Abstract
While the global population is constantly increasing and natural resource steadily decreasing, greater pressure is placed on companies to tackle environmental and social issues. Frugal innovation is established as a profitable business strategy that satisfies the demand for essential needs, empowers local communities and preserves the natural ecosystem. The use of SSCM practices can balance the conflicting objective of quality and affordability with more inclusive and environmental friendly activities. Existing investigation regarding SCM for frugal innovation is incomplete since it does not look at the entire product life-cycle and avoids dealing with upstream and downstream relationships. This work has the objective of developing an integrated framework that helps companies in identifying the correct supply chain strategies for the specific context of frugal innovation products. Based upon an extensive literature review the knowledge on frugal innovation and sustainable supply chain management was systematized, in order to derive a collection of best practices to efficiently implement this type of products. Then by employing multiple case-studies and semi-structured interviews, the framework was validated and tested. The results proved the relevance of all the activities suggested in the framework and showed that most of them are actually being implemented in practice. Furthermore respondents acknowledged that increased efficiency and more environmental targets can be achieved by employing the model.

Keywords: Frugal innovation, Framework, Sustainability, Supply Chain Management

1. Introduction
In the next years companies will face radical changes in the business environment, due to the rapid growth of the global middle-class.

Growing product consumption, increasing pressure on scarce natural resources and strengthening of social inequalities need to be addressed with innovative business approaches (Roland Berger, 2014). Frugal innovation are recognised as a great solution for corporations to tackle these problems, since they equally balance profit generation, environmental protection and social empowerment (Basu et al., 2013).

Frugal innovations are simple product or services that minimize costs and resources without scarifying on quality and customer satisfaction (Radjou and Prabhu, 2015). They target under-served consumers with affordable and highly functional alternatives (Soni, 2013).

Even if frugal innovations appear as exceptionally valuable for users and highly profitable for companies, some firms are still sceptical, and those ones that already commercialize these products, often faces difficult challenges to make them work (Roland Berger, 2015). Most companies perceive the great potential of frugal products to gain stronger competitive advantage, but a clear idea of how to enhance success factors is still missing.

For these reasons in the past years there has been a growing interest in the frugal innovation topic (Rosca, 2015) and academic research has been increasingly exploring the theme. However authors have been mainly focused on the conceptualization of the phenomena (Tiwari and Herstatt, 2014; Bhatti, 2012; Bhatti and Ventresca, 2013; Zeschky et al., 2014; Basu et al., 2013) and have been failing in providing a holistic approach for frugal innovation management.

Supply chain management (SCM) practices could increase process efficiency, customer satisfaction and environmental sustainability of frugal products, but few research on this topic was already done. Further investigation on the link between SCM and frugal innovation is relevant and necessary, since the lack of a standardized framework needs to be filled.

This paper aims to provide a comprehensive framework to help decision-makers in managing frugal innovations through the analysis of supply chain
strategies. The objective of the study is to create a tool which integrates all processes involved in the development of frugal products, and supports corporations to improve economic, environmental and social performance in the entire value-chain.

The paper is organized as follows. Section 2 summarizes the extensive literature review performed to gather relevant information on the frugal innovation and sustainable supply chain management topics. Then, in Section 3 the methodology is described. Section 4 shows the development and the structure of the framework. Afterwards, Section 5 analyses the results obtained from the validation and testing of the model. Finally, in Section 6 the major conclusions and future research directions are discussed.

2. Literature Review

2.1 Frugal Innovation

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 (Zeschky et al., 2014; Ernst and Young, 2011; Soni, 2013). 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 (Bhatti, 2012; Tiwari and Herstatt, 2014; Radjou and Prabhu, 2015).

Frugal innovation’s main characteristic are: focus on core functionalities to serve customers in the simples and shortes way (Engel, 2014); employ robust materials to bear harsh physical environments (Basu et al., 2013); design user-friendly components that can be used without previous knowledge (Roland Berger, 2014); and target volume-driven markets with high growth rate (Tiwari and Herstatt, 2013). Furthermore the furgal products lower the overall costs of operation (Tiwari and Herstatt, 2012); leverage local resources as sourcing inputs (Radjou and Prabhu, 2015); are developed time effectively (Roland Berger, 2015); and improve social, environmental and economic sustainability (Basu et al., 2013).

