



# **Implementation of Frugal Innovation Projects**

An overall strategy for a sustainable success

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**Industrial Engineering and Management**

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## Abstract

There are severe disparities in the level of development in countries worldwide and the Least Developed Countries struggle to assure the sustainable evolution of most of their critical areas and to implement business projects that could create a significant impact.

Implementing Frugal Innovation Projects that satisfy needs, create value and use fewer resources while addressing sustainability helps mitigate this problem. This dissertation examines the extent to which it is possible and sustainable to implement these projects.

The dissertation starts by contextualising the current situation of Least Developed Countries, more specifically, of São Tomé and Príncipe, before characterising the research problem to be studied. A review of the state-of-the-art literature is then conducted, notably with regards the relevant areas of project implementation. An Action Research focused on the implementation of a Frugal Innovation Project (Valúdo) in a Least Developed Country (São Tomé and Príncipe) is then developed, answering positively to the research question. Finally, a framework for the Sustainable Implementation of Frugal Innovation Projects is proposed based on the conclusions of the action evaluation.

**Key words:** Least Developed Countries, Frugal Innovation Projects, Sustainability, Supply Chain Management, Logistics, Action Research

## Resumo

Existem graves disparidades no nível de desenvolvimento dos países do mundo inteiro e os Países Menos Desenvolvidos lutam para garantir a evolução sustentável da maioria de suas áreas críticas e implementar projetos de negócios que possam criar um impacto significativo.

A Implementação de projetos de inovação frugal que atendam às necessidades, criem valor e usem menos recursos enquanto abordam a sustentabilidade, podem ajudar a mitigar esse problema. Esta dissertação examina até que ponto é possível e sustentável implementar esses projetos.

A presente dissertação começa com a contextualização da situação atual dos Países Menos Desenvolvidos, mais especificamente, de São Tomé e Príncipe, antes de caracterizar o problema de pesquisa a ser estudado. Uma revisão da literatura de ponta é então conduzida, principalmente em relação às áreas relevantes da implementação do projeto. Uma Pesquisa-Ação focada na implementação de um Projeto de Inovação Frugal (Valúdo) em um País Menos Desenvolvido (São Tomé e Príncipe) é então desenvolvida, respondendo positivamente à questão da pesquisa. Por fim, é proposto um *framework* para a implementação sustentável de projetos de inovação frugal, com base nas conclusões da avaliação da ação.

**Palavras-Chave:** Países Menos Desenvolvidos, Projetos de Inovação Frugal, Sustentabilidade, Gestão da Cadeia de Abastecimento, Logística, Pesquisa-Ação.

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## List of Acronyms

LDC – Least Developed Country

LDCs - Least Developed Countries

FI – Frugal Innovation

FIP – Frugal Innovation Project

FIPs – Frugal Innovation Projects

STP – São Tomé and Príncipe

BoP – Base/Bottom of the Pyramid

ToP – Top of the Pyramid

EM – Emerging Markets

DM – Developed Markets

SC – Supply Chain

SSCM – Sustainable Supply Chain Management

GSCM – Green Supply Chain Management

CLSC – Closed-loop Supply Chain

SL – Sustainable Logistics

GL – Green Logistics

RL – Reverse Logistics

DfL – Design for Logistics

DfBoP – Design for the BoP

DfS – Design for Sustainability

AR – Action Research

KE – Key Elements

KAE – Key Action Elements

FE – Functional Elements

# Chapter 1 - Introduction

## 1.1 Problem Contextualisation

The differences in development between the different countries of the world reveal not only a disequilibrium in meeting the population's needs, but also in the opportunities presented to those born in each reality. Despite the lack of consensus on the reasons behind these progress asymmetries, most of the underdeveloped countries are pressing for solutions.

In the era of sustainability and equality, “what is needed is a better approach to help the poor, an approach that involves partnering with them to innovate and achieve sustainable win–win scenarios where the poor are actively engaged and, at the same time, the companies providing products and services to them are profitable” (C. Prahalad, 2006, p.3).

Frugal Innovation aims to “create significantly more business and social value while minimising the use of diminishing resources such as energy, capital and time” (Radjou & Prabhu, 2015, p.22). As such, it proposes to develop simple solutions, focused on the basic functionalities of products and services, that are easy to use and acquire, at a low price.

As yet, very little is known about Frugal Innovation and the current knowledge is purely theoretical. Having a clear understanding of the best strategy for success can be a major challenge, since missing one step generally entails the failure of the project. Structuring a Frugal Innovation Project (FIP) in an Least Developed Country (LDC) is normally associated with complexity, inefficiency and high costs.

There are currently no practical tools to help frugal innovators efficiently structure a plan for their projects' sustainable implementation, and there is therefore an opportunity to help solve this issue. This is the motivation for the present dissertation.

## 1.2 Objectives

The main objective of the present dissertation is to conduct an assessment on how to successfully implement sustainable Frugal Innovation Projects in LDC. The intermediate objectives are:

1. Contextualization of countries' development, and specifically of São Tomé and Príncipe as an LDC;
2. Understand the state of the art regarding the major aspects under consideration: Frugal Innovation; Supply Chain Management, Logistics and Sustainability; and analysing the actual circumstances in which a project is to be developed,
3. Effectively Implementing a FIP in a Least Developed Country and understand success and failure factors using a specific research methodology;
4. Deriving conclusions and future work possibilities.

### 1.3 Methodology

The methodology to be followed throughout this dissertation is shown in Figure 1.

The first step is to contextualise and characterise country's development and LDCs.

The second step involves an extensive literature review to structure and understand the extant knowledge by characterising the state of the art on FI, Supply Chain Management, Logistics and Sustainability.

The third step is to apply Action Research into the implementation of a specific Frugal Innovation Project.

The fourth step is to develop and structure a framework with a view to combining the knowledge acquired with the project implementation and correlating the learning data.

The fifth and final step is to reflect on the conclusions of the thesis and present future avenues of research.

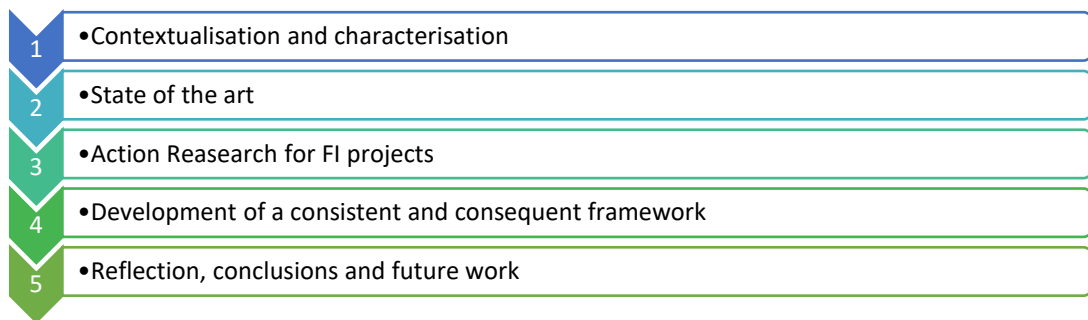


Figure 1 – Thesis methodology.

### 1.4 Structure of the Dissertation

This thesis is divided into seven chapters.

This first chapter is an introductory description of the present work.

The second chapter is a contextualization of the LDC and the environment in which the project implementation takes place.

The third chapter provides the state of the art on Frugal Innovation, Sustainability, Supply Chain Management and Logistics. This section helps structuring the existent knowledge and understanding it.

The fourth chapter presents the methodology to be followed.

In the fifth chapter, the implementation of a FIP is described.

The sixth chapter describes the development and proposal of a framework for FIP implementation.

The seventh chapter presents the master thesis' conclusions as well as future work possibility.

## Chapter 2 - Contextualisation

The following chapter aims to contextualise the current situation and characterise the problem in/for which this master thesis is developed. Section 2.1 start by presenting some key points regarding countries' development, notably that of least developed countries. Section 2.2 introduces the country in which the entire research for this thesis is conducted: São Tomé and Príncipe, and describes its characteristics, background, history and current situation. This leads to the characterisation of the problem to be solved and the FI project to be implemented, which are set out in Section 2.3. Section 2.4 presents the chapter conclusions.

### 2.1 Countries' Development

The World Bank distinguishes countries by their Gross National Income per Capita, a classification that is reviewed each year (World Bank, 2019).The categories are distributed as:

- Low income countries: US\$995/year or less.
- Lower middle-income countries: US\$996/year to \$3,895/year.
- Upper middle-income countries: US\$3,895/year to US\$12,055/year.
- High income countries: US\$12,056/year and above

The IMF classification uses a multi economic factor, which depends on the per capita income level, the export diversification, and the degree of integration into the global financial system. The countries are categorised as advanced, emerging, or developing. (International Monetary Fund, 2019)

The United Nations (UN) adopts a more comprehensive development classification. The countries are classified as developed, developing and least developed. This global institution understands that a country's development is linked to both economic factors and also social and geographical aspects. As such, the Human Assets Index (HAI) and the Economic Vulnerability Index (EVI) were developed. These indexes, shown in Figure 2, (described in UN's Committee for Development Policy, (2018b)) and the Gross National Income (GNI) allow the development of all countries to be evaluated.

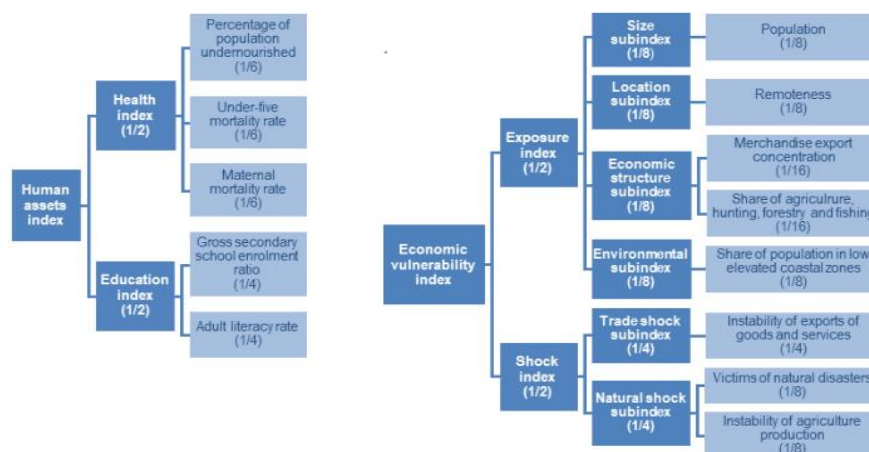


Figure 2 - Composition of the HAI and EVI Index. Source: (UN's Committee for Development Policy, 2018b)

The distribution of development across all countries is displayed in Figure 3. As can be seen, although most of the nations are in developing or developed stages, the most problems are found in Africa which has a large portion of the world's least developed countries (shown in red).

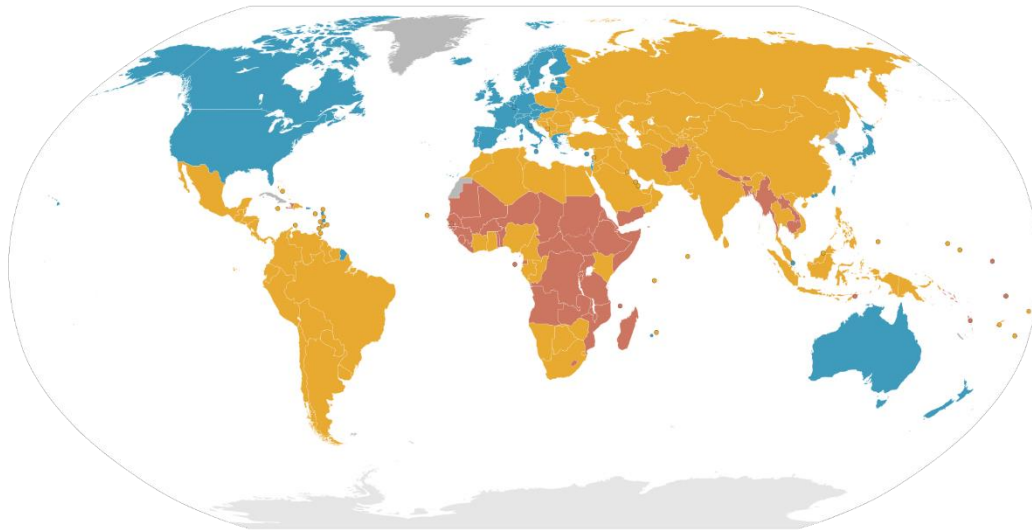


Figure 3 - Map of Development Distribution. Source: UN and IMF.

### 2.1.2 Least Developed Countries

According to the UN, Least Developed Countries (LDCs) are those with the lowest income level and where, due to structural constraints, it is difficult to pursue sustainable development.

The distribution of the LDCs around the world is shown in Figure 4. Statistically, “LDCs comprise approximately 13 per cent of the world’s population, but account for less than 1.3 per cent of world gross domestic product (GDP) and for approximately 0.9 per cent of world trade”. (UN’s Committee for Development Policy, 2018a)



Figure 4 - Distribution of the LDCs. Source: (UN's Committee for Development Policy, 2018a)

## 2.2 São Tomé and Príncipe

While Portugal has had a historical link with São Tomé and Príncipe (STP), it is almost completely unknown in most other countries in the world.

Before the Portuguese revolution of 25 April 1974, STP was a Portuguese colony where agriculture prospered. Despite being a small country, it was one of the world's biggest producers of high-quality cocoa and coffee. It was divided in large farms (called roças) and smaller farms connected to the roças. All farms were connected by railways, and the roças had their own ports to transport the agricultural products to the main city of São Tomé (considered the cleanest city African in several years), where it was exported to Portugal. Each roça had a functional hospital and school. The farms were managed by the Portuguese and it is known that farm work was difficult, intense and had been done by slaves until the abolition of slavery.

STP had all the resources to continue prospering after becoming an independent country, but as in other ex-Portuguese colonies, the independence process failed. Over the next 44 years, São Tomé lost most of its economic resources as well as its infrastructures, depending now on external aid to maintain its poor economy. STP had been abandoned without any idea of how to govern itself.

São Tomé and Príncipe was classified as an LDC, in 1982. Only 36 years later (in 2018) the UN's Committee for Development Policy started the process for graduate STP to the level of Developing Country. STP's development indexes were as shown in Figure 5. The decision on this graduation, in 2019, was not to graduate STP until 2024, because despite fulfilling two of the three required criteria, the EVI index showed STP was not economically stable for the UN to stop providing help in critical health and education sectors.

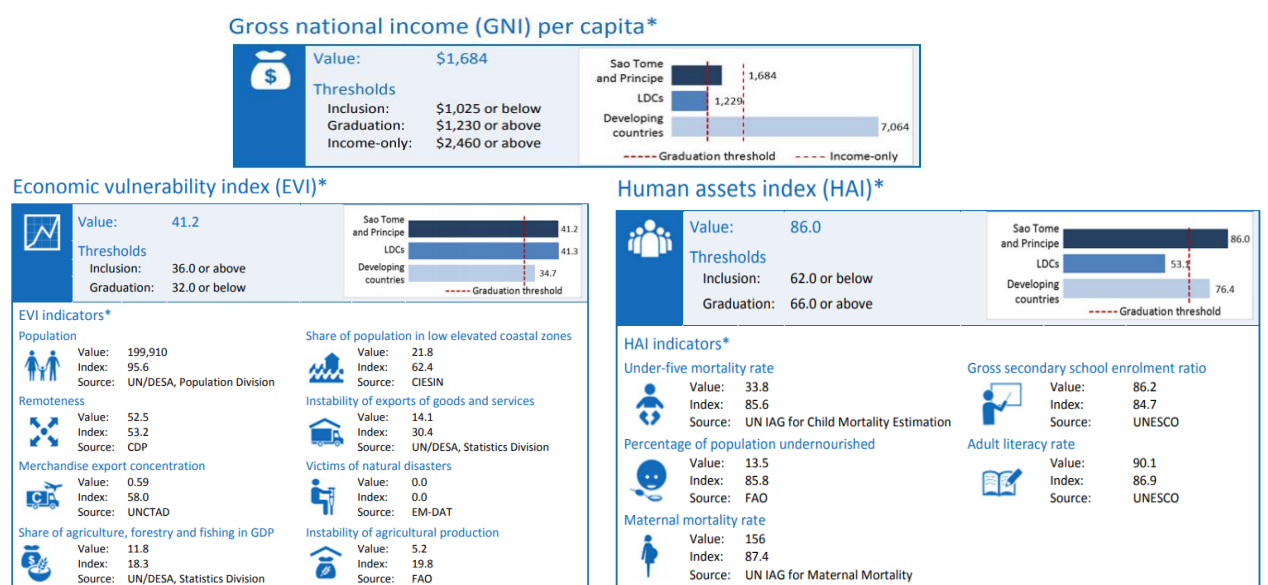


Figure 5 - STP's Development Indexes. Source: UN's Committee for Development Policy (2018b)

It is often said in Portugal that STP is a small paradise on earth, but it is perhaps more correct to use the past tense. Nowadays, a great effort is being made to recover STP's agriculture and to stimulate its touristic potential, but the structural, political, governmental and social problems remain a challenge.

São Tomé and Príncipe has a small economy, based mainly on agricultural production that has become increasingly dependent on the export of cocoa beans, since independence in 1975. "STP depends heavily on imports of food, fuel, most manufactured and consumer goods, and changes in commodity prices affect the country's inflation rate. Maintaining control of inflation, fiscal discipline, and increasing flows of foreign direct investment into the nascent oil sector are major economic problems facing the country. In recent years, the government has attempted to reduce price controls and subsidies."(Central Intelligence Agency, 2019)

### 2.2.1 Actual Situation in São Tomé and Príncipe

The state of play in STP described below was obtained by living on the island, experiencing its problems, connecting with locals to understand their circumstances and current situation, and by talking with more informed people in influential positions. These are some of its difficulties:

- **Energy**

STP's energy comes from burning fuel. There are several generator units distributed around the island, but most of them are situated near the capital. It is normal for communities further from the capital to have no access to a public energy supply. Failures in the fuel supply fails, even in the capital, lead to periods of 24/24 hours without any energy. Most companies in STP have their own power generators, as do some houses where the wealthiest and upper middle-class families, and expatriates live.

- **Water**

Despite almost 9 months of rain a year and many water springs in STP, this water is not used to create a sustainable treated water supply system for the communities. Many diseases such as typhoid fever and other bacterial infections are spread through the water, because of piping contamination and lack of quality control. The public water supply company is also responsible for the public energy supply, and it is incapable of dealing with the demand. As with energy, some people have the means to install water pumps that will supply them with potable water; otherwise, people can go up to 24 hours without water. There are community water fountains where locals go to fill every available bottle or tank for daily use and supplies. This task is usually done by the children.

- **Food**

There is a common saying that the people of STP will never starve to death because food falls from the sky. It is a tropical country and fruit trees are abundant, since the Portuguese brought many of them from other tropical countries like Brazil. Many different types of bananas are found and are given different uses. All of the typical dishes use fish, leaves and spice. A regular meal for a local is fish with fried banana. Beans are also part of the menu. The local markets supply typical tropical fruits and vegetables. Those with land create their



own plantations and breed animals. But instead of using mainly local sources of nutrients, nowadays imported rice and pasta, vegetable oils and processed baby food are increasingly used. Eggs and pork are two examples of products that are forbidden imports because of disease control. There is a local beer company providing the locals with their favourite drink, and imported soft drinks are popular. With the increase in tourism, the children now eat many candies and sugary products, which makes them happy but increases their health and teeth problems. Most people struggle to have food every day due to the family limited budget, but children are a priority. Even though people look healthy, many of them only have one meal a day and they are often malnourished because of the lack of diversity in their diet.

- **Health**

In the past, each roça had a hospital, divided in different medical specialties but there is now just one hospital and a few health centres for the entire country, despite the rising population. There are not enough qualified doctors to meet demand. Hospital supplies are constantly failing. The most complicated cases are sent to Portugal, as part of a medical alliance. Many NGOs fly specialised doctors into STP for short periods to assist people who wait months for them. Every expatriate knows not to go to the public hospital but to choose one of the few private clinics to avoid complicating any condition. On the other hand, diseases like malaria can now be treated with the aid of better disposable tests and remedies. With the help of Taiwan, STP was able to almost eradicate Malaria. Public health is endangered by the number of stray dogs that spread diseases. Rats and cockroaches are another daily menace.

