missing as well as a commonly accepted definition. Moreover, in the literature reviewed, sometimes, concepts were not clear and exposed in a contrasting way depending on the author. For example, many times frugal innovation has been defined as *jugaad* or grassroots, but as we studied in the first chapter, even if with some common features, they are distinct notions. This implies that the papers that report the phenomenon in a theoretical, objective, clear and exhaustive manner are a few and they tend to often refer each other, proposing the same visions and definitions. Many papers deal with the phenomenon, but they are mainly case studies that reach conclusions only related to the specific context, or theoretical papers that study the phenomenon with other issues, focusing more on the last ones rather than on frugal innovation.

The limitations exhibited above are useful in providing interesting suggestions for future research on frugal innovation. Certainly the research should proceed in order to gain a better and deeper comprehension of the phenomenon. The literature should be reviewed and the topic, according to what has emerged, should be reconsidered from a global point of view. Also, the constellation of notions around frugal innovation needs to be reviewed and updated with the aim to clarify the theoretical framework, achieve a commonly accepted idea of the different types of innovation and eliminate the current inaccuracies and contradictions.

In particular, it would be interesting to further explore the relationship between the development of frugal innovation and the income class of the relative country and the reasons that preclude its diffusion in very low-income contexts.

Another aspect that could be further investigated regards the engagement and collaborations between the actors involved; as it has already emerged, these kinds of relationships appear to be fundamental in the development and diffusion of frugal solutions, but due to the lack of data it is difficult to understand the real impact and the underlying dynamic; for the same reason it is also problematic to discover and introduce new aspects that could bring improvements.

A useful and appropriate future research should also focus in creating and establishing some key performance indicator and some basic standards in order to facilitate the impacts' measurement process, only through these it will be gained a strong knowledge about the effects that frugal innovation has.

Furthermore, a new research project should be undertaken in order to detect novel and hidden cases of frugal innovation; especially in the developed countries a deep investigative work has to be conducted, because there might be many situations in which innovation is not classified,

and thus not examined, as frugal even if it possesses all the fundamental characteristics. This could be viewed as the starting point for a new stream of studies on frugal innovation that might achieve an exhaustive comprehension of the phenomenon and a common accepted definition. To conclude, although the limitations presented, the analysis on the topic has raised some interesting questions, in particular with respect to the theoretical background, the diffusion context and the future developments. Future research is fundamental, and we have all the reasons to believe that frugal innovation could have a great impact on our lives and on our planet.

4.3. Conclusion

As explained by the title itself "Frugal innovation and development: what do we know?", the aim of the work was to explore this novel phenomenon, trying to understand in what it consists and the context in which it is usually developed.

The topic was first studied from a theoretical point of view, presenting the current state of the art, the most relevant definitions, concepts and examples, and some interesting gaps of research, the ones that guide us in all the work, have been identified. We then move to a systematic review of the existing literature and more than two hundred cases on frugal innovation have been analysed according to some variables, trying to find an answer for the proposed research questions. Subsequently, the results have been elaborated and presented, providing some interesting contributions and insights for future research.

In the first part of the elaborate, many definitions have been presented and we noticed how the concept of frugality varies according to the scholars: some consider it as a mindset, an approach, other as a new product or a process and still others as an ability. At this point, it is possible to affirm that the topic under discussion being frugal innovation, is at the same time a product, a process and a business model. Of course, frugal approaches might exist, but they do not own all the necessary features to be classified in this category of innovations. Speaking of frugal innovation's characteristics, we consider the definition of Tiwari and Herstatt (2014) and the one of Agarwal, Brem et al. (2012) the most appropriate; in fact the former refers to frugal innovation as a new or significantly improved product, process or marketing and organizational methods, while the latter focuses the aspects of affordability, good enough quality and no-frills structure. These aspects are the same outlined in the findings, where we state that innovation to be defined as frugal has to be affordable, functional and simple.

Moving to the context, it is possible to affirm that frugal innovation is, for some aspects, driven by resource-constrained environments but nowadays it is a global phenomenon, diffused in really poor countries as well as in the high-income ones. The high number of different types of

actors involved, from MNEs to small informal firms, passing through universities, consumers and NGOs, is the proof of its increasing diffusion and importance. At the present time, this type of innovation is more focused on social aspects, being mainly aimed at satisfying the needs of people in the emerging markets. Nevertheless, the economic aspect has every day more significance and probably it is the driver of frugal innovation's adoption in developed countries; in fact the topic under discussion can create new businesses and opportunities and minimize the use of resources, while maintaining good quality and functionalities, thanks to this aspects frugal innovation can be seen as the solution to the low-growth of Western markets.

Frugal innovation is not just a new type of innovation, it revolutionizes how innovation is currently done. The knowledge flow, in fact, has always been from developed markets to emerging ones, and this has been the cause of some great inequalities between countries. Now the situation is different, the innovation process is changing, through deeply and significative alterations and this could open possibilities for completely different scenarios in the future.

The phenomenon is still unknown by the majority of people, but everyone should gain awareness of it. As we already pointed out, frugal innovation has a positive impact from a social, economic and environmental perspective. The last mentioned aspect, in particular, has a strong ethic implication; in fact, we have to take care more of our environment and planet, the current practices and processes are no longer sustainable, and a new way of innovating that is characterized by a low use of resources and positive green impacts is probably what we need. As Bouckaert et al. (2008) state, "frugality is a global good, a necessary condition for global sustainability and intergenerational justice". Moreover, frugal innovation, through its social attention, has already brought benefits to millions of people and has improved living conditions in many areas, and we have reasons to believe that this aspect will be even greater in the future. Hoping that the environmental and social aspects could proceed in improving our life's quality and in helping to preserve our planet, we consider appropriate to conclude that frugal innovation is the future, it is the obligated way to achieve progress of our society without destroying our planet, while taking into account also the one who live in underdeveloped contexts.

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