Compared with other similar notions, such as ‘Bottom of the Pyramid’, ‘Jugaad’, ‘Reverse Innovation’, ‘Inclusive Innovation’ and ‘Resource-Constrained Innovation’, frugal innovation is proved to be a more comprehensive concept (Tiwari and Herstatt, 2014; Hamacher, 2014; Bhatti & Ventresca, 2013). In fact it “fully encompass the key characteristics of these individual related terms” (Tiwari and Herstatt, 2014, p.13) to unify these theories.

In the last years different macro-economic changes made companies look at frugal innovations as an essential long-term business strategy. Eight key drivers can be identified: 1) increase of middle class consumers (Bhatti, 2012; Roland Berger, 2014; Zeschky et al., 2014); 2) greater pressure on natural resources (Radjou and Prabhu, 2015); 3) growing sustainability awareness (Engel, 2014; Edelman, 2014); 4) further firms addressing social inclusion (Bocken and Short, 2015); 5) raise of the sharing economy (Booz & co, 2012; Mahmood, 2013); and 6) intensification of global competition (Zeschky et al., 2014; Radjou and Prabhu, 2015).

Many companies are still suspicious about frugal innovation success since they often face arduous challenges (Soydan, 2012; Roland Berger, 2015). Firms encounter hurdles in the design phase, e.g. understand hidden needs, balance quality with low cost and use time consuming R&D processes. Then in the production stage they fail in the design-to-cost approach, have limited access to skilled workers and are unable to guarantee supplier’s quality. Finally regarding the marketing activities, corporations have difficulties to choose the right sales channel, overcome poor infrastructure and protect brand image.

In order to facilitate corporations in the implementation of frugal business models, researchers have suggested the following best practices, listed in Table 1 (Engel, 2014; Basu et al., 2013; Radjou and Prabhu, 2015; Roland Berger, 2015; Zeschky et al., 2011; Tiwari and Herstatt, 2014; Soni, 2013).

<table>
<thead>
<tr>
<th>Best practice</th>
<th>Benefits</th>
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<tr>
<td>Innovative distribution and sale models</td>
<td>Overcome poor infrastructure and last mile-challenges</td>
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<tr>
<td>Knowledge of the local context</td>
<td>Reach low income consumers</td>
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<tr>
<td>External collaboration</td>
<td>Understand essential needs and cultural preferences</td>
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<tr>
<td>Clean slate approach</td>
<td>Cut costs and access local know-how</td>
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<tr>
<td>New business model</td>
<td>Meet extreme price objectives with minimalist solutions</td>
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<tr>
<td>Technology fusion and analogies</td>
<td>Support the product innovation with new operational practices</td>
</tr>
<tr>
<td>Dual brand strategy</td>
<td>Reduce development costs and increase affordability</td>
</tr>
<tr>
<td>Customer-driven modularity</td>
<td>Avoid brand cannibalization and leverage economies of scope</td>
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<td></td>
<td>Respond to the needs of different customer segments</td>
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Lastly the theoretical models that attempt to conceptualize the frugal innovation process have been analysed. While some frameworks lack of empirical foundation, e.g. Bhatti (2012) and Soni (2013), and others do not capture the frugal approach holistically, e.g. Bhatti & Ventresca (2013) and Zeschky et al. (2014), they generally do not deliver practical insights about the management of frugal product.

2.2 Sustainable Supply Chain Management

According to Simchi-Levi (2000, p.1) SCM refers to “a set of methods used to effectively coordinate suppliers, producers, depots, and stores, so that commodity is produced and distributed at the correct quantities, to the correct locations, and at the correct time, in order to reduce system costs while satisfying service level requirements”.