- **Education**

With the rapid increase in population, the number of children attending school keeps rising. Each class already has around 70 children, but the schools' infrastructures are still just prepared for around 25. Some schools still use the same desks and chairs as in colonial times. Students that fail some years (due to lack of support or because they need to work to help provide for their family) are forgotten and never go back to complete the regular school programme. In some cases, when teenage girls get pregnant, they are left to their own devices to serve as an example for others. Nevertheless, many young people complete school and some manage to go to university or to Portugal to obtain a professional qualification as part of an alliance between the two countries.

- **Agriculture**

After independence, most of the farms were nationalised and the land given in equal parcels to the families living there. While this gave families a means of living, the opportunity for large scale production was lost. A few companies were able to negotiate agreements with the government for the agriculture exploration of a few former farmlands. A current example of this is the palm tree plantation of around 4000 hectares that is connected to a foreign private investment for organic palm oil exploration and production. Other companies work with cocoa, coffee and coconut, buying the local producers' products.

- **Infrastructures**

After independence, the rail roads were dismantled, and the iron used for electricity and light

poles. There are 3 main roads, connecting the capital to the north, centre and south of the island. The connection between São Tomé and Príncipe is made by plane or boat. The country's roads are all in need of immediate repair and maintenance. Agreements made with the Chinese government (trading fish for construction) have enabled a few improvements to be made. Hospitals, health centres, schools and public service buildings require modernisation and improvements. There are no public transportation services, but locals driving their own yellow old cars and Toyota HiAce's (typically called "hiaces") that fit 20 people into a 9-seat space serve as public transport. There is one international airport in the capital of São Tomé and a national airport in Príncipe. Flights connect São Tomé with Angola, Portugal, Ghana, Cape Verde and Gabon. These connections are not daily and only a few allow exports via air cargo.

- **Fuel**

Natural gas, diesel, petrol and kerosene are imported from Angola. Kerosene is the main cooking energy source in the houses of local families. All motorbikes use petrol as fuel and all power generators use diesel. STP is almost 100% dependent on fossil fuels. STP has not kept their business agreement with Angola (failures and delays in payment) and as Angola is also struggling to meet their own fuel needs, less fuel is arriving in STP, leading to entire weeks without kerosene or diesel. STP is now starting to turn its eye to the exploration of their own oil wells. Some fuel companies have been prospecting the areas and there is a possibility of future production. It can be questioned whether this is the best strategy for STP or, given its characteristics and size, whether it would be preferable to explore renewable energy sources and become self-sustainable.

- **Employment**

Unemployment will inevitably increase given that families have around 5 children each and teenage pregnancy is on the rise. There is much informal employment that makes it difficult to structure a good social security service that could provide employees with stability. Public institutions are the biggest employer.

- **Investment**

Most of the companies and projects acting in STP come from private foreign investment. Most have the state as participant. This has been the *modus operandi* for many years.

- **Import/Export**

STP is considered to be a logistics nightmare. Air cargo has been cancelled, leaving just sea cargo as an option. Ship owners and shipping agencies working in STP face a major problem with the international seaport safety working conditions. Export cargo vessels only allow the export of full containers, leaving no space for small companies to combine their cargo and downsize costs; there is no clear exportation schedule which means exporters are often unable to meet product deliveries. STP is heavily dependent on importation to satisfy the needs for food, medical supplies, construction materials, mechanic tools, and almost all daily goods that are just an internet click away in the developed countries.

- **Waste/Pollution**

It is said that 40 years ago STP was a clean country, but now it is the exact opposite. Like almost every underdeveloped country, STP does not have systems to deal with all the waste created in the country or, more importantly, with all the waste that is brought to the country. Every item imported brings a tremendous amount of different forms of plastic. Industrial food wrapping plastic, plastic and glass bottles, cans and all other recyclable items that can be reutilised in developed countries, just lie in the streets of STP. The people are not aware of the problem and garbage is thrown in the street or burned. STP produces a lot of residues but not enough for waste companies to arrange for its exportation. The waste also gives rise to pollution in the sea and beaches and in the air. Air pollution is linked to the burning of garbage, and with vehicles without emissions control. Although some initiatives and NGOs are focused on this matter, a solution is still a long way off.

- **Tourism**

The current goal is to increase the affluence of tourists visiting STP. The Principe island is on its way to becoming self-sustainable following heavy investment from a foreign entrepreneur. The luxury rehabilitation of old farmhouses and building of new luxury resorts has allowed the island to create more value. Simultaneously, measures fostering sustainability are being implemented: reducing waste, building houses for the locals, producing their own renewable energy and creating little agriculture projects. Bringing tourism to the islands can help create other related businesses as well as stimulate the locals to pay more attention to the way they are treating their own paradise country.

- **UN/NGOs**

Many NGOs work in several areas in STP. Even the UN has a tremendous presence in the islands, working towards better education, health and economic development.

- **Population**

The future population growth of Sao Tome and Principe is assured by its youthful age structure – more than 60% of the population is under the age of 25 (Figure 6). “Although Sao Tome has a net negative international migration rate, emigration is not a sufficient safety valve to reduce already high levels of unemployment and poverty.” (Central Intelligence Agency, 2019)

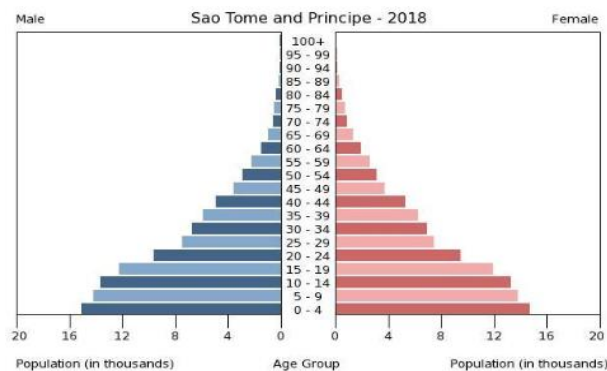


Figure 6 - Age Distribution in STP. Source: (Central Intelligence Agency, 2019)

### 2.3 Problem Characterisation

Creating value for the economy of a country, especially if an LDC, may be considered as a successful strategy for increasing the country's development. Implementing a Frugal Innovation Project in the most sustainable way possible can be rewarding for all stakeholders. However, the implementation of business projects can be difficult due to all the constraints existent in this type of markets. When discussing the importance of creating value through business implementation, the following research question arise:

- Is it possible to sustainably implement Frugal Innovation Projects in LDCs?

The development of a master thesis answering this research question requires a state of the art on the relevant business innovation areas and the application of an adequate methodology. A FIP will be implemented in STP, an interpretation of the result of the implementation and its extrapolation towards a useful tool will be suggested.

### 2.4 Chapter Conclusion

The world's disparities regarding countries' development are severe, with the African continent being the most deprived of development opportunities or need satisfaction. STP is one example of a country facing development constraints, being considered one of the Least Developed Countries. With problems in sustainably evolving in most of its critical areas, stimulating economic growth with the implementation of business projects can create a significant impact. Implementing FIP, focused on satisfying needs and creating value while decreasing the use of resources, with a critical sustainability concern, appears to be a solution.

The focus of this dissertation will be understanding to what extent the implementation of these projects is possible and to understand how to pursue it.

## Chapter 3 - State of the Art

What are the key aspects of Frugal Innovation Projects? Section 3.1 defines frugal innovation and describes the main characteristics of FI products before moving on to the characterisation of the FI market and explaining the success factors and main obstacles of FI. Section 3.2 introduces the relationship between sustainability and FI. The next section presents the concept of Sustainable Supply Chain Management and its link with FI. Section 3.4 introduces the logistics concepts and strategies. In section 3.5 the importance of design is explained. Finally, section 3.6 concludes and introduces chapter 4.

### 3.1 Frugal as Innovation

Innovation is held to be “the multi-stage process whereby organisations transform ideas into new/improved products, service or processes, in order to advance, compete and differentiate themselves successfully in their marketplace” (Baregheh et al, 2009, p. 1334). This “multi-stage process” is said to be both social and organisational since it requires “individual creativity, organisational structure, environmental context, and social and economic factors” (Bhatti, 2012, p. 16), thus leading to improvements in the outcome through greater effectiveness or efficiency. Innovation occurs by changing business dynamics, creating new technologies and synthesising existing technologies (C. K. Prahalad & Mashelkar, 2010).

Frugal means careful use of resources (McIntosh, 2013). Some authors defend it can be seen from two perspectives (Bhatti, 2012). From the consumer perspective, a frugal solution is low cost and affordable, serving consumers in constrained environments. The firm complements this in that the frugal solution is achieved by designing, producing, delivering and maintaining it under the necessary constraints.

Basu, Banerjee & Sweeny (2013) propose a comparison based on four characteristics: driver, process, core capabilities and location in order to explain why frugal innovation is more than just innovation.

Table 1 shows that on one hand, innovation is based on a top-down event in which the market accepts innovations entering the market but, on the other, FI starts by understanding market needs so becomes a bottom-up process. The core capability of FI is functionality, that is, the product is adaptable and simple. It is also advocated that a “design innovation process that properly considers the needs and context of citizens in the developing world is necessary to develop appropriate, adaptable, affordable, and accessible solutions, products and services”(Basu et al., 2013, p. 63).

When frugality and innovation are allied, it makes it possible to “do more with less for more people” (C. K. Prahalad & Mashelkar, 2010, p. 2). FI is understood both as an outcome and a process, with the process being referred to as frugal engineering and the outcome as FI (Weyrauch & Herstatt, 2016).

Table 1 - Comparing Frugal Innovation with Conventional Innovation. Adapted from (Basu et al., 2013).

Characteristic	Frugal Innovation	Conventional Innovation
Driver	What is in need	What would be nice to have
Process	Bottom-up	Top-down
Core Capabilities	Functionality	Desirability and design
Location	Developing and emerging markets	Developed markets

FI seeks to reduce financial and environmental costs and to minimise time, while delivering well-designed, good-quality products and creating value for underserved markets (Bhatti, 2012). Customer value is created by integrating affordability, quality and sustainability when redefining business models, reconfiguring value chains and redesigning products (Radjou & Prabhu, 2015).

FI is also stated as “a new management philosophy, which integrates specific needs of the BoP markets as a starting point and works backward to develop appropriate solutions that may be significantly different from existing solutions designed to address needs of upmarket segments” (Gupta, 2011, in Brem & Wolfram, 2014, p. 65).

Roland Berger (2014) emphasises that FI allows the creation of new, much simpler and affordable products or services, while keeping “at least the same value in terms of functionality” as any original and more complex (and expensive) ones but using limited resources.

In a conclusive and embracing definition, “frugal innovations are products, services, processes and business models that target underserved customers of low-mid market segments with high-quality solutions at affordable prices. They are developed in a sustainable and cost-effective manner that minimise the use of resources, materials and capital in the entire value chain, while enhancing social value” (Rocca, 2016, p. 7).

Different theories on innovation have been developed to keep up with market evolution. For a better understanding of FI, it is vital to compare it with other innovation concepts currently in use.

### **Reverse Innovation**

Reverse Innovation is the process of taking ideas that have been developed in an emerging market to satisfy local needs, and then successfully transfer them (with some modifications) to developed countries, as low-price offerings (Basu et al., 2013; Consultancy, 2015b; Hossain et al., 2016).

Ostraszewska & Tylec (2015) state that reverse innovation is a result of various types of innovation implemented in emerging markets, especially FI. As such, the major features of a reverse innovation product are not only the lower price but also the quality of the product or service

being provided. The extreme case of reverse innovation is the development of new products in emerging countries which are only subsequently introduced in developed markets (Basu et al., 2013). Thus, reverse innovation proves that developed countries are not always the hubs for innovation (Hossain et al., 2016).

### ***Jugaad Innovation***

Jugaad innovation occurs when the starting point of an innovation is the problem that needs to be solved and it is the final users of the solution found that instigate the innovation process. This improvisational approach is a creative way of solving problems, “at a low cost, in a short amount of time, and without serious taxonomy or discipline” (Brem & Wolfram, 2014, p. 4).

Jugaad innovation products are designed by and for people at BoP as a “result of poverty and exigency” (Brem & Wolfram, 2014, p. 4)

### ***Gandhian Innovation***

This type of innovation originates in India and relates to two of Gandhi’s commandments: to “prize every invention of science made for the benefit of all”, and that “earth provides enough to satisfy every man’s need, but not every man’s greed” (C. K. Prahalad & Mashelkar, 2010, p. 3). Gandhian Innovation is therefore divided into three types: “Technology-driven innovation” where emerging market companies “take advantage of Western Technology” and create new business models for its implementation; “Capability-driven Innovation”, in which new technical expertise is created in order to resolve market needs and problems; and a mix innovation where external technology and internal capabilities are merged to obtain quality products with lower production cost (Brem & Wolfram, 2014).

Bearing in mind “the mantras of affordability and sustainability” (Soni, 2013), the innovator must follow five principles when implementing this kind of innovation. The “goal is inclusive growth”, to achieve “the purpose of “more from less for many” by moving from “low price, low performance” to “low price, high performance”” (Altenburg & Lundvall (2009), in Basu et al. (2013)); the vision should be unambiguous”, meaning leadership is essential and a “human dimension” must be included; “stretch targets” are indispensable, with specific goals and time frames; everyone involved has to “learn to innovate when faced with constraints”; and the focus should always be on people (C. K. Prahalad & Mashelkar, 2010).

For clarity, Table 2 presents a comparison of the orientation and BoP focus of the four types of innovations. FI is the only concept that sees the BoP as a market and that is both product and process oriented.

Table 2 - Comparison of orientation and BoP-focus between different innovation concepts. Adapted from (Ostraszewska & Tylec, 2015) and (Brem & Wolfram, 2014).

Characteristic	Reverse Innovation	Jugaad Innovation	Gandhian Innovation	Frugal Innovation
Orientation	Product solution oriented	Problem oriented	Social claim	Product and process oriented
BoP focus	As source	As environment	As environment	As market and as source

In a more specific analysis, Brem & Wolfram (2014) selected three categories in which all concepts can be compared. In Figure 7, we see that the emerging market orientation can be defined as low, medium or high, depending on whether the orientation is towards international or emerging markets, respectively. Figure 8 addresses, in this case considering only the social and environmental dimensions, is low, medium or high as none, if one or both dimensions are taken into consideration.

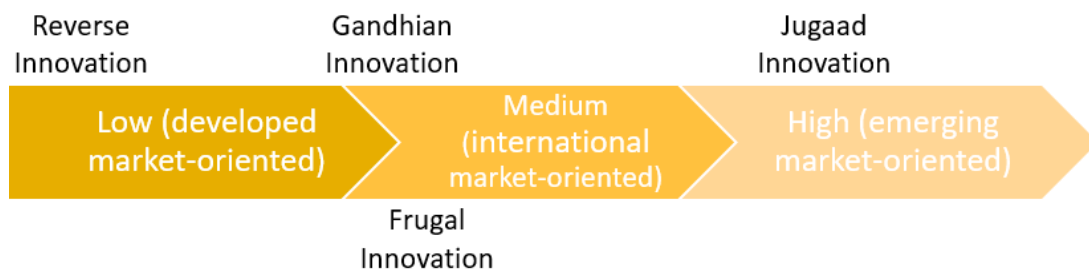


Figure 7 - Emerging market orientation. Adapted from (Brem & Wolfram, 2014)



Figure 8 - Classification in Sustainability. Adapted from (Brem & Wolfram, 2014)

Rosca et al. (2016) argue that “frugal innovations have a high variety in terms of products, services and business models, since they can reintegrate value chains, reengineer products and services to account for affordability constraints and local socio-cultural differences, reconfigure resources and reinvent business models”(Rosca et al., 2016, p.10). As such, when fully embraced, FI “can be a firm driver of progress in achieving sustainable solutions.” (Basu et al., 2013, p.78)

Pansera & Sarkar (2016) state that “innovations arising from within the BoP might have a tremendous impact not only in terms of serving unmet and ignored consumer needs, but also



longer-term impacts through enhanced productivity, sustainability, poverty reduction and promoting entrepreneurship behind the regional borders in which they originally emerge”.

### 3.1.1 Characteristics of the Frugal Innovation Products

FRUGAL is an acronym that stands for “Functional, Robust, User-friendly, Growing, Affordable and Local”. Those products embody the Pareto principle: “meet 80% of the requirements at 20% of the costs” with a twist on robustness for heavy-duty use (Roland Berger, 2015, p.2).

Basu et al. (2013, p.66) claim the core competences of FI, which were developed by the Frugal Innovation Lab at Santa Clara University, are “becoming a standard for developing appropriate, affordable, adaptable, and accessible solutions and assessing an innovation’s adequacy and readiness for successful market penetration”. These competences are: Affordability, Robustness, Adaptation, Green Technologies, Use of Local Resources, Simplification, Lightweight, Mobile Enable Solutions, Human Centric Design and New Distribution Models (Basu et al., 2013).

The main characteristics are described in more detail below:

#### **Functionality**

Functionality is the core capability of an FI product, that is, the product must be rugged, lightweight, adaptable and simple (Weyrauch & Herstatt, 2016).

#### **Robustness**

As frugal innovations target customers living in rural and semi-urban areas, in developing economies, the “products need to cope with various infrastructural shortcomings such as voltage fluctuation, abrupt power-cuts, dust, and extreme temperatures” (Tiwari, Kalogerakis, & Herstatt, 2014, p.3) and so they must be robust.

#### **User-friendliness**

Since most FIP buyers do not have any experience with similar products, “companies cannot presume a significant level of familiarity on the consumer side in dealing with their products. FIP therefore need to be easy-to-use and fault resistant” (Tiwari et al., 2014, p.4).

#### **Growability**

FI has the potential for inclusiveness (the intention of benefiting people universally). Starting with the area in which it was developed (Prahalad & Mashelkar, 2010), it can grow to reach wherever it is needed.

#### **Affordability**

Hossain, Simula, & Halme (2016, p.133) claim that “affordability is one of the main underlying factors affecting purchasing decisions relating to new solutions, especially in the context of low-income markets, where a significant number of people live on an extremely limited income”. Since FIP do not use sophisticated technology, they meet BoP customers’ basic needs at a low cost,

but provide a relatively high value (Brem & Wolfram, 2014). They also target mass markets and use scale economies (Bhatti & Ventresca, 2013).

“Affordability is the most essential attribute of a frugal product; and the best way to achieve this goal is to utilise local resources”(Roland Berger, 2015b, p.14).

### Locality

In order to succeed at the BoP, FIP need to adopt a local strategy: “Local suppliers, local development and R&D, local production, local employees and local distribution channels” (Rosca et al., 2016, p.11).

### 3.1.2 The Frugal Innovation Market

As shown by (Basu et al., 2013), FI highlights how to innovate in and for resource-constrained environments. FI also has direct benefits for BoP members since it is they who innovate and take advantage of that innovation. “Those BoP innovators seek opportunities for growth and advancement and become an important source of the innovations from which they will benefit and that may also be transferred to more developed countries” (Basu et al., 2013, p.67).

As can be seen in Figure 9, the FI market is in both emerging and developed countries.

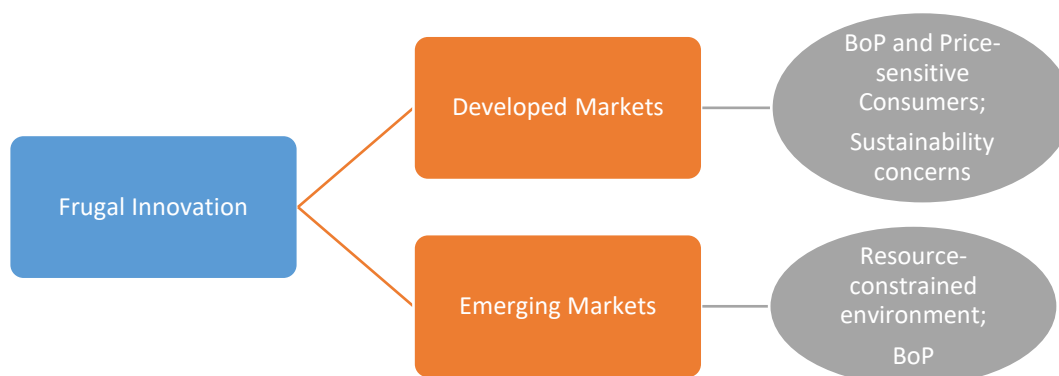


Figure 9 – Frugal Innovation Market.

