TÉCNICO LISBOA

Department of Engineering and Management

Implementation of Frugal Innovation Projects: An overall strategy for a sustainable success

Constança Fernandes[a*]

[a]*University of Lisbon, Instituto Superior Técnico – Taguspark, Av. Prof. Doutor Cavaco Silva, 2744-016 Porto Salvo, Portugal*

Extended Abstract
October 2019

A B S T R A C T

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 study examines the extent to which it is possible and sustainable to implement these projects.

The present work 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.

Keywords: Least Developed Countries, Frugal Innovation Projects, Sustainability, Supply Chain Management, Logistics, Action Research

1. Introduction

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 FI Project in an 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.

1.1 Contextualisation

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 study 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 São Tomé and Príncipe, an interpretation of the result of the implementation and its extrapolation towards a useful tool will be suggested.

1.2. State of the Art

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"

* constanca.fernandes@tecnico.ulisboa.pt

(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).

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).

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).

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). 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.

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".

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).

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).

2. Methodology

2.1. 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.

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.

2.2 The AR Steps

An AR project comprises a pre-step and four basic steps, as shown in Figure 1.

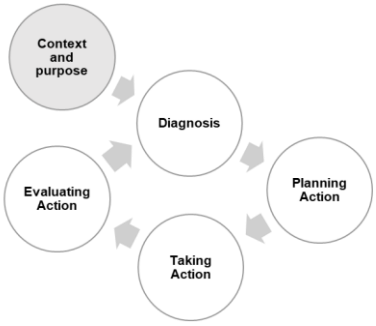

Figure 1-AR Process Steps

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.

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.

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.

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.

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.

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.

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.

2.3 The AR Learning Cycle

Within each AR step, the AReseacher 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.

Figure 2 shows how the AR project steps and learning cycle are combined.

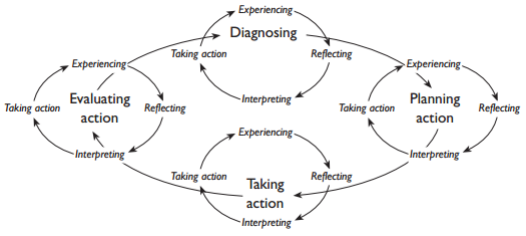

Figure 2 - AR Learning Cycle

3. Implementation

3.1 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.

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.

3.2 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 AResearcher and the CEO of Valúdo.

This AR project, Valúdo, began with the arrival of the AReseacher 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?

3.3 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 supress local needs for similar products which are sold at a much higher price when imported.

People

This planning involves allocating the right people to the right positions with the right responsibilities:

•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.

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.[4]

3.4 Taking Action

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

3.4.1 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 24ºC, 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.

3.4.2 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.5 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.

The Coconut Flow

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. 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 3.

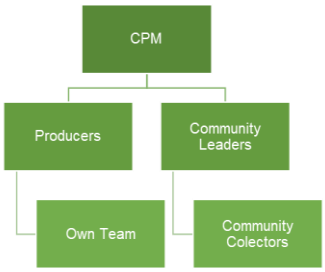

Figure 3-Community based SC Structure

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 4. 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 4-Coconut Inspection

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.

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 5. 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 5 - 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.7 In addition, for the purposes of traceability, reports and information on each step were registered and available for clients to see.

3.4.3 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.

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.

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 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. 9 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.

3.4.4 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 6.

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 6-Coconut Supply Activity

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.

When 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 7, 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 7-Exportation Activity

3.5 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.

4. Implementation Framework

4.1 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, in Figure 8, 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.

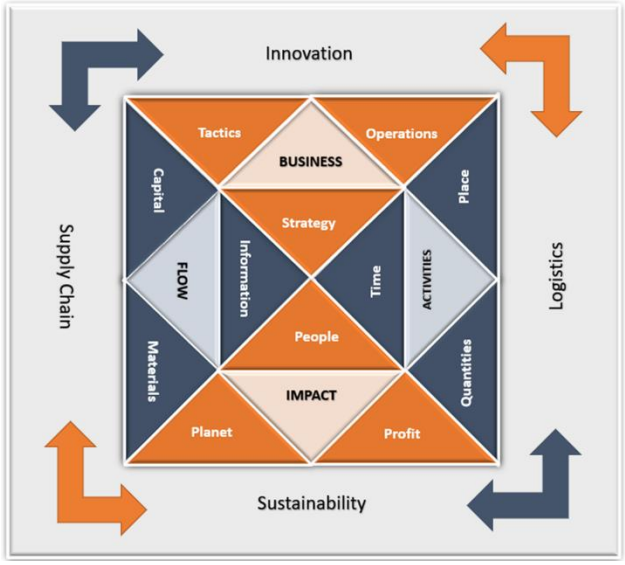

Figure 8- FIP Implementation Framework

4.2 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.

4.3 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.

4.3 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.

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

An 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 country.

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.

6. References

Ahi, P. & Searcy, C., 2013. A comparative literature analysis of definitions for green and sustainable supply chain management. *Journal of Cleaner Production*, 52, pp.329–341.

Bai, C. & Sarkis, J., 2012. *Sustainable Supply Chains*, Available at: http://link.springer.com/10.1007/978-1-4419-6105-1.

Dubey, R. et al., 2017. Sustainable supply chain management: framework and further research directions. *Journal of Cleaner Production*, 142, pp.1119–1130.

Esfahbodi, A., Zhang, Y. & Watson, G., 2016. Sustainable supply chain management in emerging economies: Trade-offs between environmental and cost performance. *International Journal of Production Economics*, 181, pp.1–17.

Lu, M. & De Bock, J. eds., 2014. *Sustainable Logistics and Supply Chains. Innovations and Integral Approaches*, Springer.

Rosca, E., Arnold, M. & Bendul, J.C., 2016. Business models for sustainable innovation – an empirical analysis of frugal products and services. *Journal of Cleaner Production*, pp.1–13.