Mentzer et al. (2001) derives three core SCM characteristic: (1) a systemic approach that views the supply chain as a whole, (2) a strategic orientation toward converged cooperative efforts, and (3) a customer focus to create unique value.

SCM enhances sustainable competitive advantage (Cooper et al. 1997), reduces lead times (Verma et al., 2006), and minimise the costs (Christopher, 2011).

Progressively the growing complexity of global networks and increasing concerns about sustainability issues, forced companies to extend their responsibility to bottom and upstream tiers (Seuring and Müller, 2008). Corporations started to introduce the 3BL approach in their supply chain operations, developing SSCs that not only improve long-term economic performance, but also prioritize environmental and social goals (Carter and Rogers, 2008). SSCM responds to increasing external pressures for reducing the negative effects of supply chain activities, and as well guarantees various cost benefits (Sacaluga and Frojan, 2014).

Seuring and Müller (2008, p.2) defined SSCM as “the management of material, information and capital flows as well as cooperation among companies along the supply chain while taking goals from all three dimensions of sustainable development, i.e., economic, environmental and social, into account which are derived from customer and stakeholder requirements”.

Eight main drivers motivate firms to the move towards creating sustainable supply chains, and they can be classified as (1) legal demands/regulation, (2) customer demands, (3) response to stakeholders, (4) competitive advantage, (5) environmental and social pressure, (6) reputation loss, (7) internal business process, and (8) financial reasons (Seuring and Müller, 2008).

Companies can obtain various benefits through the implementation of SSCs, as presented in Table 2.

2.3 SCM and Frugal Innovation

Even if SSCM could enhance the performance of frugal products, only two authors attempted to study the implications frugal innovation have on SCM.

Radjou and Prabhu (2015) propose a decentralized manufacturing strategy of factory-agnostic products based on modular architecture and standardized components. Furthermore they underline the benefits of establishing local networks for both procurement and distribution activities. Finally they recommend the implementation of ERP software to share data with suppliers and retailers.

Millstone (2014) focuses on the relevance of the design phase to ensure product affordability. Furthermore she suggest the shortening of the supply chain by placing numerous small-sized factories close to the suppliers and to the final market. Then she recommends the use of responsible sourcing practices and the development of labour intense manufacturing activities. Finally she stresses the importance of companies offering services rather than products and highlights that efficient transportation is a necessary premised step.
condition for the circular product flow between business and customer.

Further investigation on the link between SCM and frugal innovation is relevant and necessary, since the lack of a standardized model needs to be filled. This work contributes to the development of a structured framework of SC strategies for frugal innovation in order to increase firms’ success rate, efficiency and reliance.

3. Research Methodology

The research methodology employed is a multi-methodology approach (Mingers and Brocklesby, 1997) based on four complementary research methodologies: Literature Review, Grounded Theory, Semi-structured Interviews and Case-study Analysis (Saunders, et al., 2009). While the first two methodologies are employed for the development of the framework, the other two are necessary for the validation of the model.

3.1 Literature Review

The literature review had the aim of identifying and selecting a collection of best practices which can be employed to manage frugal products. On one side the research focused on the area of sustainable supply chain management in order to gather strategies that could be transferred to the frugal innovation context. The search was performed through online libraries, publishers and databases, using the keywords “sustainable supply chain”, “green supply chain”, “corporate social responsibility”, “sustainability” and “closed-loop supply chain”. The result after the initial data treatment, was the selection of 47 papers for in-depth investigation.

On the other side to identify examples of frugal products, firstly different databases have been screened to select per-reviewed papers, and secondly consultancy reports, online journals, foundation disclosures and specific websites have been examined. The terms employed for the keyword research were “frugal innovation”, “jugaad”, “social innovation”, “resource-constrained innovation”, “inclusive innovation”, “reverse engineering” and “bottom of the pyramid”. The criteria employed to select relevant product and services were two: they had to be a) cheaper than available alternatives in the market and b) tackle social or environmental issues. A database with 62 frugal innovations that belong to 12 industry sectors and have been developed in 21 different countries was created. It represents a consistent and balanced sample, as it entails a cross-country and cross-industry set of firms from different SC echelons and of various dimensions.