### Emerging Markets

The emerging markets (EM) “are in one sense facing resource constraints, but in another sense they can explore and exploit global technologies to leapfrog over and above legacy and aging technology systems in developed countries” (Bhatti & Ventresca, 2013, p.9).

According to (Rosca et al., 2016), there are increasing trends in innovation in/for EM that when associated with “economic growth in emerging markets and the recession and slow growth in wealthy nations is forcing much attention to be redirected to populace markets in emerging markets”. FI plans “to serve large bottom and lower middle-class population demands”. When serving the BoP, FI’s value proposition “is related to higher standards of living. First, the standard of living is increased through the provision of basic services at lower costs”, and second, BoP

consumers can retain and use the savings for other activities. “Most of the developed products are based on given social problems, and the product or service ideas aimed to provide solutions to those problems”(Rosca et al., 2016, p.7).

Roland Berger (2014, p.4) claims FIP are "made mostly for and in emerging markets such as China, India or Brazil and are perfectly tailored to the specific demands of the lower and middle market segments".

Rosca et al. (2016) defends “that limiting products and services to basic functionalities and items allows the provision of better value for lower cost and lower prices” (FI values). Therefore, “a higher number of BoP customers can be achieved. High distribution costs have to be considered by Multi-National Corporations looking to reach remote areas, because they will increase the total costs and subsequent consumer prices” (Rosca et al., 2016, p.11).

In addition to dealing with the three main challenges, shown in Figure 10, emerging market entrepreneurs and firms are producing innovations; these resolve their local needs while allowing them to profit if they are able expand to neighbouring developing nations and even beyond to developed markets (Khanna & Palepu, 2005). “Working around lack of resources, skills, and the ability to still meet demand with affordable high quality solutions are what many of today’s “frugal” innovators seek to accomplish” (Bhatti, 2012, p.9).

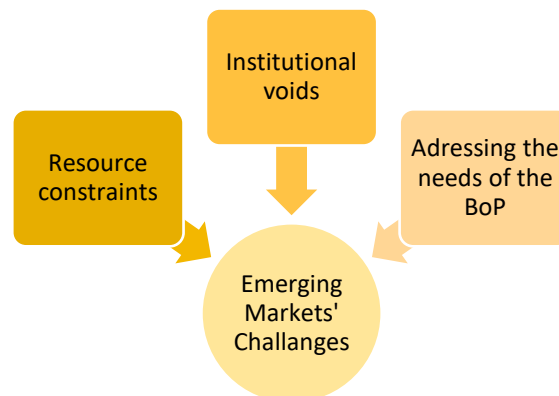


Figure 10 – EM Challenges for Innovation. Adapted from (Khanna & Palepu, 2005)

### Developed Markets

"In developed countries, sustainably providing basic services to all citizens is increasingly challenging" (Bhatti & Ventresca, 2013, p.10).

FI is starting to be in increasing demand in developed markets due to increased poverty, slow economic growth, and the consequent reduction in consumer spending. In addition to temporary emergency situations, (such as “accidents, natural disasters and the recent refugee movement) that foster frugal solutions where “basic needs have to be met in an effective manner until new provisions are made and infrastructures re-established” (European Commission, 2016, p.25), a new reality of consumer frugality has emerged. This is not just due to the growing resource constraints but to the fact that the final consumer is more aware of concepts like durability, sustainability, ‘do-it-yourself’ and lower consumption, associated not only with the product but also the respective companies (European Commission, 2016).

### 3.1.3 Success Factors and Main Obstacles

An FI implementation strategy can only be effective if certain success factors and obstacles are taken into consideration.

The key factors that enable an FI strategy to succeed are:

1. Lower overall cost of ownership. This is achieved when reducing costs of usage, maintenance and repair, from acquisition to the disposal of the FIP (Tiwari et al., 2014);
2. Economies of scale. FIP need access to voluminous business in order to cope with overall cost reduction and unit costs, as well as the associated low profit margins, (Tiwari et al., 2014);
3. Trade-off between customers' expectations and producers' satisfaction. The product must satisfy the consumer's needs and expectations, but should also enable the producer to obtain a competitive advantage (producing what is needed with cost efficiency) (Roland Berger, 2015b);
4. Market analysis. This involves not only the analysis of the target markets and customer needs, but also defining the customer segments, business model, margin targets and pricing limits (Roland Berger, 2015b);
5. Product design. It is important to define the concept and the specific product functions, and to analyse alternative functions and production costs. (Roland Berger, 2015b);
6. Value chain integration. This entails deciding what to make and what to outsource in terms of product development, procurement, production, logistics, marketing and sales. The focus should be on local collaborations for distribution, marketing and sales (Roland Berger, 2015b); (Roland Berger, 2014));
7. Change management. Helping all the stakeholders facing change, overcoming scepticism and becoming enthusiastic about the new ideas (Roland Berger, 2014).

The main obstacles faced when trying to implement FI are:

1. Producers' lack of knowledge. Most producers have insufficient knowledge of the markets, competitive prices and local engineering skills. This may lead to "problems with the planning of product costs and the design of the value chain" (Roland Berger, 2015b);
2. Lack of openness when developing FIP. Important stakeholders, notably in the financial department, seem reluctant to invest in this type of product (Roland Berger, 2015b);
3. Inadequate coordination with local regulatory institutions and strict cost control (Roland Berger, 2015b).

### 3.1.4 Frugal Innovation Products Examples

A broader view of the current situation FIP is provided by Table 3, which sets out information on products, companies, the industry in which they are integrated, the country of origin, the size of the company and the SC echelon they are serving. It is clear to see that 32 of the 61 companies are micro or small businesses. Working within these micro and small businesses implies specific SC strategies and logistics practices, which are distinct from the needs and characteristics of large companies. As the majority of the identified companies operate in the midstream, they impact all the SC and, if they fail, other stakeholders will certainly fail as well.

Table 3 – FI Products Examples. Source: (Rocca, 2016)

Company	Product	Industry	Country	Size	Supply Chain Echelon
MotionECO	Biodisel	Oil & Gasses	China	Micro	Upstream
Husk Power Systems	Rice Husk Gasification	Oil & Gasses	India	Large	Upstream
Eco-Fuel Africa (EFA)	Carbon neutral fuel	Materials	Uganda	Small	Upstream
ProPlanet	Recycled tapperware	Materials	Colombia	Small	Upstream
Rematerials	ModRoof	Materials	India	Micro	Upstream
Global Alliance for Clean Cookstoves	Technology and fuels	Materials	USA	Small	Upstream
Conceptos Plasticos	Recycled plastic houses	Utilities	Colombia	Small	Upstream
300\$ House	Affordable housing	Utilities	USA	Medium	Upstream
Reaction	Exo	Utilities	USA	Small	Upstream
Renault	Dacia Logan	Automotive	Romania	Large	Midstream
Tata Motors	Nano	Automotive	India	Large	Midstream
Mitti Cool	Mitti Cool Refrigerator	Consumer goods	India	Small	Midstream
Godrej & Boyce Manufacturing	ChotuKool	Consumer goods	India	Large	Midstream
Kenya Stove	Ecological stove	Consumer goods	Kenya	Micro	Midstream
Ghana Bamboo Bikes	Bamboo Bicycle	Consumer goods	Gahna	Small	Midstream
Solar Cooker International	CookKit	Consumer goods	USA	Micro	Midstream
Solar Serve	Cookstoves	Consumer goods	Vietnam	Small	Midstream
Glatt Stove	La Estufita	Consumer goods	Mexico	Medium	Midstream
Optic Group ICH	Recycled PET glasses	Consumer goods	Mexico	Small	Midstream
BanaPads	Banana pad for women	Consumer goods	Uganda	Large	Midstream
M-Kopa solar	M-KOPA IV Solar Home System	Consumer goods	Kenya	Large	Midstream
Nokia	Nokia 1200	Electronics	Finland	Large	Midstream
Logitech Computer	Mouse M215	Electronics	USA	Large	Midstream
DataWind Inc	Ubislate 7	Electronics	India	Large	Midstream
Foldscopes	Folding microscope	Health care	USA	Micro	Midstream
Coolar	Solar energy fridge	Health care	Germany	Micro	Midstream
General Electric	Logiq Book	Health care	USA	Large	Midstream
General Electric	MAC 400	Health care	USA	Large	Midstream
Siemens	Tomography Scanner	Health care	Germany	Large	Midstream
Philips	Bedside Monitoring System	Health care	Netherlands	Large	Midstream
Embrace Global	Embrace Warmer	Health care	China	Large	Midstream
Tata Chemicals Limited	TataSwatch	Health care	India	Large	Midstream
D-Rev	ReMotion Knee	Health care	USA	Small	Midstream
BMVSS	Jaipur Foot	Health care	India	Large	Midstream
CVDW	Child Vision	Health care	England	Small	Midstream
GRIT	Grit Freedom Chair	Health care	USA	Small	Midstream
Ion Ag+	Water Filter	Health care	Mexico	Micro	Midstream
Mettler Toledo	Basic Weighing Scale	Industrials	Switzerland	Large	Midstream
G-Thrive	gthrive	Industrials	USA	Micro	Midstream
First Energy	Oorja	Industrials	India	Medium	Midstream
IluMexico	Solar Systems	Industrials	Mexico	Medium	Midstream
HabiTec	Wood Furniture for schools	Industrials	Angola	Small	Midstream
KickStart	Water pump	Industrials	USA	Medium	Midstream
Lotus Foods	Rice sales	Retail	USA	Micro	Downstream
Global Cycle Solutions	Sun King Mobile Light	Retail	Tanzania	Small	Downstream
Onergy	Solar system	Retail	India	Medium	Downstream
We Care Solar	Solar Suitcase	Retail	Tanzania	Micro	Downstream
Pollinate Energy	Solar Systems Retail	Retail	India	Small	Downstream
Global Easy Water Products	Irrigation system	Retail	India	Small	Downstream
Empower Generation	Solar products	Retail	Nepal	Small	Downstream
Thrive	Solar products	Retail	India	Small	Downstream
A Little World	Rural banking	Financials	India	Large	Downstream
Safaricom	M-Pesa	Financials	Kenya	Large	Downstream
Kopo Kopo	Mobile money platform	Financials	USA	Small	Downstream
Aravind Eye Hospital	Eye Care System	Consumer services	India	Large	Downstream
Narayana Health	Helth City	Consumer services	India	Large	Downstream
Naandi:	Water services	Consumer services	India	Medium	Downstream
Echale a tu casa	Affordable housing	Consumer services	Mexico	Micro	Downstream
Jibuco	Drinking water access	Consumer services	Rwanda	Medium	Downstream
mPedigree	Heath application	InformationTechnology	Nigeria	Micro	Downstream
M-Farm	Agriculture application	InformationTechnology	Kenya	Micro	Downstream
<b>61 Products</b>		<b>12 Industries</b>	<b>20 Countires</b>		

## 3.2 Sustainability

According to Esfahbodi, Zhang, & Watson (2016), sustainability is not a singularity of the developed world. In emerging economies, firms have also started to pay attention to their supply chain management activities, as they have faced “tighter environmental restrictions from their governments and intense scrutiny from an increasingly educated society and competitors”. In this way, the manufactures can meet EM needs and expectations and “compete in the global market, because they conform to international legislation” (Esfahbodi et al., 2016, p.2).

### 3.2.1 Sustainable Frugal Innovation

Sustainability-driven FI is defined as “the desire to generate solutions designed to minimise the impact on the environment combined with the scarcity of material and financial resources” (Pansera & Sarkar, 2016, p.15), leading to the development of more efficient solutions; together with Sustainable FI (Rosca et al., 2016) (undertaking FI with a concern for the triple bottom line), these concepts present a plausible resolution for “doing more with less for more people” (C. K. Prahalad & Mashelkar, 2010, p.2), while thinking about long term impacts.

It is important to find the link between the sustainability three dimensions (people, planet and profit). When the cost of production is reduced, the purchasing cost is also reduced. Products at a lower cost can lead to greater access, and the savings can be applied in education. The higher the education, the better the employment opportunities, the possibility of developing new ideas and the more productive the work will be. (Rosca et al., 2016)

After analysing products considered frugal or reverse innovations, Rosca et al. (2016) found that these goods not only focused on the economic value, but also on creating social and/or ecological value. Table 4 presents their major impacts in each sustainability dimension.

When striving to make FI more sustainable, the following must be taken into account: 1) a more sustainable business model will be achieved if the value chain is more collaborative and inclusive; 2) better education, training and knowledge leads to a more sustainable business model; 3) “the sustainability of a business model at the BoP in developing countries is highly dependent on the local competences, resources and capabilities used”; and 4) “the involvement of local NGOs enhances the success of a business model” (Rosca et al., 2016).

Table 4 – Frugal Innovation Products' impacts on each Sustainability dimension.

<b>Environmental Impacts</b>	<p>Reduction in:</p> <ul style="list-style-type: none"> <li>• material usage;</li> <li>• production resources;</li> <li>• emissions;</li> <li>• Water and energy consumption.</li> </ul> <p>(the reduction in resource consumption is achieved through the use of waste and renewable materials for value creation)</p>
<b>Social Impacts</b>	<ul style="list-style-type: none"> <li>• Job creation;</li> <li>• Involving locals in making essential products and services available to people at the BoP;</li> <li>• Education;</li> <li>• Health;</li> <li>• Improvement in living standards.</li> </ul>
<b>Economic Impacts</b>	<ul style="list-style-type: none"> <li>• Greater employment opportunities for locals;</li> <li>• Integration of local entrepreneurs and women into value chain, freeing them from hard labour in agriculture</li> </ul>

Following an exhaustive analysis of the extant literature, Rocca (2016) structured the possible outcomes of FI in each sustainability dimension, when two of them are connected and when the three are aggregated. The result is Figure 11.

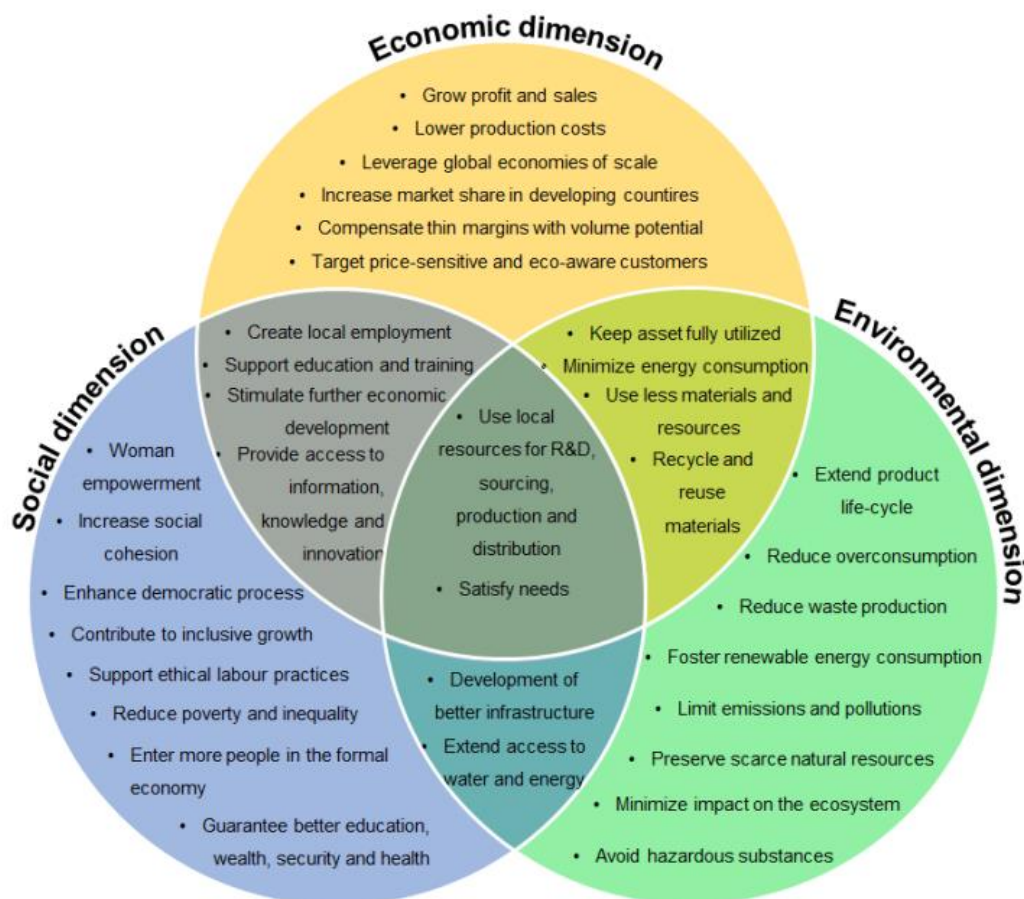


Figure 11 - Frugal Innovation outcomes in Sustainability. Source (Rocca, 2016).

Although synergy can undoubtedly be achieved between FI and Sustainability, the correct Sustainable Supply Chain Management strategy needs to be applied.

### 3.3 Sustainable Supply Chain

it is essential to understand and structure the current knowledge on Sustainable Supply Chains (SSC) and its management (SSCM), in order to clarify its importance for FIP. Section 3.3.1 defines and characterises SSC and SSCM, with reference to how SSCM includes characteristics resulting from the concepts of Green Supply Chain Management and Closed-loop Supply Chains. Section 3.3.2 sets out the SC features of both developed and emergent markets. Section 3.3.3 introduces the idea of SSCM in and for FIP, presents the Frugal Innovation Supply Chain Framework and analyses the impact of product design.

#### 3.3.1 SSCM Definition and Characterisation

The processes involved in an SC strategy are presented in Figure 12. Both plan/design and source are considered in the development phase of the entire process. The former is the phase in which the product creation and development takes place, the latter is when all the necessary partners and suppliers are brought together. The other processes such as supply, production, distribution and sales are more operational. Bendul, Rosca, & Pivovarova (2016) propose a structure based on the Supply Chain Operations Reference (SCOR), dividing an SC into three phases: Plan and Source (including plan/design, source and supply), Make (produce) and Deliver (distribute and sell).

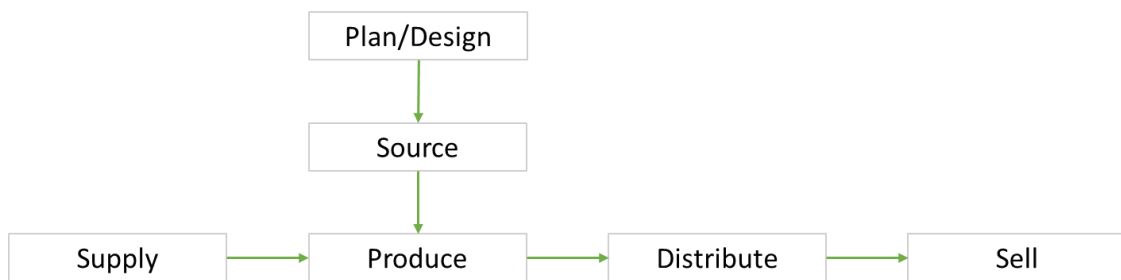


Figure 12 – Supply Chain processes.

According to Ahi & Searcy (2013), Supply Chain Management is the management of the flows of materials, services and information. This is possible thanks to the coordination between stakeholders with the ultimate aim of meeting final customers' needs. The outcomes of SCM are the creation of value, efficiency improvement and overall improvement in the SC performance. The focus of SCM is: flow, coordination, relationship, value, efficiency and performance (Ahi & Searcy, 2013).

Dubey et al. (2017, p. 1120) and Ahi & Searcy (2013) define Sustainable Supply Chain Management as “the voluntary integration of social, economic, and environmental considerations with the key inter organisational business systems to create a coordinated supply chain to effectively manage the material, information and capital flows associated with the procurement, production and distribution of products or services to fulfil short term and long term profitability, stakeholder requirements, competitiveness and resilience of the organisation”. They also describe the main drivers of SSCM, as presented in Table 5.



Table 5 – Drivers of SSCM.

