Frugal innovation process: multiple case study with footwear companies

Abstract

Purpose – The purpose of this research is to investigate the process that leads to frugal innovation in the footwear sector in companies in the Southern Region of Brazil.

Design/Methodology/Approach - Qualitative and descriptive research of multiple cases with 6 different footwear companies. Data was collected and presented through the identification of innovations that can be classified as frugal.

Findings - In total, six shoe companies were analyzed, eight shoe experts were interviewed and eleven frugal innovations were identified. The main method of development of frugal innovations was bricolage. Professionals with this ability are called "Gyro Gearloose" in the shoe sector. Some innovations showed reductions in cost of up to 96.66%. This study found results that corroborate the analysis of other researches on frugal innovation and bricolage.

Research limitations/implications - One of the limitations of this research is the fact that it only evaluated the perspective of the companies in the form of their representatives, the footwear experts interviewed.

Practical implications – This study demonstrates how shoe companies are able to produce frugal innovations at low costs without jeopardizing the quality of its products.

Social implications – The social implications of this study can be divided in three aspects: people, environment and economy.

Originality/value – This is research connects with the study of others researchers on the topic of frugal innovation and presents empirical evidence on cost reductions of significant margins in an industry of global proportions. Besides, it presents the process of frugal innovation inside the companies, rather than just show the final result of the innovation.

Keywords - Frugal Innovation, Shoe Sector, Process, Measurement, Outcome.

Paper Type – Case Study.

1. Introduction

The term innovation is understood as the implementation, or significant improvement, of products (goods or services) or processes, which are made available to consumers or applied in the business unit itself (OECD/Eurostat, 2018). For innovation to be recognized, it needs to be actually applied, either through commercialization or through application in the company's internal processes. From the search for understanding and using innovation, it is noticed the plurality of facets it can present. Over time, several innovation proposals were presented (OECD/Eurostat, 2018).

One of these recent proposals is frugal innovation (Hossain, 2020). It appeared in the literature around 2009 with the publication of an article in The Economist magazine (Pietrasik, 2009; Pisoni, Michelini and Martignoni, 2018). Frugal innovation is generically referred to as "[...] the ability to do more with less" (Radjou and Prabhu, 2014; Corsini, Dammicco and Moultrie, 2020, p.196; Santos, 2020, p.250) and comprises the idea of creating value by making conscious and reduced use of materials and resources such as energy, capital and time, without limiting the quality of the innovations (Weyrauch and Herstatt, 2016; Agarwal, Oehler and Brem, 2021). Frugal innovation originated in countries like India, where the scarcity of social and economic resources forces companies to find cheap innovative solutions, thus being able to offer products to a more price-sensitive social class (Radjou and Prabhu, 2015).

Despite the growth of studies on frugal innovation, there is a need to understanding this phenomenon in other countries and in more depth. This understanding must encompass frugal

innovation not only as a result, represented by products or services, but also as a process (Weyrauch and Herstatt, 2016). In this sense, the footwear industry presents itself as a very fruitful empirical research environment, for several reasons.

The global footwear industry is economically relevant. It is responsible for the annual global production of approximately 23 billion pairs of shoes (Pacheco-Blanco *et al*., 2018; Ted-ed, 2019; Statista, 2022). In Brazil, the footwear industry is the fifth largest footwear producer in the world, behind the United States of America, China, India and the United Kingdom. This industry is marked by international competitiveness, in which low prices are a purchasing decision factor for 50% of customers (Statista, 2023).

It is understood that the study of frugal innovation can contribute significantly in this context in several ways. Firstly, frugal innovation can help footwear companies in targeting efforts towards more sustainable production and processes. The footwear production process raises environmental concerns related to the high rate of waste generation and the variety of materials in its composition (Alves *et al*, 2009).

Inadequate management of this waste can pose risks to the quality of life in communities, creating public health problems and environmental degradation. Footwear companies need to comply with international standards and regulations if they are interested in exporting their products. Using tools for identifying and eliminating environmental problems, companies can become competitive in foreign trade (Gatelli *et al*., 2010).