3.2 Grounded Theory (GT)

GT had the aim of generating theory from simultaneous collection and analysis of data (Glaser and Strauss, 1987). The method was employed to identify common patterns and achieve generalization of concepts. The procedure used for the GT research was based on three coding processes, which enabled to move from the empirical material to the abstraction of the developed theory (Strauss and Corbin, 1998).

Open coding was used to create conceptual categories, which are patterns and set of actions performed to solve problems or overcome specific issues. Axial coding combined the initial concepts by identifying similarities and relations between categories. The activities previously decomposed were constantly compared between each other and reconnected according to shared objectives. Selective coding refined and integrated the categories to form the core concepts that constitute the framework.

3.3 Semi-structured Interviews

Semi-structured interviews aim to provide a basis for interpreting statistically significant findings (Flick, 2009) and to gather feedbacks for qualitative studies. Due to the novelty of the theme it was decided to contact companies, as well as experts in the field of frugal innovation.

In order to choose the companies to be interviewed, the database previously created in the literature review section was employed. From the 62 firms contained in the sample, 19 were discarded, as they commercialized services and the framework is targeted at product-oriented businesses. Lastly the final dataset includes 43 companies, which have all been contacted twice by mail and 6 of them answered positively, allowing the interview.

Experts with a strong knowledge of the frugal innovation phenomenon were selected to create a secondary sample. From the 13 specialists emailed, 6 offered availability for the interview.

3.4 Case-study

The use of multiple case-studies aims to generalize theoretical understanding and relate it with empirical investigation. The method has been employed for the 6 companies that agreed on being interviewed. First multiple sources of evidence were consulted (Yin, 2003) to collect data. Then the material was categorized and sorted in a board in order to produce organic knowledge and systematize the data in a standardized manner.

The boards were used before the interviews to prepare questions specific for each company, and were update after the surveys with the additional information that emerged from the discussion. The objective of the boards is to structure the companies’ activities, as to facilitate the validation process.
4. Framework for Frugal Innovation Supply Chain

4.1 Framework Development

In order to efficiently develop the framework, the structured procedure, presented in Figure 1, has been followed.

At this stage of the framework development selective coding was employed to guarantee the consistency of the model.

The final output of these activities is the Frugal Innovation Framework represented in Figure 3.

In the first stage the database of 62 frugal innovation examples, which was created after the literature review, has been employed. By applying the open coding technique to the 62 solutions, 80 best practices were identified. On the other side the 47 SSCM articles that were selected for in-depth investigation, were examined. 33 papers contained material relevant for the study, and 29 practices were identified. The final output is a database composed of 109 practices that represent efficient strategies to implement frugal innovation, while balancing sustainability goals.

In the second stage the practices previously collected were sorted and organized. Axial coding was employed to link and aggregate the practices with the same scope. In particular objectives that explained the use of a set of practices were defined and used as condition to form groups. This led to the creation of action areas: each of them contains a goal and the activities which can be performed to achieve it. At the end of this process all the 109 practices were allocated to 27 objectives.

In the third stage the framework structure was created. Then the action areas formerly defined have been allocated to seven phases that represent a generic value chain. Some modules were specific to a unique process, while others were common to different phases.

4.2 Framework Elements

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

The phases form a linear course which encompasses all value chain’s processes and covers the entire product life-cycle. The seven sequential phases include the five processes that characterize SSCM, namely design, procurement, production, distribution and disposal, and two additional activities which are crucial for frugal innovations, i.e. sales and use.

The objectives specify for each phase the milestones that the firm has to achieve and guide decision-makers in crafting a strategy specific for frugal innovations. The objectives can be:

a) features that the product should possess to be classified as a frugal innovation e.g. low cost of ownership, durable or environmentally sustainable;

b) goals established for the company as a whole, e.g. respond to regulations, reduce impacts on nature or delay end of life;
c) specific characteristics of the process that outline more detailed performance measures for the particular phase, e.g. overcome poor infrastructure or effective and efficient distribution strategy.