<b>Drivers</b>	Green warehousing
	Strategic supplier collaboration
	Environment conservation
	Continuous improvement
	Enabling information technologies
	Logistics optimization
	Internal pressures
	Institutional pressures
	Social values and ethics
	Corporate strategy and commitment
	Economic stability
	Green product design

When considering implementing SSCM practices, their enablers and barriers must be addressed. Table 6 presents the key enablers and barriers for SSCM implementation, according to Ansari & Kant (2016).

Table 6 – Enablers and barriers for SSCM implementation. Adapted from (Ansari & Kant, 2016)

<b>Enablers</b>	<b>Barriers</b>
Government regulations	Lack of information and transparency
Information sharing	Lack of training and expertise
Top management commitment	Supplier incompetence
Collaboration with partners	Cost implications
Adoption of green practices	Lack of top management commitment
Customer pressure	Lack of financial resources
Environmental management	Design complexity (not easy to reduce the consumption of resources and energy)
Reverse logistics	Inadequate facilities for reverse logistics
Innovation	Lack of IT implementation
Organisation Competitiveness	

All strategies are welcome when aiming for full sustainability, including different approaches with similar and common objectives. This is the case of Green SCM and Closed-loop Supply Chains. It can be said that if GSCM (which focuses on the environment but also has an impact on economic and social aspects) and CLSC (with possible outputs in the three Sustainability pillars) both impact Sustainability, then SSCM can obtain better results by adopting some of these two practices. It is therefore necessary to define and characterise both GSCM and CLSC.

## Green Supply Chain Management

Srivastava (2007) in Simão, Gonçalves, & Taboada Rodriguez (2016, p.400) defines GSCM as “an integrating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, delivery of the final product to the consumers as well as end-of-life management of the product after its useful life and this approach can reduce the ecological impact of industrial activity without sacrificing quality, cost, reliability, performance or energy use”.

If green strategies are applied to the different stages of the SC, it leads to competitiveness and better economic performance. Therefore, GSCM strategies can be applied in the: inbound logistics, production or the internal supply chain, outbound logistics, and reverse logistics. These strategies include “involving materials suppliers, service contractors, vendors, distributors and end users working together to reduce or eliminate adverse environmental impacts of their activities” (Gupta, Abidi, & Bandyopadhyay, 2013, p.82).

As can be seen in Figure 13, GSCM integrates greener strategies in all SC processes. Table 5 demonstrates that some of these strategies are already drivers towards sustainability.



Figure 13 – The GSCM Equation. Adapted from (Gupta et al., 2013) and (Simão et al., 2016)

## Closed-loop Supply Chain

The traditional SC does not cover the end-of-life (EOL) products, which may have a tremendous impact on SC sustainability; this problem is mitigated by introducing the Closed-loop Supply Chain (CLSC) concept. In Govindan, Soleimani, & Kannan (2014, p.603), Guide and Van Wassenhove (2009) define CLSC as “the design, control, and operation of a system to maximise value creation over the entire life cycle of a product with dynamic recovery of value from different types and volumes of returns over time”.

A better understanding of the structure of a CLSC is given in Figure 14, which shows “both forward (supplying raw materials, processing, assembling, distributing/retailing, and consuming) and reverse (repairing, reconditioning, remanufacturing, recycling, and disposing) supply chain processes simultaneously”(Govindan & Soleimani, 2016, p.372).

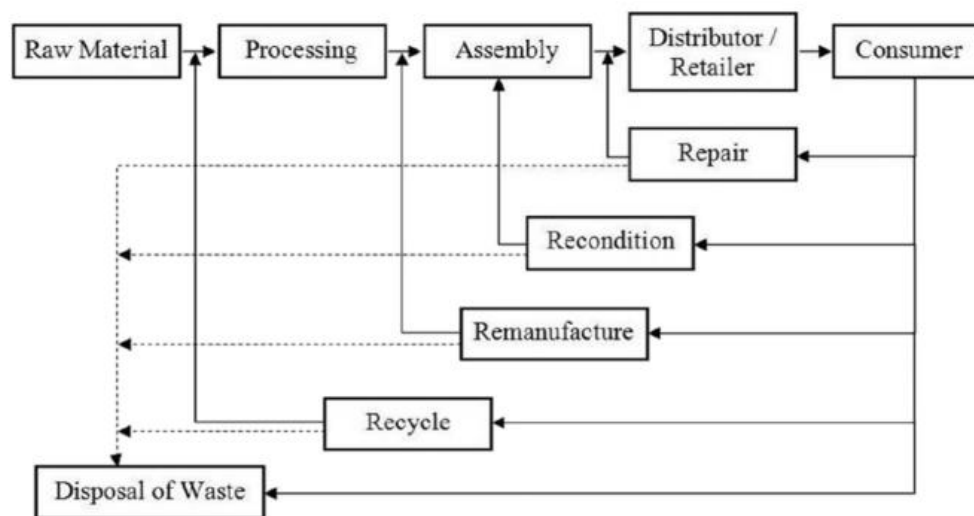


Figure 14 – Closed-loop Supply Chain Structure. Source: (Govindan & Soleimani, 2016)

The implementation of a reverse supply chain in the traditional SC imply an higher investment, but it also fosters sustainability and improves the dynamic performance of the SC by using the product return-flow as a supplier for production(Cannella, Bruccoleri, & Framinan, 2016).

As described in this section, there is an organic relationship between SSCM and both GSCM and CLSC; the SSCM uses strategies resulting from the connection with the other two giving rise to better results in the three Sustainability pillars.

### 3.3.2 SC Characteristics in Different Markets

Each SC must be adapted to the circumstances in which it operates. This adaptation occurs at all levels of the supply chain and depends, for instance, on the type of the product being offered or type of market being served. Regarding the type of market, it is known that there is a considerable difference between operating in developed and developing countries. FI always focuses on price sensitive customers, which are found in both markets; therefore, the next sub-sections presents the characteristics of the supply chains in each market.

### Developed Markets

The Developed Market SC tends to be more focused on reducing costs, differentiation and securing the supply. These markets are characterised by the availability of an infrastructure for delivery purposes (Bendul et al., 2016).

Table 7 sets out a sample of the strategies applied at each stage of the SC.

Table 7 – SC stages for Developed Markets. Adapted from: (Bendul et al., 2016).

<b>Design/Plan</b>	<ul style="list-style-type: none"> <li>• Simultaneous engineering and logistics-oriented product design</li> <li>• Collaborative Planning, Forecasting and Replenishment</li> </ul>
<b>Source/Procurement/Supply</b>	<ul style="list-style-type: none"> <li>• Industry parks / commercial freight villages</li> <li>• Supplier Relationship Management (SRM)</li> </ul>
<b>Produce</b>	<ul style="list-style-type: none"> <li>• Just-in-time / just-in-sequence production</li> <li>• Lean manufacturing</li> <li>• Kanban production</li> <li>• Modular design</li> </ul>
<b>Distribute</b>	<ul style="list-style-type: none"> <li>• Intermodal transport</li> <li>• Multi-channel management</li> </ul>
<b>Sell</b>	<ul style="list-style-type: none"> <li>• Customer Relationship Management (CRM)</li> <li>• Integrated services and products</li> <li>• Efficient consumer response</li> </ul>

### Emerging Markets

There has been a boom in the research on the Emerging Markets. New strategies have been developed to promote EM economy and suppress populations' basic needs and they are now starting to be implemented. Table 8 presents some approaches for each stage of the SC for the EM.

Table 8 - SC stages for Emerging Markets. Adapted from: (Bendul et al., 2016).

<b>Design/Plan</b>	<ul style="list-style-type: none"> <li>• Design focusing on basic functionalities</li> <li>• Customer-centric design and local development teams</li> </ul>
<b>Source/Procurement/Supply</b>	<ul style="list-style-type: none"> <li>• Low material cost</li> <li>• Low lifecycle cost</li> <li>• Early supplier involvement and supplier management</li> </ul>
<b>Produce</b>	<ul style="list-style-type: none"> <li>• Labour intensive assembly method</li> <li>• Outsourced assembly method to final customer or distributor</li> <li>• Low variance</li> <li>• Modular Design</li> <li>• Reduced and less appealing packaging</li> </ul>
<b>Distribute</b>	<ul style="list-style-type: none"> <li>• Locally embedded distribution channels</li> <li>• Traditional and new distribution channels</li> <li>• Outsourced service and maintenance</li> </ul>
<b>Sell</b>	<ul style="list-style-type: none"> <li>• Integrated services and products</li> <li>• Tailored marketing</li> </ul>

Distribution is one of the major challenges when operating in the EM. Tang & Sodhi (2016, p.128) suggest that “in developing countries, the distribution infrastructure is inadequate and formal distribution channels do not reach most consumers unlike in developed countries with large retailers and their supply chains”.

After analysing the current situation at the BoP, Shoprite (2014) structured three trends in BoP distribution. The first is the growth of formal markets. Although informal markets are still largely well-established, there is an increasing share of shopping places like supermarkets. The second trend is the direct link with the retailers, allowing faster product rotations and low inventory at the small retail shops. Lastly, the information revolution has resulted in the internet penetrating these markets, thus opening doors for mobile apps.

With respect to strategies for distribution at the BoP, both (Tang & Sodhi, 2016) and (Shoprite, 2014) agree that distributing finished goods through micro-entrepreneurs not only helps overcome the high cost of ‘last-mile’ distribution but also alleviates poverty. They also suggest piggybacking on existent dealer networks or retail networks. Tang (2016) adds a further strategy, namely using a smaller town as a hub that supplies smaller areas, while Shoprite (2014) proposes creating hybrid partnerships with NGOs, micro-finance institutions and cooperatives.

All these strategies can be correlated with the “tailored strategies” established by Blanco (2007). He advocates applying one of the following three structures: Out-of-market supply for the entire product, local assembly with out-of-market supply for components or subassemblies or local production and assembly. Figure 15 summarises the advantages and disadvantages of each structure. This capability entails considering local production and/or assembly, evaluating tax risks and influencing traditional corporate financial models (Blanco, 2007).

SUPPLY STRATEGY	DRIVERS	ADVANTAGES	DISADVANTAGES
Out-of-market	<ul style="list-style-type: none"> <li>» Capital intensive</li> <li>» Limited local demand</li> <li>» Minimal product customization</li> <li>» High product value density</li> </ul>	<ul style="list-style-type: none"> <li>» Minimal facility investment</li> <li>» Minimal political risk</li> </ul>	<ul style="list-style-type: none"> <li>» Longer customer lead times</li> <li>» No local capabilities</li> <li>» Exposure to exchange rates</li> </ul>
Local-assembly with out-of-market components	<ul style="list-style-type: none"> <li>» Capital intensive</li> <li>» Product customization</li> <li>» Customer service</li> <li>» Modularity</li> </ul>	<ul style="list-style-type: none"> <li>» Builds local capability</li> <li>» Tax incentives</li> <li>» Reduced lead times</li> </ul>	<ul style="list-style-type: none"> <li>» Exposure to exchange rates</li> <li>» Increased supplier coordination</li> </ul>
Local production and assembly	<ul style="list-style-type: none"> <li>» Labor intensive</li> <li>» Regional suppliers</li> <li>» Regional market expansion</li> <li>» Market-driven product design</li> <li>» Low product value density</li> </ul>	<ul style="list-style-type: none"> <li>» Builds local capability</li> <li>» Tax incentives</li> <li>» High customer service potential</li> <li>» High growth potential</li> </ul>	<ul style="list-style-type: none"> <li>» Political risk</li> <li>» Major capital investments</li> <li>» Local talent</li> <li>» Local supplier base</li> </ul>

Figure 15 – Supply Strategies: drivers, advantages and disadvantages. Source: (Blanco, 2007)

Manners-Bell, Cullen, & Roberson (2014) structured the barriers affecting logistics and the supply chain in the EM, dividing them into direct and indirect challenges, as shown in Table 9.

Table 9 – EM barriers for Logistics and SC. Adapted from: (Manners-Bell et al., 2014)

<b>Direct barriers</b>	Weak road transport and ICT infrastructure
	Poor shipping connectivity and port capacity
	Lack of air transport and airports
<b>Indirect Barriers</b>	Lack of development of the services industry
	The level of urbanisation and the distribution of population
	Extremes of income distribution
	Low penetration of foreign direct investment
	Barriers to market access
	Corrupt and inefficient customs and border administration
	High business costs of crime and violence including terrorism

Hirschinger, Spickermann, Hartmann, von der Gracht, & Darkow (2015, p.12) adds that since “emerging economy countries represent important links in global supply and distribution networks, improving their transportation and logistics systems will have essential impacts on the global value chains in which they participate”.

They conclude by saying that “emerging economies will take advantage of free trade zones to consolidate their position in the international market and encourage investment”. Accordingly, logistics will experience rapid growth, value-added services will expand and logistics service industry in emerging economy countries will undergo a significant consolidation process” (Hirschinger et al., 2015, p.9).

### 3.3.3 Sustainable SCM in/for Frugal Innovation

The value chain for FIP entails cooperation, partnerships and alliances (Esfahbodi et al., 2016), and acting local: local materials, suppliers, production and distribution. Local distribution means local shops, shopkeepers, entrepreneurs, NGOs and women (Rosca et al., 2016). This is the only way to deal with the low profit margins and institutional barriers of developing countries (Esfahbodi et al., 2016).

#### *The FISC Framework*

After interviewing companies working with FIP in EM, and consolidating all the information acquired, Rocca (2016) structured what he called the Frugal Innovation Supply Chain Framework (FISC). Based on the current knowledge about SCM and FI, the interviews, and the experts’ validation of the framework, the extensive version of the framework presented in Figure 16 was

obtained. This framework allows its users to understand if they are using the correct FI strategy at any given moment, and to adjust anything what needs improving.

A simpler version of this tool was then created just “to show how the phases are interrelated with each other and to provide a global vision for the development of FIP” (Rocca, 2016, p.77). The circular FISC “should be employed in the first stages to identify companies’ priorities, since it provides a holistic overview of the processes and supports strategic decisions” (Rocca, 2016, p.77).

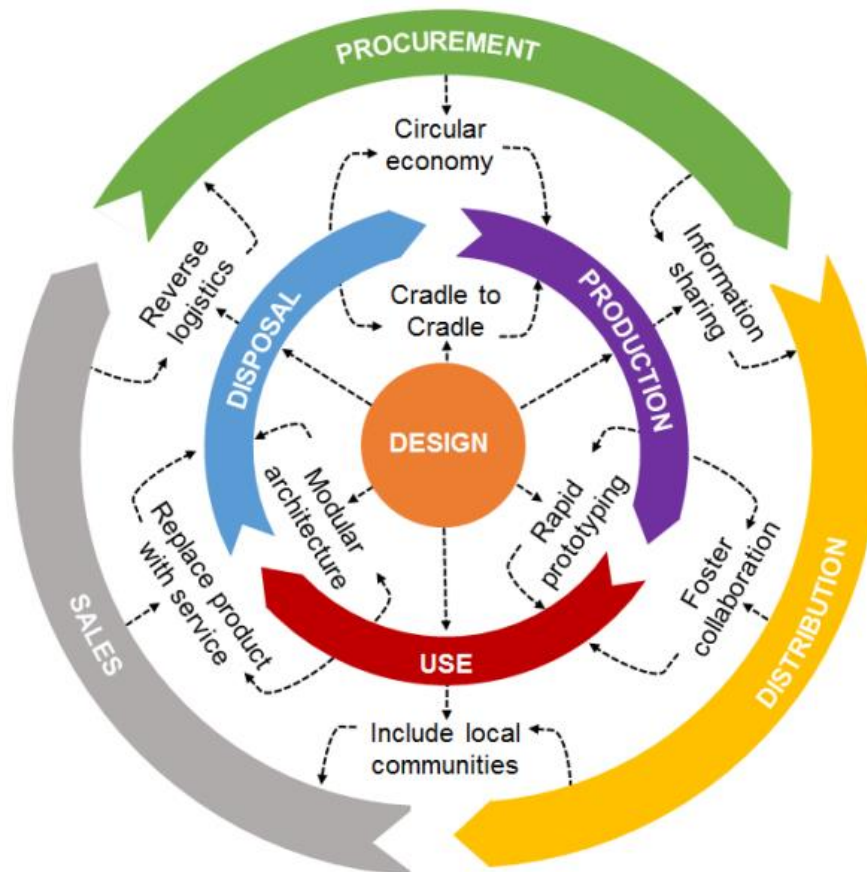


Figure 16 – FISC Framework. Source:(Rocca, 2016)

In addition to the main SC processes, the circular FISC framework adds the stages of Use and Disposal given the importance of Sustainability and the FI goals. One of the framework’s main characteristics is that Design is at the centre. There are three main reasons for this: “ 1) it is the priority of each company, as it strongly affects the market success of the solution; 2) it directly influences all the other phases, by defining the product characteristics, the materials and the technology; 3) it establishes whenever the developed innovation is frugal, since the functionality, the cost and the environmental impacts are determined” (Rocca, 2016, p.77-78).

### 3.4 Logistics

Logistics has been “increasingly identified as a core element of supply chain management” (McFarlane, Giannikas, & Lu, 2016, p.105). Like supply chain management, the purpose of logistics is to provide “customers with the level and quality of service that they require” at the minimum total cost (Christopher, 2011, p.42).

Speranza (2016, p.1) claims that “logistics, and the broader concept of supply chain management, is mainly intended as a business function that has the scope to make goods available where and when needed and in the needed quantities”.

When logistics links manufacturing with the distribution of raw materials and finished products, it not only focuses on efficiency and cost reduction, but also adds value to the products (Lu & De Bock, 2014).

Table 10 describes the characterisations found in the available literature in order to summarise the existing definitions of Logistics.

As contended by Christopher (2011), logistics is an integrative and planning concept that “seeks to create a framework through which the needs of the marketplace can be translated into a manufacturing strategy and plan, which in turn links into a strategy and plan for procurement” (Christopher, 2011, p.12).

Table 10 – Definitions of Logistics.

<b>Christopher (2011, p.2)</b>	<p>“Process of strategically managing the procurement, movement and storage of materials, parts and finished inventory (and the related information flows) through the organisation and its marketing channels in such a way that current and future profitability are maximised through the cost-effective fulfilment of orders.”</p> <p>“Logistics is concerned with all inventory within the business from raw materials, sub-assembly or bought-in components, through work-in-progress to finished goods.”</p>
<b>Grazia Speranza (2016, p.1)</b>	<p>“logistics, and the broader concept of supply chain management, is mainly intended as a business function that has the scope to make goods available where and when needed and in the needed quantities.”</p>
<b>Lu &amp; De Bock (2014, p.149)</b>	<p>“logistics management as the part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers’ requirements.”</p>
<b>Piotrowicz &amp; Cuthbertson (2015, p.213)</b>	<p>“deliver the right material in the right quantity, at the right time and of the right quality with a continuous material/information flow.”</p>
<b>Rushton, Croucher, &amp; Baker (2015, p.662)</b>	<p>“range of activities that includes preparedness, planning, procurement, transport, warehousing, tracking and tracing, and customs clearance.”</p>



Seroka-Stolka (2014, p.303)

“the actions of which the objective is to minimise costs and maximise profits.”

Slats, Bholá, Evers, & Dijkhuizen (1995, p.2)

“value-adding process that directly supports the primary goal of the enterprise, which is to be competitive in terms of a high level of customer service, competitive price and quality, and flexibility in response to market demands.”

“Logistics is an important area which every company has to concentrate on and differentiate themselves with their competitors” (Neeraja, Mehta, & Chandani, 2014, p.674) .

Rushton et al. (2015, p.19) argues that Logistics “planning should be undertaken according to a certain hierarchy that reflects different planning time horizons”. As such, it should be divided into three levels: strategic, tactical and operational. As shown in Figure 17, each topic covers a range of issues.

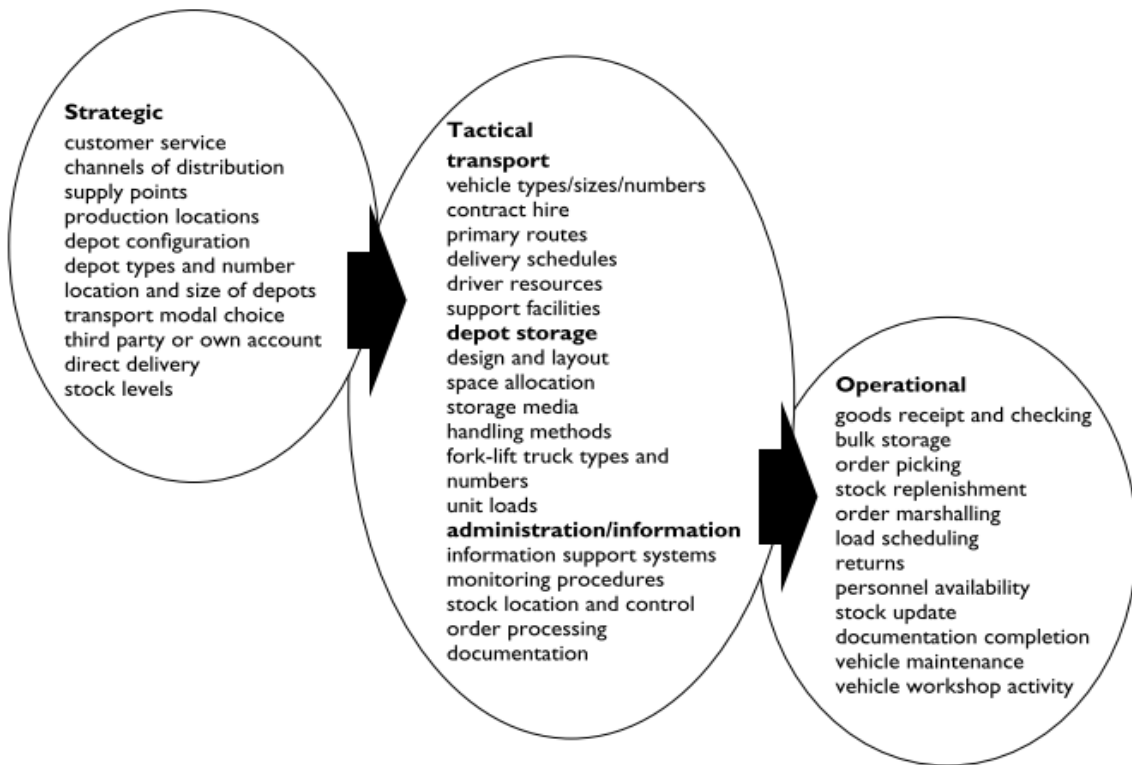


Figure 17 – Planning for Logistics. Source: (Rushton et al., 2015)

### 3.4.1 Sustainable Logistics

Although logistics was originally about minimising costs, maximising profitability and achieving customer service targets, companies became more interested in minimising the social and environmental impacts of their activity following the heightened concern about sustainability (Bai & Sarkis, 2012).

Lu & De Bock (2014) defend that “from social (people), environmental (planet) and economic (profit) perspectives, sustainable logistics and supply chains are the engine for a more competitive and unified market, and a prerequisite for the further growth in international trade”. They add that

“to be able to comply with these demands, logistics must be highly efficient, reliable, safe, secure, environmentally friendly and cost-effective” (Lu & De Bock, 2014, p.2).

Green and Reverse Logistics may contribute to more sustainable logistics (SL) just as GSCM and CLSC influence SSCM.

### 3.4.2 Green Logistics

Since green logistics “can be defined as producing and distributing goods in a sustainable way, taking account environmental and social factors”, it is “contributing towards, and ensuring, sustainability” (Seroka-Stolka, 2014, p.303).

Bai & Sarkis (2012, pp.147-171) structured some knowledge on this topic from which the following can be highlighted:

- Green Logistics is the “systematic measurement, analysis, and, ultimately, mitigation of the environmental impact of logistics activities”;
- The “effort to mitigate environmental externalities in logistics activities includes reducing of consumption of non-renewable energy sources, air emissions, greenhouse gas emissions, and waste”;
  - Technological efforts (e.g. replacing diesel vehicle fleets with hybrid);
  - Efforts involving better ways to plan and execute the movement of goods (e.g. “increasing the utilisation of trucks while maintaining inventory levels under control; or using modes of transportation that have lower greenhouse gas emissions”);
- “There are five main logistics variables that, when combined, drive the environmental impact of logistics:
  - Distance. How far are products being moved? Where are they loaded/unloaded?
  - Mode. Which mode of transportation is being used?
  - Equipment. What kind of equipment is being used for the logistics operation? What kind of fuel and how much fuel does it consume?
  - Load. How much product is being loaded into the conveyance? How efficiently is it loaded?
  - Operation. How skilful is the driver in operating the vehicle? How optimal is the logistics plan?”

An objective can be structured for each of the above variables (Bai & Sarkis, 2012). As presented in Table 11, these objectives can be broken down into activities divided in the three logistics dimensions.

Table 11 – Green Logistics Strategies. Source: (Bai & Sarkis, 2012)

	Strategic	Tactical	Operational
<b>Reduce Distances</b>	Include environmental impacts in network design	Flexible territories/service contracts that allow for increased density of pickup/delivery networks	Advanced vehicle routing that includes congestion, fuel consumption modelling, and flexible time windows
	Local sourcing	Identify cross-industry partnerships to reduce empty-miles	
<b>Modal Shift</b>	Evaluate network design incorporating facilities alongside intermodal terminals	Collaborate with customers/suppliers to adjust order quantities, inventory levels, lead times and service levels to allow multiple modes in lanes	Define a clear hierarchy of preferred modes by lane
	Design networks to support flexible inventory and service levels to allow various network speeds	Develop multi-modal third-party logistics providers	Develop multimodal experience by operating lanes across multiple modes
<b>Cleaner Equipment</b>	Joint investment in cleaner technologies, including early trials, to foster equipment innovation	Incentivise capital investments to regularly upgrade/replace ageing equipment	Track equipment performance (fuel consumption, emissions, noise)
		Pilot new technologies to obtain real operational environmental performance	Develop environmentally aware, preventive maintenance plans
<b>Loading Planning</b>	Redesign product packaging to improve conveyance utilisation	Add environmental metrics to logistics planning reports	Track and report the environmental impact of every move
		Review “green scenarios” in load planning	Optimise conveyance loading using analytical approaches (OR)
<b>Operational Excellence</b>	Develop an environmentally aware logistics culture	Benchmark environmental operational performance	Develop operational environmental dashboards (e.g., fuel consumption, idling)
		Recognise top environmental performers regularly	Establish targets and incentives

### 3.4.3 Reverse Logistics

Piotrowicz & Cuthbertson (2015) underline the importance of reverse flows, listing some of their sources such as: “waste, reusable or recyclable packaging, unsold products, end-of-life products, scrap, by-products, recalls, damaged products, commercial agreements enabling returns etc. These diverse forms of reverse flows have different impacts on managerial issues and tasks concerning reverse flows and reverse logistics” (Piotrowicz & Cuthbertson, 2015, pp.311-312).

The following definition of Reverse Logistics can be found in Govindan et al. (2014): “the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal” (Govindan et al., 2014, p.603).

RL faces a number of barriers, including “lacking importance and attention from management, and lacking policies, systems, and resources to properly implement reverse logistics” (Arnette, Brewer, & Choal, 2014, p.379).

Govindan et al. (2014) explains how RL works, namely “reverse logistics, in general forms, start from end users (first customers) where used products are collected from customers (return products) and then attempts to manage EOL products through different decisions are undertaken including recycling (to have more raw materials or raw parts), remanufacturing (to resale them to second markets or if possible to first customers), repairing (to sell in the second markets through repairing), and finally, disposing of some used parts” (Govindan et al., 2014, p.603).

The main objective of RL is to “recapture (ing) value from the point of consumption to the point of origin”, and therefore “the reverse flows do not necessarily have to end at the point of origin but instead can end at any point of recovery or disposal” (Brix-Asala, Hahn, & Seuring, 2016, p.415). Hence, Table 12 presents the necessary activities to recapture value.

Table 12 – Reverse Logistics Practices. Adapted from (Brix-Asala et al., 2016).

Reverse Logistics Categories	Corresponding Activities
Product Return Management	Product Acquisition (to obtain products from the end-users)
	Reverse Logistics (to move products from point of use to disposition; network for collecting returns)
Remanufacturing Operational Issues	Testing, sorting and disposition (some returns are unfit for intended process)
	Refurbishment (re-use, repair, remanufacture, recycle or disposal)
Remanufactured product market development	Re-marketing (of refurbished goods)

Product design is important aspect of RE that must be addressed. Christopher (2011, p.250) claims that “products must be designed with their end-of-life in mind” and Ülkü & Hsuan (2017) suggest the stakeholders should be integrated in order to implement modular products and that “product take-back and recyclability laws at the product’s end of life demand firms to include design-for-recyclability in the new product development process. Modular designs enable mass customisation and are pre-condition for disassembly” (Ülkü & Hsuan, 2017, p.4240).

Although Reverse Logistics is in regular use in developed countries, it is not popular among EM. This may be explained on one hand by the fact that “the impracticality of reverse logistics as the culture of recycling is not yet deeply entrenched” within EM and, on the other, reverse logistics involves high costs and other constraints (Geng, Mansouri, & Aktas, 2017, p.255).

While Reverse Logistics focuses “on saving money and increasing value by reusing or reselling materials to recover lost profits and reduce operational costs”, Green Logistics “focuses on the forward flow of the supply chain” (Seroka-Stolka, 2014, p.304) and mitigating the environmental impacts of SC activities. When combined, both strategies contribute to sustainable development. Figure 18 highlights activities considered important to both GL and RL.

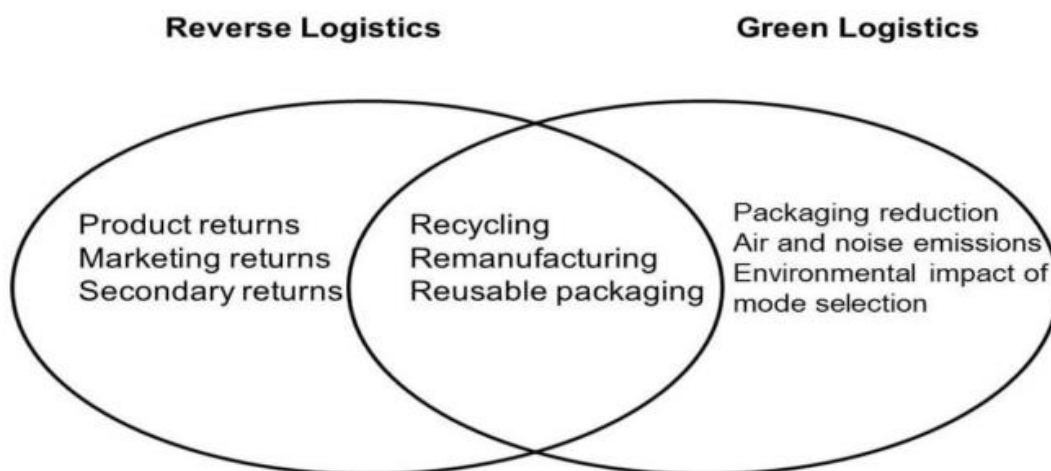


Figure 18 – Mixing Green and Reverse Logistics. Source: (Seroka-Stolka, 2014)

This knowledge on GL and RL can all be used to structure a more Sustainable Logistics strategy that would impact the overall sustainability of the SC. Just as an SSCM depends on Sustainable Logistics, GSCM and CLSC depends on Green Logistics and Reverse Logistics, respectively.

### 3.5 Design

The design process “includes various product design attributes such as aesthetics, durability, ergonomics, interchangeability, logistics, maintainability, marketability, manufacturability, procurability, reliability; remanufacturability, safety, schedulability, serviceability, simplicity, testability, and transportability” (Dowlatshahi, 1996, p.188).

Blanco (2007) defends that product design must take place near the market which companies are targeting and, therefore, that product design must integrate affordability, customer needs and SC to enhance growth and profitability.

Product design impacts the entire SC. If the needs of FIP consumers are to be satisfied while embracing sustainability and the logistics demands of the FI market, it is important to focus on three quests of the product design: Design for Logistics, Design for the BoP and Design for Sustainability. If these three could be combined, it would undoubtedly increase the probability of success for the entire Frugal Innovation SC.

## Design for Logistics

“Product design impacts the packaging and transportation of a product by making distribution more efficient and reducing costs” (Arnette et al., 2014, p.379).

Figure 19 presents Dowlatshahi's (1996) structure of the impact of designing for logistics among the SC. He also notes that “logistics must be intuitively an integral part of the design process along with performance, size and weight, reliability, safety, manufacturability and cost”, and also take “environmental impact, energy conservation, and solid waste transportation and disposal” into consideration (Dowlatshahi, 1996, pp.191-192).

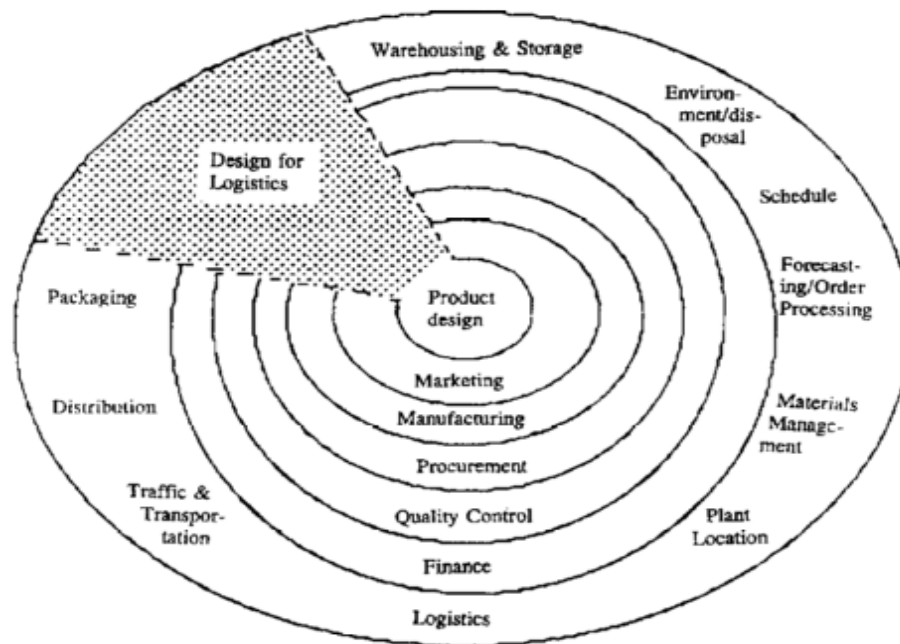


Figure 19 – Design for Logistics Integration. Source: (Dowlatshahi, 1996)

Chaudhuri (2016) adds that “a design for logistics process requires understanding the logistics process from production location to the buyer, and an understanding of the complexity of the logistics requirement in the supply chain”.

Simchi-Levi, Kaminsky & Simchi-Levi (2000, p.177) argues that three strategies can be applied to tackle SC costs, especially those of transportation and inventory, and enhance service levels: economic packaging and transportation; current and parallel processing; and postponement/delayed differentiation. Table 13 summarises key points on each Design for Logistics strategy.

Table 13 – Design for Logistics strategies. Adapted from: (Simchi-Levi et al., 2000)

<p><b>economic packaging and transportation</b></p>	<ul style="list-style-type: none"> <li>• Product design for efficient packaging, storage and utilisation of the retail space;</li> <li>• Packaging design for a better consolidation of products at the cross-docking points;</li> <li>• Packaging is often delayed, and products are repackaged at the cross-docking;</li> </ul>
<p><b>current and parallel processing</b></p>	<ul style="list-style-type: none"> <li>• Due to the redesigning of products, several manufacturing phases occur at the same time, minimising lead times;</li> </ul>
<p><b>postponement/delayed differentiation</b></p>	<ul style="list-style-type: none"> <li>• Takes advantage of standardisation. This can be achieved by redesigning the products or the production processes.</li> </ul>

### Design for Sustainability

Arnette et al. (2014) defends that “the idea of designing with the triple bottom line in mind is essential as we move new product development forward” (Arnette et al., 2014).

Ceschin & Gaziulusoy (2016) consider the evolution of the concept of Design for Sustainability and claim that it “has progressively expanded from a technical and product-centric focus towards a focus on large scale system level changes, in which sustainability is understood as a socio-technical challenge” (Ceschin & Gaziulusoy, 2016, p. 32).

### Design for BoP

Market contexts influence the process of designing a product. Designing for the BoP must be a more “problem-driven” process (unlike designing for the ToP which is a solution driven process). In light of this, designing for the BoP entails recognition of some of the associated constraints (Jagtap et al., 2014). Jagtap et al. (2014) suggests dividing these into the following distinct areas: Market Information, Regulatory Environment, Physical Infrastructure, Knowledge and Skills and Access to financial Services, as shown in Table 14).

Table 14 - Constraints in Designing for the BoP. Adapted from: (Jagtap et al., 2014)

<b>Market information</b>	In the product design for the BoP, businesses often lack detailed information about the BoP markets.
<b>Regulatory environment</b>	The regulatory frameworks are under or undeveloped in the BOP. In addition, bureaucracy in developing countries can be time consuming and monetarily expensive.
<b>Access to financial services</b>	Lack of access to credits, insurance products, and banking services. This places restrictions on purchases  The designers must take the price-performance relationship into account when designing for the BoP.
<b>Knowledge and skills</b>	The poor are generally illiterate and have no knowledge or skills on the availability of products, usage of products, etc.  The skill levels of the poor must be considered when designing products for the BoP.
<b>Physical infrastructure</b>	There are inadequate infrastructures (e.g. roads, electricity, water and sanitation, hospitals, etc.) at the BoP.  The developed countries have the necessary logistics system to access consumers, sell to them, and service products.  Minor changes may be required for specific products. At the BoP, the existence of a logistics infrastructure cannot be assumed.



### 3.6 Literature Review Gap

Some important areas of FIP have been addressed. An extensive literature review was conducted to understand the extent of knowledge in the areas of social responsibility, environmental concern, respective business model, logistics. The results are presented in Table 15.

After analysing the literature related to FI in the abovementioned areas, it was immediately apparent that there is a large gap in the knowledge on the overall implementation of FIPs.

Table 15 -Literature Review on FI and the main Issues addressed.

Author	Main Issues Addressed					
	Social	Environmental	Business	Logistics	Market	Product
Basu et al., 2013		X		X	X	
Bhatti and Ventresca, 2013					X	
Bhatti and Ventresca, 2012	X				X	
Bocken and Short, 2015		X	X			
Bound & Thornton, 2012		X	X		X	
Carina Millstone, 2014		X	X	X		
Eagar et al., 2011			X			X
Hamacher & Rai, 2015	X				X	X
Herstatt & Tiwari, 2012					X	
Iain Cameron, 2012			X			
Kahle et al, 2014	X					
Kondis and Stehli, 2014					X	
Pansera and Sarkar, 2015						X
Ray and Ray, 2010			X			
Roland Berger, 2012			X		X	X
Roland Berger, 2014			X		X	X
Roland Berger, 2015			X		X	
Roland Berger, 2015			X		X	X
Rosca, Bendul, & Reedy, 2015	X	X				
Sharma and Iyer, 2012						X
Soni, 2013			X		X	
Tavoletti, 2013	X		X			X
Tiwari and Herstatt, 2012						
Tiwari and Herstatt, 2014			X		X	
Tiwari et al., 2014			X			X
United Nations Development Programme, 2014	X		X		X	X
Winterhalter et al., 2012			X			
Wohlfart et al., 2016						X
Zanandrea et al., 2012						X
Zeschky et al, 2014			X		X	
Zeschky et al, 2014			X		X	
Zeschky, Winterhalter, & Gassmann, 2014					X	

It can also be seen that the available literature on Frugal Innovation is much more oriented towards emerging markets, not mentioning the reality of the LDCs, in which the market cannot yet be considered as emerging.

### 3.7 Chapter Conclusions

FI is a path to pursue if the needs of constraint-based markets are to be satisfied whilst remaining competitive and providing quality. FIP are developed on the basis of functionality and affordability and they are driven by what the target consumers need. The FI process is therefore a bottom-up process that is now starting in emerging and developing markets.

FI can be compared with other types of innovation developed the BoP. However, FI stands out for being a product and process-oriented innovation that uses the BoP both as a market and a source for innovating. Successfully working in and for the BoP necessarily entails operating locally (using local suppliers, production, distribution channels, etc.).

Both emerging and developed markets can benefit from the implementation of FI products in the market, but the greatest challenges are found in the EM.

Sustainability is of the most importance to FI. Frugal innovation has a manifest impact on social, economic and environmental sustainability. Whereas other types of innovation focus on only one or two of the three sustainability pillars, FI has the potential to address all three.