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

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

4.3 Framework Scope, Use and limitations

The framework is a pro-active tool that helps companies in managing frugal products and improve their economic, environmental and social performance in the entire value-chain. Its scope is to offer guidelines to choose the most appropriate strategies and ensure that they fit to the unique frugal innovation characteristics.

The framework provides a structured method that suggests best practices for all the processes along the product’s life-cycle. It encourages companies to use a holistic approach in the development of the solution, by stimulating the creation of integrated business models rather than just products.

The framework can be used from companies who already have frugal products in their portfolio to validate their practices and evaluate if new ones could be implemented, as well as by corporations who have no prior experience with frugal innovations to prioritize objectives.

Several benefits can be attained with the use of the framework:
- Have quick access to formalized and systematic knowledge on frugal innovation and its best practices
- Set intermediate objectives and perform incremental changes by focusing on specific action areas
- Anticipate constraints that might appear in the final processes by looking at the whole life-cycle cycle

First it is relevant to underline how the framework includes and integrates different managerial concepts into a single tool. In fact for most of the phases, the model has used principles that stem from various business theories and linked them to the frugal innovation approach.

The connection between some of the concepts has already been suggested in the literature, but its evolution from the theoretical domain to the practical application has never been performed before. Therefore the framework represents the most complete and structured work that synthetizes various business approaches into the frugal innovation environment. This interconnection is shown in Figure 2, where a colour code expresses to which phase the specific theory is linked.

![Figure 2 - Link between frugal innovation and other management theories](image)

Secondly, it is necessary to define the limitations of the model. In particular it is strongly product-oriented and its scope does not include frugal services. This is due to the great difference between the processes of service development and product manufacturing.

Then it is assumed that prior to use of the framework a series of activities have been performed. These tasks include problem identification, market analysis, solutions assessment and all actions that guarantee the product responds to the customer needs.

Finally it should be clarified that the practices suggested are not universally the best solution and according to the context another option might be favourable. An extensive analysis of successful examples has been performed, but to the novelty of the theme, the variety of environment and the different target markets, often alternative decisions can be taken.
Figure 3 - Framework for Frugal Innovation Supply Chain (FISC)
5. Validation

For the validation of the framework two methodologies were followed. The case-study approach has been employed to collect data and generate measurable outcomes that were used for a quantitative analysis. The semi-structured interviews enabled the gathering of feedbacks and suggestions to improve the framework and were used for a qualitative analysis.

5.1 Quantitative Analysis

The data from each individual company was structured, standardized and then aggregated, with the aim of testing if the activities suggested in the framework are actually being implemented in practice.

For each of the 6 firms analysed, it was verified which practices were being executed, and which one were not. A framework specific for every enterprise was created: the practices are underlined in yellow, if they are being performed, in red, if they are not being performed, or in white, if they do not apply to the specific case-study. These graphs enable corporations to have a quick overview of their strengths and liabilities and can be used as basis for re-designing processes and operations. In particular they highlight on which areas to focus in order to improve global performance and form the groundwork for implementing new practices.

Then the results from all the 6 case-studies were combined to derive general conclusions about the model and validate the framework. A binary variable was assigned to every practice, 0 if is underlined in red, 1 if is underlined in yellow, and it was iterated for all the companies’ framework. The final output of the process expresses for every practice the number of companies that have implemented it, but as well the cumulative result for the objectives and the total value for the phases. These outcomes aggregated at different detail level were necessary to analyse the framework with increasingly precision. The main conclusions that were derived are the following:

- The majority of the practices contained in the model are proved to be relevant, as on average they are being performed by 4 out of 6 firms
- The observed data match the developed theory, since 67% of the suggested activities are actually being executed in the real cases
- 6% of the practices are not being performed by any company, as they are highly complex ad require strong capabilities
- Design, Production, Distribution and Sales that are the phases with the highest number of practices executed and on which the majority of the firms concentrated its efforts (values around 100)
- In the Procurement, and Disposal phases many practices could not be implemented due to cost constraints (values around 50)
- The objective social value was considered the most relevant by firms (the value scored is more than twice the average)
- All the 6 companies achieved the objective brand loyalty, as firms realized it is crucial to build a trusted brand, which is deeply committed to clients

5.2 Quantitative Analysis

The interviews with experts and companies were used to reinforce the validation process and to collect comments about the framework.