The sustainable management of a Supply Chain entails coordinating all SC processes. Moreover, the SSCM drivers, enablers and barriers must be taken into consideration because an SC is not an isolated organism and external pressures play a key role in the overall success.

Green Supply Chain Management and Closed-loop SC strategies can be extremely useful when trying to establish a sustainable supply chain. The former focuses on introducing green changes into the traditional SC, while the latter takes advantage of the return flow of final products.

Logistics is the core element of SCM that leads to the delivery of the right product to the right customer, in the right place, with the right price, while assuring its right conditions and quality. The entire process must take place at the right time. The inclusion of the sustainability goal means that adopting strategies like Green Logistics or Reverse Logistics must be adopted.

Different strategies must be applied in line with the target market and adjustments made to the SC to successfully satisfy customers' needs. Whereas a SC for developed markets can focus on efficiency, the focus in emerging markets must be on lowering the costs and designing products with basic functionalities.

There is still little knowledge about SSCM for FIP, but some research is now underway. The project design/design for logistics is fundamental when working with FI as it impacts Sustainability and, therefore, the SSC for FIP.

## Chapter 4 – Methodology

This chapter gives an overview of the methodology applied in this dissertation and presents the Action Research (AR) methodology and methods of inquiry. Section 4.1 introduces the methodology by providing definitions and main characteristics. Section 4.2 explains how AR is to be applied, describing each step. Section 4.3 the AR learning cycle is explained. Section 4.4 concludes.

### 4.1 Action Research

It is only possible to broaden the knowledge on how to sustainably implement FIPs in LDCs by complementing a literature review on the subject with experimentation and learning from the process.

Action Research as a research methodology assumes that a complete understanding of a system entails trying to change it. It is this aiming for change move that makes AR different: AR is about taking that required action and working to make something happen.

This methodology was chosen with the aim of both problem solving and contributing to science AR allows the generation of situation specific, emergent and incremental theory:

- An AR project does not set out to generate theoretical universal knowledge, but the generation of theory is an incremental cycle that emerges from reflection on the data, implementation and outcomes of applying the methodology. (Brannick & Coghlan, 2005)

Working directly with the team that brings a project to fruition and being part of that team can shed new light on theoretical knowledge that may lead to its improvement. Real-world information that could have a practical impact on theoretical literature knowledge is usually lacking. The opportunity of being part of something real is what makes a particular AR project significant.

According to Brannick & Coghlan (2005) There are four main conditions for the successful execution of the AR Project:

- Participation. an AR Project must reflect the cooperation between the AResearcher and the members of the organisation.
- Real-life issues. The AR project is guided by a concern for real life practical outcomes. It is governed by constant and iterative reflection as part of the process of organisational change and improvement
- Joint-meaning construction. The process of integrating events, articulating meaning and generating understanding, must be a collaborative process between the AResearcher and the members of the organisation
- Workable solutions. The AR project must engage in significant work and sustainable change has to come out of the project.

An AResearcher requires skills in diagnosis, intervention in organisational issues and problems, learning in action and journal keeping. Designing the AR project confronts the AResearcher with

the question of framing the issue, determining its scope, gaining access and negotiating an appropriate role. The researcher needs to position the research in relation to both the research programme and to the needs of the organisation(Coughlan & Coghlan, 2002).

## 4.2 Action Research steps

AR focuses on both investigation and implementation processes. It offers the possibility of gathering data in the field by using non-traditional methods while involving the practitioners who want to improve organisations and communities.

An AR project comprises a pre-step and four basic steps, as shown in Figure 20

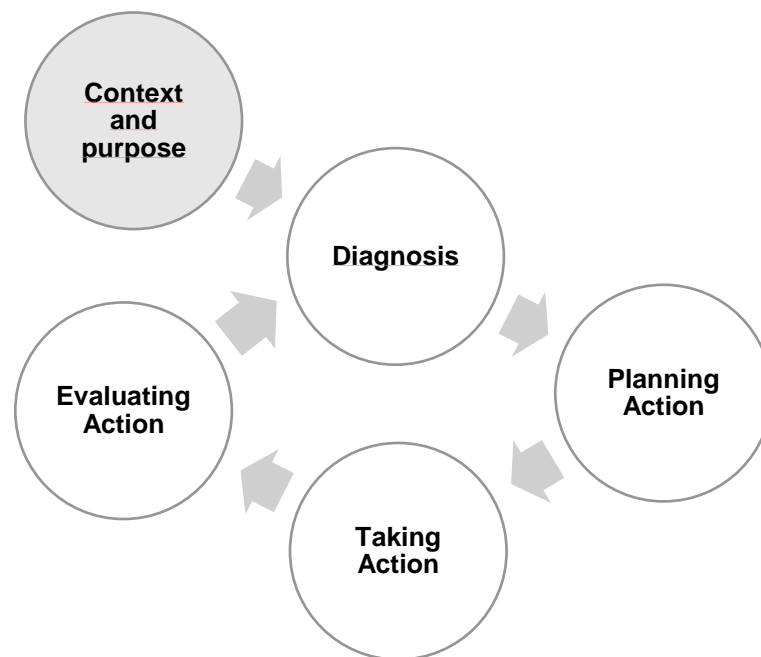


Figure 20 - AR Steps

### 1. Context and purpose (pre-step)

This AR cycle pre-step provides a better understanding of the project, the driving forces for its implementation and the desirable outcome of the AR. The ethical background must be also taken into account:

- Actions have a direct and indirect impact on “the roles, responsibilities, accountabilities and actionabilities of the people, so cannot be treated without ethical considerations”(Brannick & Coghlan, 2005).

For the AR project in question, a “pre-understanding of the corporate environment, the conditions of business, the structure and dynamics of the operating systems”(Brannick & Coghlan, 2005) is required, as well as an understanding of the context and actual situation of the country, the communities involved, the company project. These goals are achieved through pure inquiry. Observation and Reflection allows the base for action to be structured.

## **2. Diagnosis**

The diagnosis phase in the AR cycle comprises a framing of the project with regards data. This collaborative stage includes gathering, feedback and analysis of data. It is during the diagnosis that the framing of the issues takes place, as well as the selection of which issues are to be solved in the following action related stages.

Most data is gathered based on perception, observation, discussion and inquiry. This data is generated from working directly with each work team, helping solve problems and developing the project. Being a systematic presence in the daily actions, with a directly observable behaviour, can provide a better understanding of people's behaviour and relationships as well as the basis for inquiry.

Providing the correct feedback on the generated data to the managing department is a key factor for the accuracy of the following analysis. At this point, communication is considered a major concern. Presenting data, ideas, changes can be a hard and time-consuming mission. Analysing the data for proceeding to action planning needs to be a collaborative process. Everyone involved must be in agreement with the analysis conclusions so the project can evolve.

A global and workable issue needs to be selected and framed. The action steps are then to be planned and taken so that the chosen question can be successfully resolved.

## **3. Planning Action**

This collaborative step concerns the preparation of the action to be executed:

- Questions regarding bureaucratic authorisations and formalities, factory building, machine choice and delivery, and the structuring of both the supply chain and logistics, must be addressed.
- A managing team responsible for each major sector must be formed.
- All required actions need to be allocated to distinct areas: Business Innovation, Sustainability Impact, Supply Chain Flows and Logistics Activities.
- All sectors are of major importance and all actions must take place at the right time.
- Working in collaboration with each sector team, and also with local institutions and people is essential and the certification processes are extremely valuable.
- Everyone involved is required to understand the importance of making things happen and following the established guidelines. For that purpose, meetings must be held with the managing team and subsequently with the employees to explain the process and to encourage the commitment of the working teams.
- All planning is to be undertaken in line with the requirements of the owners of the organisation and its business strategy.

The best way to involve the managing team and to ensure everyone was onboard is to present them with the planning action; exploratory diagnostic inquiry (where the AResearcher can

understand the emotions and thoughts of all stakeholders and act in accordance) is the strategy used to manage the team's perception of the project.

#### 4. Taking action

At this stage, the planned action is to be implemented, and all interventions made. A two-year timeline was established for this step of this FIP implementation. All actions are to be presented separately in the different base\key elements: **Business Innovation, Sustainability Impact, Supply Chain Flows and Logistics Activities.**

Working as both the AResearcher and the project's COO, managing all the different project elements, requires being in control of many people. For this purpose, making use of several inquiry methods ensures a better understanding of everyone's perspectives.

A confrontive inquiry method is to be followed during the project implementation. This method allows the AResearcher to present ideas and challenges to all employees, showing a path to be followed but keeping the possibility open for them to propose inputs and complementary solutions.

#### 5. Evaluating action

In this final step, all the actions that took place while working to resolve the framed issue are to be evaluated. It is necessary to answer questions like whether the action taken was correct or taken in the appropriate manner and to determine what is left for another AR cycle.

### 4.3 Learning cycle

Within each AR step, the AResearcher goes through a learning cycle. It provides the perspective necessary to contribute to academic knowledge, achieved after combining all the leaning cycles that take place in each AR step. This learning cycle includes experiencing, reflecting, interpreting and taking action.

How the AR project steps and learning cycle are combined is shown in Figure 21.

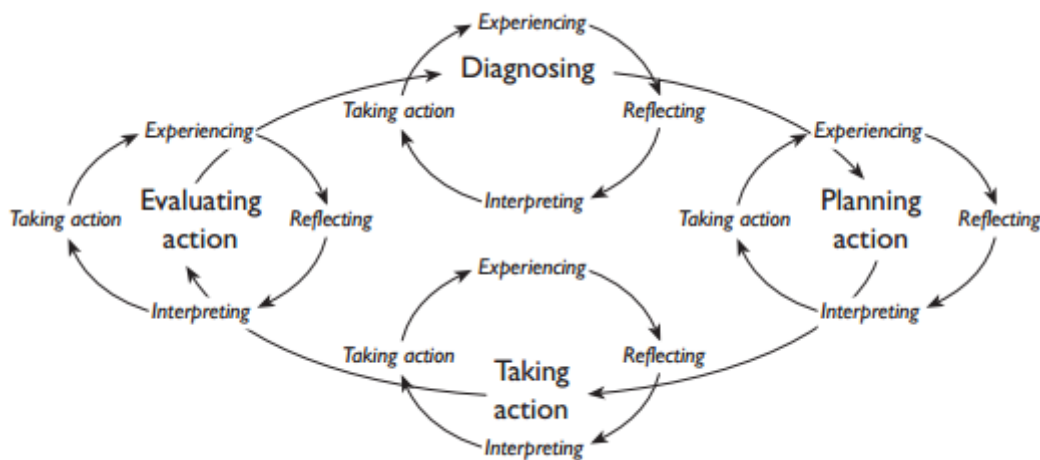


Figure 21 - AR Learning Cycle

For the purpose of this AR, the learning cycle for each AR step is to be presented in boxes, associated with the different key project elements: Business Innovation, Sustainability Impact, Supply Chain Flows and Logistics Activities.

#### 4.4 Chapter Conclusions

This chapter set out the methodology to be applied in the implementation of an FIP in an LDC. Action Research is determined to be the most appropriate research methodology since it allies the resolution of real-life issues with the contribution to academic knowledge. It allows what is normally theoretical expertise to be experienced and may add critical value to it.

The implementation of the AR project encompasses four main steps: diagnosis, planning the action, taking the action and evaluating the action; these steps are preceded by a pre-step which contextualises the project.

Within the execution of the AR project, each step is associated to a learning cycle, providing a starting point for the contribution to the existing knowledge.

## Chapter 5 – Implementation of Valúdo

Chapter 5 addresses the implementation of the AR Project – Setting up Valúdo as a Sustainable Frugal Innovation Project in STP - using the AR methodology, Section 5.1 presents the context and purpose of the AR project, underlining its characteristics and the driving forces for the project implementation. Section 5.2 sets out a diagnosis of the issue in hand. Section 5.3 describes the planning of the necessary action for the resolution of this issue. Section 5.4 is the action step of the AR cycle. Section 5.5 offers evaluation of the action taken and Section 5.6 concludes.

### 5.1 Context and purpose (pre-step)

An FI Project like Valúdo can have a significant social and environmental impact as well an economic impact. Implementing Valúdo in a country with the many constraints described in chapter 1 can bring benefits for both employees and the communities where the coconut is to be purchased and enhance the country's international recognition. The national industrial sector can also gain from this industry modernisation and utilisation of local raw materials that normally go to waste.

The coconut is in itself a frugal fruit as every part of it can be used to produce other goods. It is a low-cost raw material that is transformed into affordable products that are easy to introduce into daily life and it can really make a difference. The manufacturing process is also very simple. In STP, making use of every possible sub-product of the coconut means that a large portion of the population would have cheaper quality alternatives for daily use. In sum, the whole project was developed from a frugal innovation perspective.

Sustainability was an important driving force for the implementation of Valúdo. With an impact on the people, planet and profit, the aim of bringing the Valúdo project to fruition was to minimise some of STP's development gaps. It was essential to understand that the business could only evolve if it sought to be a profit-making venture and the assumed market value of the product was assured.

As very few companies in STP were capable of exporting and the large majority employed fewer than 25 people, it was expected that the new business project would be welcomed. Nevertheless, the many bureaucratic constraints inherent to a new business were foreseen. The communities working directly and indirectly with Valúdo were expected to welcome the project and help it succeed.

Valúdo aimed to be the biggest sustainable Santomean company working with coconut. The long-term goals were to recover all the coconut tree fields, to make the collecting system environmentally sustainable and the factory self-sustainable, to obtain several important certifications and to enter the international market.

Starting in May 2017, this company wanted to sustainably develop the production of high-quality coconut sub-products. Now directly employing 65 workers and indirectly helping more than 300 families improve their incomes, this project has had a tremendous impact in STP. The results of Valúdo have helped give value to private foreign investment.



## 5.2 Diagnosis

As the previously available data required for the AR Project was very limited, which made an effective diagnosis difficult.

When the AR Project started, there was just the physical space for the factory. Information on the best machinery set and coconut manufacturing was collected during a trip to Sri Lanka and analysed in cooperation with the AR researcher and the CEO of Valúdo.

This AR project - Valúdo – began with the arrival of the AR researcher in the company and came to an end 2 years later. This time period would provide the opportunity to set, implement and manage the whole project.

The diagnosis entailed framing the AR Question: **Is it possible to sustainably implement a Frugal Innovation Project like Valúdo in STP?**

Although the choice of this issue would undoubtedly raise other questions during the action phase, it would offer a great opportunity to learn, to test and perhaps add to literature knowledge, for the professional growth of all involved, and hopefully the success of the business.

## 5.3 Planning Action

Every action plan needs to connect people with a strategy, information, and a timing, so that an idea can evolve into a project. The Action Plan of an AR Project is no different; a strategy must be developed for its execution, all the information required for a better understanding of the project collected, and realistic timings set for its execution.

### *Business Innovation Strategy*

Valúdo aimed to build the first certified organic and fair-trade coconut supply chain in Africa. The main products were to be exported and sold in high-end markets assuring the necessary capital flow for the project to prosper. All sub-products were intended to suppress local needs for similar products which are sold at a much higher price when imported.<sup>1</sup>

### *People*

This planning involves allocating the right people to the right positions with the right responsibilities<sup>2</sup>:

- The coconut purchasing manager (CPM) was given the following tasks: to determine which coconut tree fields were still in decent production condition; to meet the local producers and community leaders and introduce them to the company and its purchasing objectives; to structure a purchasing plan.

- The human resources manager (HRM) was responsible for announcing the start of Valúdo's hiring process, managing the candidate interviews and finding out about the contractual requirements and rules from the National Work Direction.
- Both the production manager (PM) and quality manager (QM) spent time learning the production process and quality requirements. They needed to learn about HACCP (Hazard analysis and critical control point), hygiene and safety, report making and people management in order to be able to apply all the concepts and rules when taking action.
- The CEO took the responsibility for the commercial area and general management. The construction plan of all infrastructures was also under the CEO's responsibility. The COO was assigned with planning and coordinating actions, managing all teams and resolving the daily problems.

#### *Information*

It was necessary to establish an information management structure from the outset with the team managers reporting to the COO and the COO to the CEO. Given that the number of employees was expected to quickly increase, the information flow would be eased if the managers and workers communicated well with each other and directly to the COO.<sup>3</sup>

#### *Time*

The implementation of Valúdo was planned to last 2 years, after which the project should be left on automatic pilot and require only daily management and supervision. During this time frame, the infrastructures required for the coconut transformation must be built, the supply chain structured, and the daily activities ensured.<sup>4</sup>

1. It was first important to understand and define the strategy since this provides a starting point for all the planning. The focus on frugality and sustainability, together with the desire to obtain both the organic and fairtrade certifications, were of the most importance to the analysis and operationalisation of all the required actions.
2. Defining this approach and sharing it with all the team members helped build a very good relationship with the whole team and improved everyone's work and focus; later, this also made it easier to understand the workers' doubts and needs and was therefore very beneficial. Moreover, an effort was made to know everyone's background and call each team member by name and to be available to talk about any question, problem and even small talk.
3. The right flow of information had a tremendous impact on the optimisation of the entire project. Failures in communication not only brought entropy, but also caused disagreements between workers, harming their dedication and the quality of the work.
4. Setting timings later helped divide the strategy into workable goals, which made the implementation process more objective.

## 5.4 Taking Action

Action was organised into key actions areas of project implementation, for a clearer understanding of what was required for its sustainable implementation.

### 5.4.1 Business Innovation

#### *Business Innovation Tactics*

Valúdo aimed to sustainably produce high quality coconut sub-products, to be sold in the local market and exported with the STP seal. The higher the exportation income, the greater the capability to develop solutions for local problems and needs.

Business Innovation Tactics are planned and executed to address gaps in strategy and imply actions and decisions related to client needs. They are: Product packaging, branding, sales and marketing

- **Packaging:** It was decided to create different packages for different uses. Normally, people use coconut oil in the kitchen for cooking or in their beauty routine in the bathroom. What is offered to them is a “one package fits all” solution. Valúdo wanted to do things differently. It was decided to have a body care version and a kitchen version. Moreover, since coconut oil melts at 24°C, it was clearly necessary to have an inside Africa and an outside Africa version. Valúdo uses jars for the outside Africa (or winter) version; an aluminium bottle for the kitchen and body care sprays was chosen for the inside Africa (or summer) version. Customers gave very good feedback on this strategy and agreed it simplified daily usage.
- **Branding:** the face of the products needed to attract customers. It was essential for the brand and the packaging design to capture all the product features, namely higher quality than the typical Asian competitors, truly helping communities and originating in a small historical paradise. A Portuguese designer assisted in this process as no one on the team had these skills.
- **Sales:** to assure a safe cashflow to the company, 95% of sales are in bulk. Selling coconut oil and flour in undifferentiated bulk packaging allows Valúdo to act as a supplier to other companies reselling Valúdo's products with their own brands or to supply clients who use the products as a component of other products. This sales strategy is applied to the international market. Nationally, Valúdo uses its own packaging and sells products directly to the public. Valúdo opened a small showroom at the factory for sales and advertising so that both locals and tourists can learn more about how the products are made and buy them.

#### *Business Innovation Operations*

Daily management of all areas responsible for the realisation of both the strategy and the tactics. The goal is to do this correctly or as correctly as the circumstances allow. FIP implementation comes down to successfully overcoming obstacles, creating solutions and delivering what is requested. Given the situation in STP, anything planned in Valúdo can change from one moment to the next and require a completely different approach.

## 5.4.2 Supply Chain Flows

### *The capital Flow*

The following actions were taken to assure the right capital flow and the outcome is explained:

- **Bulk Clients:** the goal was to export most of the production and Valúdo therefore searched for bulk customers. As Valúdo's CEO is French, the French market was investigated first. In early 2018, Valúdo got one major client who was willing to buy all the year's coconut oil production in bulk, with both the organic the fairtrade certificates (which means at the highest price due to the extra price percentage going to the fairtrade fund). This client assured Valúdo's first year of activity. However, Valúdo was new in the business and failed to ask for a 3-year purchase contract (required when working with the fairtrade certification); as a result, the client was not obliged to maintain its orders. In early 2019, no orders were confirmed by the client despite their assurances and so Valúdo spent four months struggling to survive while looking for other clients. After some hard work and good luck, other clients were found and nowadays it is hard to keep up with demand.
- **Payment/order procedure:** the production costs include the coconut purchasing costs and Valúdo pays the collectors and producers in cash every time the coconut is picked; therefore, Valúdo established that the customer must pay 50% of the order price when an order is placed. This guarantees that coconuts can be purchased and manufactured to fulfil the order; thereafter, 30% is paid with the Bill-of-Lading and the final 20% paid when the cargo is delivered to the customer's facilities. Valúdo uses the DDP INCOTERM for most customers, despite the risk for a company exporting from a country like STP.