It was proved that the data obtained from the case-studies are accurate, as most of the quantitative results were directly confirmed by the respondents. The majority of the interviewees validated the practices contained in the framework, as none of the specialist would remove any practice from the model. Furthermore they affirmed it is the most complete and well-structured tool for frugal innovations realized so far.

Firms acknowledged it would be very useful to plan strategies, and that now they would employ it to implement more actions and add value to their processes. Then interviewees stressed that by adopting some of the practices contained in the model, companies could achieve much more efficiency and meet environmental targets.

Respondents affirmed that the main barriers to the implementation of the framework would be the availability of financial and human resources, as well as the operational complexity of developing a business model, which considers all the proposed activities.

The critics moved from the respondents focused on the linearity of the framework and the absence of an initial phase containing the problem definition. Furthermore they underlined the necessity of practical experimentation to see how the model place out in reality.

Finally the most relevant suggestions that were collected are: a) develop a simpler versions of the framework that defines the minimal conditions to be fulfilled for managing frugal innovations; b) interrelate the practices to show possible trade-offs and create critical paths; c) show the benefits that corporations could obtain with the implementation of a specific set of practices; and d) establish measurable level of fulfilment for the objectives.
5.3 Compact Frugal Innovation Framework

It was decided to create a more compact and simpler version of the frugal innovation framework, represented in Figure 4. The aim is to show how the phases interrelate with each other and to provide a global vision for the development of frugal products.

As the two frameworks have different applications, they are designed to be used in a complementary manner. Two levels of analysis emerge:

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

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

The structure highlights the importance of the Design, which is the central element of the framework, and the link between the other phases, which are placed on two concentric circumferences. Moreover internal loops are created to suggest practices that can be performed to effectively connect the phases.

The compact framework is extremely useful for companies to approach frugal innovation with a broader perspective. In fact the circular structure reveals the necessity of employing an integrated approach and shows the correlation between the processes. However the complete framework is a much more comprehensive model that is still necessary to know which best practices to implement. Therefore the tools have to be used in integrated manner, in order to enhance the performance of companies in all the three sustainability dimensions. According to the development stage and the decision to be taken, the right level of analysis and the most appropriate framework should be employed.

6. Conclusion and future work

Due to great demographic, economic and cultural shifts that are changing the global market, more companies recognize frugal innovation as a profitable and sustainable alternative to traditional business. Nonetheless only few researchers attempted to create a tool for the management of frugal innovations, which could help firms to overcome difficulties and support the development of these products.

This paper used SSCM theory to build an integrated framework, which assists decision-makers in crafting strategies for frugal innovations and leverages their performance.

After a systematic literature review a collection of 109 best practices, which can be employed in the implementation of frugal products, were identified. Then through the use of grounded theory, they have been allocated to 27 objectives and aggregated in 7 sequential phases. These three elements constitute the basis of the frugal innovation framework.

For the testing and validation of the model multiple case-studies and semi-structured interviews have been employed. In particular the data from 6 companies were used to obtain measurable outcomes for a quantitative analysis, and 12 interviews have been performed. The results confirm the validity of the framework and the relevance of the practices contained in it. Furthermore it was proved that the theoretical framework is reflected in the empirical evidence and can be used as an effective tool for managing frugal innovations in the business environment.

Three main areas for future research are suggested. First the validation process should be extended to a wider sample. The data obtained from a larger number of companies would increase the reliability of the results and enable the generalization of better grounded assumptions.

Second it would be enlightening to create a product from the beginning, following the guidelines of the frugal innovation framework. Measurable results might be obtained to assess the impact that frugal innovation have on the three sustainability dimensions.

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