The capital flow resulting from the application of the business innovation tactic ensured the viability of the sustainable coconut sourcing.<sup>5</sup> It was the payment/order procedure that enabled Valúdo to structure a sustainable coconut supply, developed in line with the requirements of the certification entity. At first, Valúdo used its own capital to start the supplying chain, but it was then maintained and fed by the payment/order procedure. Part of the money clients paid when they placed an order went directly to the sustainable coconut supply chain, to pay the producers and collectors working with Valúdo.

### Sourcing

Valúdo decided not to own any coconut tree fields. Instead, the goal was to rehabilitate the existing fields, some of which were owned by local producers and the rest by the government. In addition, Valúdo started the process of obtaining the Organic and Fairtrade Certifications as the coconut supply chain needed to be sustainable.<sup>6</sup> These two objectives entailed the following:

- A declaration from the Agriculture Ministry authorising the exploration of the public fields and stating that the fields had not been treated with any chemicals in the last 20 years;
- Partnership contracts with local producers guaranteeing that Valúdo was the only coconut buyer;
- Analysing all the plots of land for chemical sediments;
- Designing the coconut supply chain, whilst respecting the communities;
- Creation of a Fairtrade fund supplied by Valúdo's sales and to be used for improving working and community conditions;

Valúdo's sustainable coconut supply chain was then created based on a community structure in which community leaders are responsible for buying the coconuts collected by the community members, and producers work with their own teams in their own fields. Above them is the Coconut Purchasing Management, responsible for coordinating the whole process, informing the producers and community leaders on the weekly coconut need, delivering the necessary money for the week and ensuring the quality and transportation of the coconut. This structure can be seen in Figure 22.

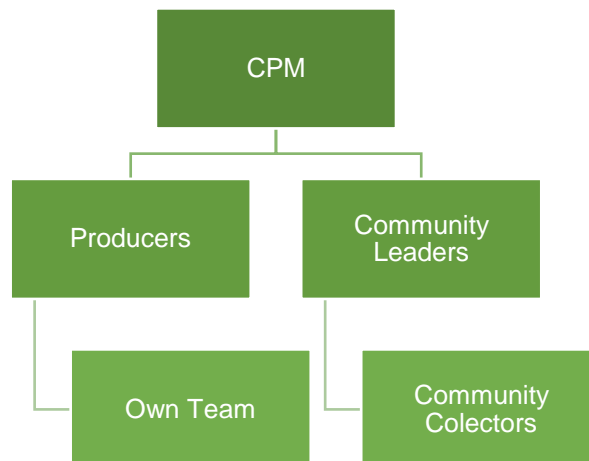


Figure 22 - Structure of the Community based SC.

The producer supply system differs from the community system in the following aspects:

- The producers are responsible for their own fields and for the coconut collecting process. Valúdo normally pays the producers for two weeks of coconut in advance. They are then responsible for paying their employees and delivering the coconuts according to the defined schedule;

- The producers are placed between the community collectors and leaders, from whom the coconuts are sold at a higher price, making sure the costs of managing the fields are covered.
- The community leaders take sole responsibility for managing the coconut buying. They earn a monthly fee, which corresponds to a percentage of the purchase they assure, and the community collectors are paid when they present the coconut at a stock point. Valúdo values the relationships between community members and leaders, which has proved very important factor when there is a surge in demand coconut increase;
- Valúdo is responsible for creating the stock points in the communities and ensuring the coconut bags are stored safely in clean locations. The producers are responsible for their own stock areas;

All suppliers have regular inspections and training sessions on the quality, ripeness and safe collection of the coconuts.

About 90% of the coconut comes from the communities. There, the Coconut Purchasing Team are responsible for inspecting the coconut and doing the first quality check. This process can be seen in Figure 23. This inspection process involves analysing 10% of the bags, looking for the right ripeness and signs of rotting and checking if each bag has the correct number of coconuts (90).



Figure 23 - Coconut Inspection Process

## Manufacturing

The next area in the The Coconut Flow is the manufacturing of the coconut to make the Valúdo products. The mostly mechanical set-up of machines allows the company to reduce the problems caused by energy breakdown which would be very difficult to resolve in STP; it also aimed to stimulate employment because most tasks require manpower and therefore more workers were hired. It was better to depend on people than on electronic equipment that required more specialised maintenance.

The installation of the production machinery was a complex process:

- First all-cargo was transported from the STP port to Valúdo's site. The unloading tools at port were not working, there were insufficient port workers and the truckers responsible for the transport could not guarantee safe transportation. Nevertheless, 90% of the machinery was unloaded using manpower and goodwill and loaded again in the truck. Figure 24 shows part of the cargo in the truck, ready for transport.



Figure 24 - Machinery Unloading Process

- Secondly, the machinery was set up at the Valúdo facilities. Again, with the help of the workers and just one poorly maintained pallet truck, all machines were put in place and connected. Figure 25 shows the moment the sedimentation tanks were installed.



Figure 25 - Machinery Installation

- Finally, all the equipment and process was tested. One of the tests on the oil expeller machine can be seen in Figure 26. This testing process was done not only to ensure all

machines were functioning correctly but also to teach Valúdo's team how to use them. The entire production process was implemented and adapted to the people's usage and production timings.



Figure 26 - Machinery Test

Nowadays, the installed production capacity is around 14 tons of coconut oil per month. This means about 250,000 coconuts can be used per month. This process requires 60 full-time workers, divided into the different production stages.

Before being used, the coconuts are checked to see if they are over-ripe and for signs of breakage. The first production stage is coconut deshelling, shown in the first image of Figure 27. The coconuts are then peeled and disinfected (second image). After these two simple very manual processes, the coconut flesh is ready to be crushed and dehydrated at a controlled temperature; after dehydration, the dry grated coconut (third image) is ready for the cold pressing (this allows the oil to be considered extra-virgin) stage where the oil is obtained (fourth image). This oil is then left for sedimentation, filtration and stocking. After all this, the certified extra-virgin organic fair-trade oil is ready to be exported in 1000L sustainable tanks.



Figure 27 - Production Steps



### *The Information Flow*

A flow of information was established to support the flow of both coconuts and capital. Weekly meetings were scheduled at the end of each week to set both the production volume and the coconut requirements so as to permit better planning for the following week.

Production volumes could constantly change due to our decision to produce only when there were client orders (keeping a low safety stock) or due to the dry season when coconut growing slows down. Dealing with these daily changes meant everyone involved had to communicate well so everything could be adapted.<sup>7</sup> In addition, for the purposes of traceability, reports and information on each step were registered and available for clients to see.

5. The project viability depended on the capital flow as this guaranteed the working capital necessary for the coconut supply. A setback in this flow could mean that the community collectors would be left without means of subsistence, and this would lead to the collapse of the whole supply chain and the failure of the project.

6. The coconut flow is the soul of the Valúdo project. The organic and fairtrade certifications were a very good way of ensuring a sustainable supply chain. It was with the help of the certification requirements that Valúdo was able to structure a coconut supply chain focused on both the coconut and the communities.

7. Promoting this work-related communication and adaptability was one of the hardest things when managing the teams in their daily activities. Most of the workers lack the critical sense necessary to adapt an activity to new circumstances or problems. Giving them the freedom to resolve problems and making them think of a possible solution turned out to be a good strategy.

### 5.4.3 Sustainability Impact

#### *Planet*

Valúdo needed to be sustainable. Working on both organic and fairtrade certifications was a step towards that goal. Valúdo stood out by becoming the first coconut manufacturing company with both certificates in Africa. The company entered a network of certified companies where customers can search for suppliers. The decision to embark on the certification process was so quick that Valúdo had two months to prepare all documents and to comply with all requirements, if it wanted to start its start up with both certificates in place. It was a hard task. Valúdo needed to register all local coconut suppliers, mark all coconut tree fields, and obtain a document certified by the National Government assuring no national coconut tree field had ever been treated with chemical products. After that, the certification auditor spent one and a half weeks in STP analysing all the fields, interviewing locals in the communities and Valúdo workers on the work conditions, and collecting material for lab analysis to ensure Valúdo's products were 100% organic.<sup>8</sup>

8. Although a challenge for all the Valúdo team, obtaining both organic and fairtrade certifications was really important for the project's sustainability. These certifications make Valúdo work hard every day so that the high standards are always met. I am unsure whether these certification companies are really focused on improving and controlling the certified projects. If they are really concerned about the planet and the people using safe and fair products, perhaps these companies should be national institutions rather than private companies demanding very costly certification processes. This would help many small businesses to sustainably improve their activity by providing them with the right tools. Nowadays, a certification process can be seen as just a marketing move.

The development of the 1L reused bottle of coconut oil was another step towards positively impacting the planet. Valúdo noticed the volume of glass bottles going to waste in hotels; as there was no waste treatment in STP, the team had the idea of taking these bottles, filling them with Valúdo's coconut oil, and selling it locally. This new package reduced waste and, because it was made of glass, ensured the quality of the product.

As the bottles were from a recognised Portuguese brand, Valúdo obtained permission from the company to use their bottles for the new product. Once permission was granted, Valúdo started to collect the bottles from the hotels and, as can be seen in Figure 28 the new package was created.



Figure 28 - Collected Bottles and new Packaging

### People

At the start of the project, Valúdo had only one car, a pick-up, which made it hard to transport the employees to work each morning. Valúdo was worried that rising fuel prices would also increase the cost of daily transportation prices. A large percentage of the workers live in the main city and this made it too difficult to support the monthly cost of transportation.

In early 2019, another pick-up was purchased thus allowing Valúdo to respond to one of the workers' main needs by assuring daily morning transport for everyone. The strategy was to define a pick up point in the main square of the capital and everyone who was there at 6.50a.m. was transported to work. This not only helped the workers save some money, but also improved Valúdo's morning productivity as all workers arrived on time. Along with this measure, Valúdo started to pay all team managers a weekly fuel allowance.

### *Profit*

In 2019, it was urgent for Valúdo to become self-sustainable. Since the start of the project, Valúdo had wanted to have a positive impact on the people working directly and indirectly for the company, the communities, the environment and economy, while still being profitable for the investors. But due to national problems regarding water, energy and fuel, it also became essential to be able to function without depending on the national supply of these resources.

To resolve this problem, Valúdo had to make a major investment which the investors rapidly agreed to due to the importance of the necessary changes in the Valúdo facilities. These changes are still in progress and they include:

- Creating Valúdo's own water supply system: The factory is located in a region where precipitation levels are high. Nevertheless, the national water supply company does not guarantee a regular water supply. Valúdo is therefore implementing a rainwater collecting system, linked to a filtration zone and water storage tanks.
- Eliminating the need for the supply of fuel for production: Valúdo will eliminate the need for kerosene by installing a boiler to heat the coconut dehydrators. The coconut fibre is separated from the shelled ball in the fields to maximise space efficiency; this is later collected and will be used as fuel for the boiler.
- Energy supply alternative: the heat from the boiler can also be used to generate power for the rest of the production process.
- Solar panels installation: the installation of a solar panel for the management offices generates the necessary power for the daily use.

Making use of all coconut sub-products also fosters sustainability. It is during the oil production that the sub-products emerge. <sup>9</sup> The coconut fibre is also being tested for use in making bricks for local construction. Some of the coconut shell is being exported for filter integration and coconut shell charcoal is being developed locally as a sustainable and more efficient alternative to the common charcoal. The coconut skin is sold as a cheaper and healthier alternative to imported synthetic animal food and is given to locally bred pigs and chickens. The production of a lower quality oil obtained using this skin is under development and will be sold locally as a substitute for imported GMO vegetable oils (because they use a lot of low-quality oil for cooking in STP). The coconut bran, resulting from the dry grated coconut pressing, can be sold to animal breeders but it can also be ground into coconut flour when required, serving as a high-quality gluten free product that can substitute the regular flours used in cooking. There is also the coconut water,

which is currently only used to give to customers visiting the factory, but the goal is to integrate it in the supply chain in the near future for local sales.

9. It is vital to understand the importance of cash flow, associated with the profit impact. The flow coming from the sale of the main product provides Valúdo with the means to invest in developing the other sub-products that can serve as alternatives for imported lower quality, more expensive, unhealthy products. This main flow also secures the coconut supply, responsible for indirectly employing hundreds of community members and the development of the communities. Although the high-quality coconut oil is not a frugal innovation product, the whole supply chain works in the most sustainably frugal way.

#### 5.4.4 Logistics Activities

Valúdo's logistics can be divided into two areas: coconut supply activities and exportation activities. The logistics for both are based on three important dimensions: time, place and price.

##### Coconut Supply Activities

Within the coconut supply, Valúdo is responsible for collecting the coconut at the stock points and delivering it to the factory facilities. This includes moving the coconut from the stock points (where the first quality control takes place) to the transportation vehicle (the boat used to transport the coconut from Ilhéu das Rolas, a smaller island where the most important coconut tree field is located, to the main island), loading the truck and ensuring the transport of the coconut bags to the Valúdo installations. All this process can be seen in Figure 29.

At first it was decided that to outsource this process to a transport company with Valúdo team loading the coconut onto their vane. But due to the cost and lack of space in the vans, Valúdo decided to buy its own truck to make up to 5 trips a week to the communities with a capacity of 250 coconut bags.

To reduce the cost of this activity, Valúdo worked on forming partnerships. One of these partnerships was with Pestana (a Portuguese hotel chain which has a resort in Ilhéu das Rolas and owns the exploration license). On one hand, the hotel needed to transport supplies from the capital to Ilhéu and, on the other, Valúdo wanted to exploit their coconut tree field. Valúdo therefore offered to transport their cargo in exchange for collecting the coconut and using their boat to transport it from Ilhéu to Porto Alegre where there is another community stock point managed by the same community leader. This partnership made it possible for both companies to optimise resources.



Figure 29 - Coconut Supply Activities

Valúdo had a daily struggle with problems arising from this activity: flat tyres (with no sub-tyres or new tyres available in the country), engine failure, fuel shortage in the country, flooding, workers for the loading absent from work, and community members not available to collect coconut due to local festivities. As a result, Valúdo always had a back-up stock (which was often not enough to deal with the disruptions in supply) and had to come up with on-the-spot solutions on a daily basis.

#### Exportation Activities

Valúdo started exporting in May 2018. Although they knew it would be a difficult process, but even after 10 exportations it did not get any easier. Valúdo already exported coconut oil and coconut flour in bulk, fresh coconut, coconut shell, and the B2C products.

The first time goods were exported, no one knew about the necessary documentation, mandatory labelling or the timings and sequence of each authorisation needed. Valúdo therefore asked another company operating in STP for help. With their advice, Valúdo chose Antwerp as the discharge point and to work with the same logistics partner for forwarding, processing, customs declaration, warehousing and distribution. The other company also helped explain the documentation needed.

On another occasion, Valúdo tried to export fresh coconuts in a refrigerated container. Although the team already knew the procedures (analysis, origin certificates, customs export authorisation, certification entity cargo validation), this time Valúdo had no pallets, no closing bags machine and no wrapping plastic (Valúdo had ordered all the necessary material but it had not arrived on time); it was also unable to get the loaded container onto the transportation truck because the available crane could not lift such a heavy container. As can be seen in Figure 30, images 1,2 and 3, the solution was to buy pallets from the food importers who sell them after they unload their cargo, hire a shoe maker who could close all the bags manually as they had done with coffee and cocoa bags in the past, and for two trucks to lift one refrigerated container. In the end, it was another mission successfully accomplished.



Figure 30 - Exportation Activities

After some problems with damaged containers and cargo, delays in shipping transit, and other logistics problems with one of STP's existing shipping agencies, Valúdo decided to work exclusively with one particular ship owner and for its shipping agency to manage the shipping, Export vessels are in short supply every month but it is safer to wait and send more containers each time than to deal with problems and damage. In 2019, Valúdo started sending two containers every time as the interval between export vessels is around 40 to 50 days and demand is rising.

Dealing with unpredictability and resource constraints make it difficult to rely on a logistics activity plan. Not only can the supply of the project's raw material fail, but also the delivery deadlines agreed with clients. Both aspects were critical for the project to succeed.

Knowing in advance that problems could arise helped the team be prepared at all times and to know of what to do if something went wrong.

Nothing can fully prepare a team for the constraints and problems of the operational area of the project. It was only by overcoming the obstacles that the team learnt to deal with it better.

## 5.5 Evaluating the action

After the two-year period for the implementation of the AR Project, it was time to evaluate the action taken.

As a starting point for the evaluation, the answer to the AR question (**Is it possible to sustainably implement a Frugal Innovation Project like Valúdo in STP?**) is **yes**.

Nevertheless, it was far from a linear and simple process. There were many unforeseeable setbacks and constraints. Managing the implementation of the project required constant monitoring of all the key action elements.

The planning is the first area for evaluation. To implement the AR Project, the managing team had to be able to coordinate the strategy with the people involved and ensure the information and timings were shared and understood. In such an overwhelming environment where everything was a priority, it was difficult remain focused on what was most important or necessary. As result, the managing team had to adjust and readjust the strategy timings several times and this might sometimes have been frustrating for the people involved. It would have been better to follow the initial plan until each task was complete; however, perhaps it was the ability to improvise daily that made the project prosper. Teamwork, adaptability and resilience were defined as the most important characteristics for a member of the managing team in a project with these characteristics.

Concerning the supply chain flows, notably the coconut flow, structuring the sourcing and production with the sustainability of all the coconut supply chain and the functionality of the production in mind proved to be the right bet. Despite the unpredictability of this supply in a country with so many constraints, the flow of information allowed most difficulties to be overcome. It was the capital flowing from the clients to the coconut supply chain that provided that necessary working capital

Given that sustainability was one of the driving forces of the Valúdo project, it was expected to be a more regular concern. Although many decisions were of course made to improve and ensure the project's sustainability, this was not always a priority due to the difficulties in other areas of the business. It was only after the project was established and when there were concerns about self-sustainability (with energy, fuel and water shortages) that Valúdo started to push sustainability measures. Nevertheless, many small steps were taken towards sustainability along the way.

Logistics were the key action area with the most serious difficulties. Valúdo understood that one plan for each activity would never be enough and that good motivational leadership focused on problem solving and adaptability was vital for the success of its activities.

The design of the whole project was focused on simplicity, adaptability and resilience. Whether it was for the selection of machines and human resources, the sourcing strategy, production, logistics, or sustainability, Valúdo had to function as a living entity that was always ready for the next move.

It is important to state that the project would have struggled to succeed without a significant flow of investment, albeit as working capital. Investing in self-sustainable solutions was expensive, as was maintaining the coconut supply when there were no orders.

## 5.6 Chapter Conclusions

The implementation of the AR project implied going through a number of phases. The context, purpose and diagnosis provided the base elements for the action plan. This step proved to be critical given that having the right strategy for the business innovation and its correlation with people, timings and information has a tremendous impact on the subsequent action taken.

Taking the action was key to understanding whether or not an FIP like Valúdo could be implemented in an LDC like STP. Implementing all the project planning provided a clear understanding of its constraints, problems and success factors.

The evaluation of the action taken was positive and this opened the possibility to extrapolate the AR Project conclusions to a wider reflection.



## Chapter 6 – Implementation Framework for FI Projects

Chapter 6 offers an overview of the framework developed to help structure the implementation of FIP in LDCs. Section 6.1 describes how the framework has been developed. Section 6.2 introduces the elements of the framework before it is presented in section 6.3. Section 6.4 gives a detailed explanation of the key action elements of the framework and section 6.5 demonstrates how these elements are correlated. Section 6.6 explains the use and scope of the framework and section 6.7 concludes.

### 6.1 Framework Development

The implementation of an FIP is not finished once the project is executed; it is a continuous process which requires constant adaptation and flexibility. Nevertheless, it seemed appropriate to develop a framework based on the knowledge gleaned to benefit future FIP.

Moreover, this framework is not intended as a guide to be read and applied once in the conceptual phase, but as a tool to assist managing teams in their regular decision making.

### 6.2 Framework Elements

The action planned and taken in Innovation, Sustainability, the Supply Chain and Logistics, namely the basic key elements (KE) when developing an FIP led to the identification of the 4 key action elements (KAE) of the framework: **Business Innovation, Sustainability Impact, Supply Chain Flows and Logistic Activities.**

Additionally, **Design** was included as the fifth Key Element (KE) due to its relevance. The design is intrinsically related to the other 4 KAE as it serves as a base for their development:

- Product Design for the BoP
- Design for Recyclability
- Closed Loop Design
- Activities Integration Design

Therefore, the framework is first organised in these 4 KAE, each of which needs functional elements. The connections between all of these sub-actionable or functional elements (FE) need to be defined and linked to make the framework functional.

### 6.3 The Framework

Figure 31 displays the framework for FIP implementation.

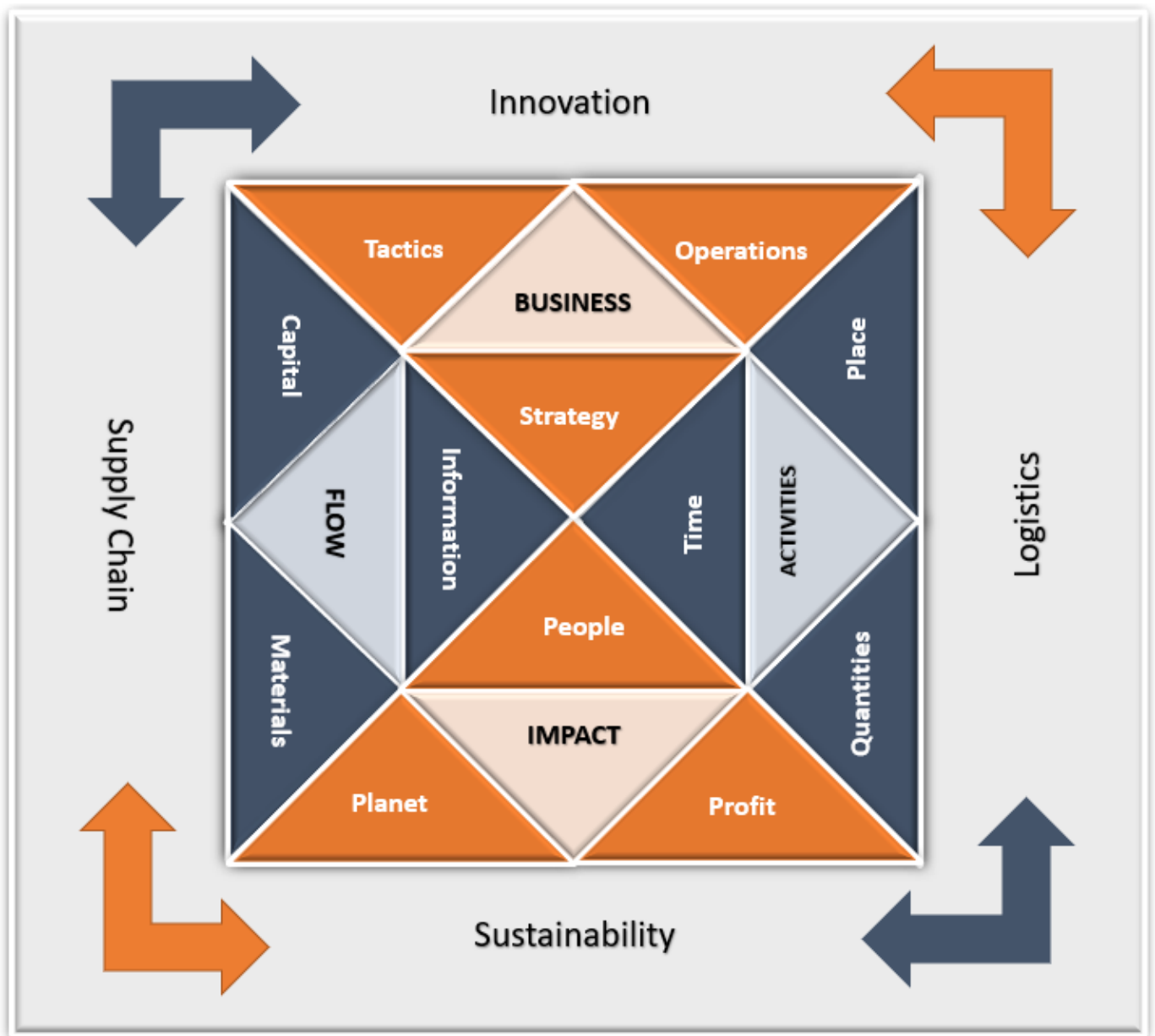


Figure 31 - Implementation Framework for FIPs

### 6.3 Key Action and Functional Elements

Starting with the conception of the four KAE; it was essential to define the KAE simply using common terminology related to the subject that could be understood by any potential user of the framework, notably in less developed countries.

#### Business Innovation

The three main questions regarding creating value when starting a business (the first KAE) and, more specifically, a frugal innovative business are: How do I want to create value (strategy), how am I going to achieve that purpose (tactics) and what do I need to have and do to be successful (operations). Based on this, the FE “strategy”, “tactics” and “operations” are defined and related, as can be seen in Figure 32. The tactics, strategies and operations must be adopted in line with the different business ideas.



Figure 32 - Business Innovation KAE

No differentiation is made for the type of innovation to make the KAE structure more embracing.

It is important to take the circumstances of the country when innovating, whether or not the aim is FI.

Nevertheless, when adapting the KAE to Frugal Innovation Projects, the FE must also be refined. As established in chapter 3, FI can be achieved not only by creating products that follow the FI values, but by seeking FI strategies, following FI tactics and/or by frugally innovating the operations required to sustainably implement a business project.

FI seeks to create more value, for more people, using fewer resources. This is its strategy. Tactically, it focuses on innovation based on needs and functionality within least developed countries, and it is both product and process oriented. Operationally, it strives to source and market its materials and products locally at affordable prices.

## Sustainability Impact

The second KAE to consider is sustainability impact. An innovative business project can only be sustainable if the impact it will have on the people directly and indirectly involved, on the planet and on profit is understood and structured. As can be seen in Figure 33, the three FE for sustainability impact are: people, planet and profit. These 3 Ps represent the impacts, both positive and negative, that an FIP may have in society, the community in which it is inserted, the surrounding environment and the economy.

It was decided to choose “people” over “social”, “profit” over economic and “planet” over “environment in order to show a bigger picture and select more meaningful words for the users.

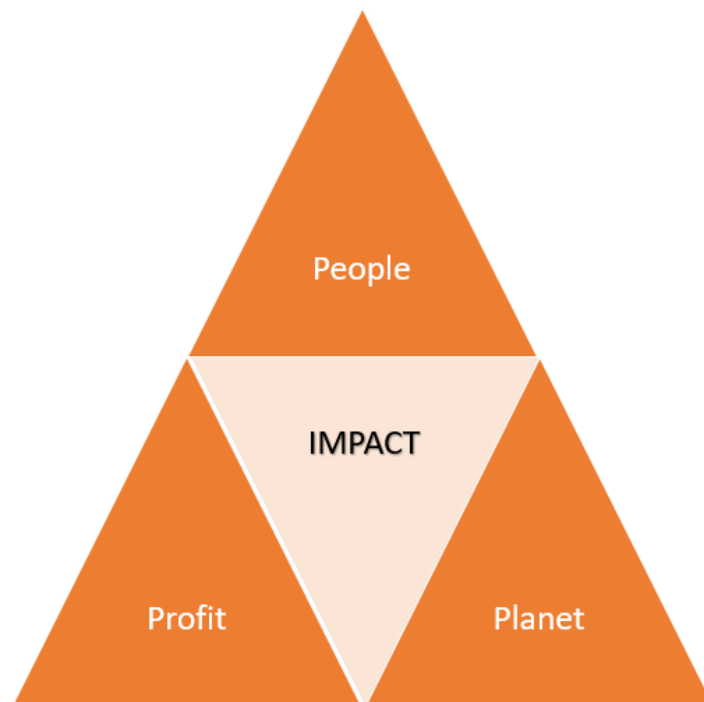


Figure 33 – Sustainability Impact KAE

Impact is difficult to understand due to its subjectivity. The goals of an FIP impact are, as described in section 2 of chapter 3, related to helping a country's development. Promoting education, higher living standards and job creation, forming local collaborations, reducing waste, using fewer resources, among others, can be a challenge due to the many natural restrictions in a least developed country.

It is not possible to boost sustainability if the project is seen in isolation; sustainability can only be achieved if the project is considered to be part of a community in which everyone must contribute.

Success will bring benefits for all the direct and indirect stakeholders and this impact may help create other projects with the same goals. These stakeholders are usually suppliers or clients who are part of the project's supply chain.

## Supply Chain Flow

The implementation of an FIP\business, be it a product or a service, always entails a flow of information, capital and materials: The Supply Chain Flow (KAE). This flow is one of the hardest actions to manage due to the many restrictions and constraints associated with the country where the project is to be developed.

It is easy to design, understand and plan how this flow of information, materials and capital (FE) should take place. An inefficient flow is a major and significant cause of project failure.

Bellow, Figure 34 presents a visualisation of the KAE flow.

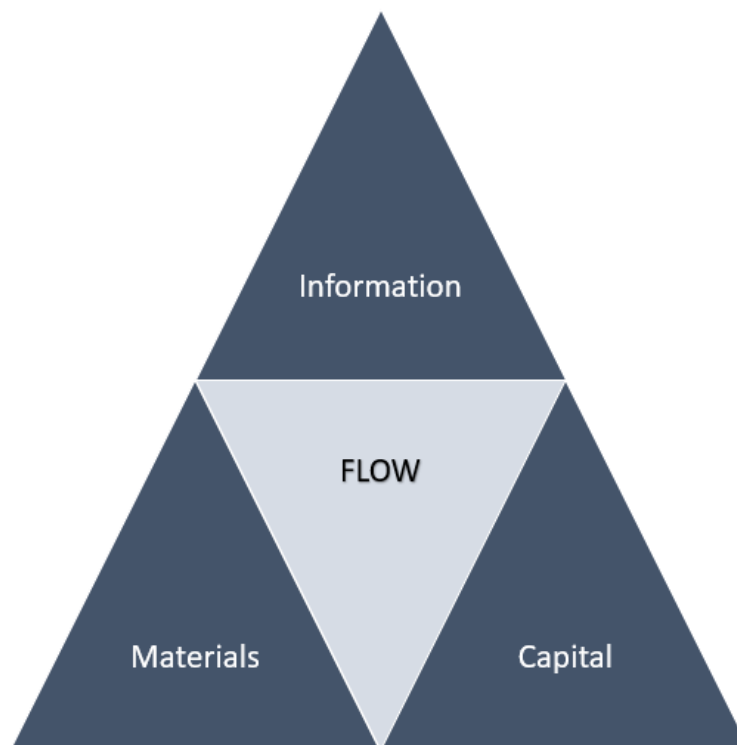


Figure 34 - Supply Chain Flow KAE

There is no special supply chain model for FI, but, more importantly, FI adaptations in supply chain management can lead to better results. Managing all the necessary flows with respect for FI characteristics while maintaining sustainability is challenging, due to the country's development situation.

Ensuring success implies high costs, overcoming barriers, and collaboration among the stakeholders. Operationalising these SC tactics involves a series of actions.

## Logistics Activities

Activities refers to the daily moves of a project. As demonstrated in chapter 5, having the right product in the right place at the right time and in the right quantities requires a range of different activities that must be put together in the most efficient and efficacy way. Logistics is the most critical part of successfully implementing an FIP, and Figure 35 displays the FE of these KAE – Logistics Activities.

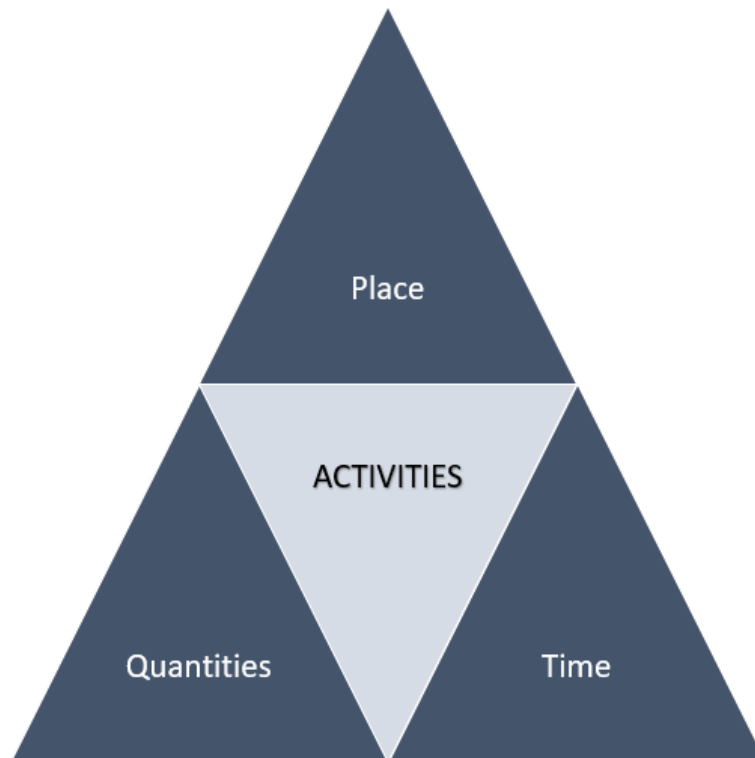


Figure 35 - Logistics Activities KAE

This representation of Logistics can be adapted to all conceptually known strategies (green, reverse, sustainable) but the application of these concepts where conditions are minimal, and no one has the necessary knowledge can be the greatest challenge. Nevertheless, if actions typically taken in other types of logistics are set to work it reduces the probability of failure and the FIP could prosper.

Although there are many possible alternatives, the three selected FE are easy to conceive and correlate to planning the path.

Geographically, “place” is the most challenging because the situation in the least developed countries usually makes it hard to deliver the right quantities at the right time. It is necessary to do a lot of preparation and consider alternative paths to be sure there are no input or output failures.

## 6.5 Interrelations

With all KAE and FE identified, the next phase was to link them all into an intuitive framework based on the AR Project findings.

The basic topics related to an FIP, namely Innovation, Supply Chain, Logistics and Sustainability, are located outside the framework structure. The starting point for an FIP must be that the business aims and is able to achieve sustainability and therefore has a sustainable impact. This is a backward and forward process, represented by the arrows.

The second feature to notice is the triangular pyramid structure of each key and sub element, thus giving equal importance to all the elements. The importance of this configuration is associated with the possibility of failure. Regardless of whether failure happens sooner or later in the process, the probability of the FIP failing increases if one KAE or FE is weaker than the others.

The two-colour differentiation is another characteristic of how the connections are built. Business Innovation and sustainability Impact (represented in orange) are directly connected because of the strategy that must be followed and the people in charge of creating and following that strategy. A good given strategy should be followed by everyone involved in the project so that the tactics and operations can have a positive impact on both the planet and profit, respectively.

The same happens with the Supply Chain Flows and Logistics Activities (represented in blue). Timings and information flow are crucial for success. When there is a good link between them and sub-elements, it means the capital spent or earned will definitely have a positive outcome regardless of the amount of either raw materials required at a certain place or final products that need to reach a client.

By connecting people with a strategy, information and a timing, as represented in the central upper square of the framework, an idea can develop into a project. Any team involved in the FIP must start defining a strategy for the business, collecting all the information required for a clear understanding of the project and setting realistic timings for each step.

The lower square of the framework is organised in a way that allows the user to understand the connecting elements between each KAE. This connection is achieved with the interrelations between the FE on the side:

- The Business Innovation Tactics interrelates with the Supply Chain Capital Flows and vice versa;
- The Supply Chain Materials Flow interrelates with Sustainability Planet Impact and vice versa;
- The Sustainability Profit Impact interrelates with the Quantities being held in the Logistics Activities and vice versa;
- The Place of the Logistics Activities interrelates with the Business Innovation Operations and vice versa.

This means that, for example, the FE “tactics” is what makes the user to think about both the flow of capital and the flow of information and materials. If the concern is about the flow of capital, tactics may be redesigned, operations restructured and strategies rethink. FE “operations” might trigger concern about the activities that must happen in the right place at the right time and with the right quantities. The inverse process is also true because planning to act in a certain place, requires operations that are connected to the tactics and the strategy outlined.

The connection between the “materials” and “planet” FE is instinctive. While on one hand the materials selected for a project have an immediate impact on the planet, on the other, if the project is focused on the planet and the environment, all the materials will be suitable for that purpose regardless of the sustainability changes required in the flow of capital, for example.

“Profit” and “quantities” are ultimately connected to process optimisation. The economic impact of a project depends not only on the quantity of resources and raw materials required but also the delivery of final products to the customer. Optimising the logistics’ actions required is the best way to reaching a profit goal.

Finally, the fifth KE, Design, serves as the glue of the framework. The designing process and, more importantly, *the adaptability of a project through the design* is a key factor to success when implementing an FIP. It can be the reason a client chooses one product over another, it may reduce production and logistics costs, social or environment bad impacts, and can improve and optimise the flow of information, materials and, in the extreme, capital.

Design as the glue between the framework’s KAE is represented by the white lines between all the triangles. It acts as the boarder zones where there is space for adaptability, optimisation, recreation and a sustainability improvement.

A bad design, disinterest in having the right design, or even having no design when trying to implement an FI Project does not mean the immediate failure of the project but, in the long run, bad design decisions will lead to bad results.

## 6.6 Framework use and scope

This framework was developed to create a tool that was acceptable academically but also one that could actually be used by people, regardless of their knowledge, who want to create value within their own circumstances and constraints.

This framework was not built for one specific market or country but can serve any project idea aimed achieving a sustainable success.

If an entrepreneur understand how each element of the framework is connected, he/she can start asking the right questions and create a path towards the successful implementation of an FIP.

Even projects that have already been executed can be improved and problems resolved. A glance at the framework helps keep track of all the necessary management activities.



By combining aspects like innovation, business, supply chains, logistics and sustainability, this tool provides a broad picture of every important area of a project.

## 6.7 Chapter Conclusions

The FIP implementation framework was developed as both an academic overview and a usable tool. Its components represent the working areas that lead to success when organically combined.

The framework structure gives equal importance to all its elements, which are organised into key elements, sub-elements and one major element.

The major features of the model are the connections between each element. When these connections are understood, the possibilities are infinite and all lead to a good implementation of the project.

Every FIP needs to find its way to create value and work from there into structuring and implementing the business project.

Many constraints must be considered and may complicate the process. Nevertheless, it is possible to achieve a sustainable success even in one of the world's least developed country.

## Chapter 7 – Conclusions and Future Work

The LDCs struggle to assure the sustainable evolution of most of their critical areas and to stimulate economic growth through the implementation of business projects. One way of mitigating these problems is to implement FIP that satisfy needs, create value, and use fewer resources while addressing sustainability concerns.

The research question for this dissertation arose from the complexity, inefficiency and high costs associated with implementing business projects in LDCs: Is it possible to sustainably implement Frugal Innovation Projects in LDCs?

The dissertation starts by summarising the state of the art literature on the key factors under consideration (Frugal Innovation; Supply Chain, Logistics and Sustainability).

Action Research was the most suitable research methodology for this study since it not only allowed real-life issues to be resolved but also contributed to academic knowledge. The positive response to the research question following the evaluation of the action taken opened up the possibility to extrapolate the AR Project conclusions to a wider reflection.

This led to the development of a framework for FIP implementation as both an academic overview and a practical tool. Its components represent the working areas that lead to achievement when organically combined: Business Innovation, Supply Chain Flows, Sustainability Impacts and Logistics Activities.

The main conclusion is that although many constraints can complicate the process, it is possible to achieve sustainable success even in one of the world's least developed countries.

In future work, it would be fruitful to implement FIPs in other LDCs. Broadening this experience would provide more essential knowledge on this important subject. Regarding the developed framework, work on the creation of a functional tool, such as an e-book, explaining each step and concern when implementing an FIP is in sight. When distributed, this product could serve as the basis for training actions and programmes in the LDCs.

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