Second, despite the strategic changes of recent decades (Schmidt *et al*, 2011), this industry remains competitively pressured. In this sense, frugal innovation can expand the vision of the market frontiers of this industry beyond the markets currently served, focusing on more price-sensitive markets (López-Sánchez; Santos-Vijande, 2022).

Third, the results of this research can inspire other companies to develop their innovation capabilities, both in products and processes, and in the development of new materials, with the aim of operating in markets with low purchasing power.

From this context, the objective of this research is to analyze how frugal innovation appears in companies in the footwear sector. For this, six companies were researched in Rio Grande do Sul. This study is qualitative and descriptive research through a multiple case study (Cooper and Schindler, 2003; Hair *et al*., 2005; Yin, 2015). Six companies were the subject of study, in which 11 frugal innovations were identified. Eight structured interviews were conducted with managers from these six companies (Eisenhardt, 1989). The analysis of the interview responses was carried out using the inferential category analysis method of Bardin (2016). This study consists of the following sections: theoretical foundation (Innovation and Frugal Innovation); method and objective; results; and, finally, final considerations.

2. Innovation process

Innovation is the result manifested either by a product (or service) that is marketed to customers; or through an improvement process that companies put into use within their own units of work, due to the innovation presenting some financial or procedural benefit to the organization, not only that but also, innovation must be something new or significantly improved (OECD/Eurostat, 2018).

The innovation development process can be summarized, for explanation purposes, in three stages, which are: the first, the moment of ideation, in which one seeks to think of ideas that could become an innovation; the second stage is the development of the project that was selected in the previous process, as it presents the best economic viability; and, finally, the third step, the dissemination, which is the commercialization or implementation of the innovation within the company itself (Roberts, 1988; OECD/Eurostat, 2018; Dziallas and Blind, 2019).

The different manifestations of innovation intensity can be divided into three fundamental categories, which are: the first is incremental innovation, which is when the innovation only presents improvements to existing products or processes that do not significantly alter the production process of the product, or the way it is used by customers (OECD/Eurostat, 2018).

The second is disruptive innovation, which is characterized by innovations designed to

destabilize (cause disruption in) markets dominated by established brands, that is, it is highly competitive and aims to confront the leadership of dominant brands in the market; disruptive innovation achieves this objective by offering significantly cheaper and simpler products or services (Christensen, 1997; Christensen, Raynor and McDonald, 2015).

And the third type is radical innovations, which presents completely revolutionary and unprecedented processes and ways of consuming, which are sometimes difficult to compare with any other type of product or service, given their considerable novelty (OECD/Eurostat, 2018).

Finally, an innovation can be identified by its different area of applicability and there are four possibilities for this. The first of them says that innovation can be segmented into product or service; the second characterizes innovation as occurring in process; the third represents the innovation that occurs in the organization, that is, in its activity structuring; and the fourth and final argument argues that innovation can be classified as a marketing activity (OECD/Eurostat, 2018).

Next, frugal innovation will be presented, which can be characterized by any of the analyses presented in this chapter, but which, however, presents some particularities that distinguish it from conventional innovation (Radjou and Prabhu, 2015).

3. Frugal innovation

The concept of frugal innovation emerged from environments and cultures with limited economic and social resources, such as India, for example, where the frugal innovation event is also called *Jugaad*, a term used to describe creative people who can find simple solutions even in adverse situations and scarcity (The Economist, 2010; Hossain, 2021). In other cultures, the term is given names such as DIY (do it yourself), or *jeitinho*, or *gambiarra* in Brazil (Hossain, 2018).

The practice of frugal innovation is capable of offering technically and financially viable solutions even in conditions of scarcity of various kinds; which, despite limitations, is capable of producing products or services of acceptable quality at affordable prices for customers who are unable to pay for conventional products (Silva, Nodari and Chaym, 2022; Rossetto *et al*., 2023). Because of these characteristics, frugal innovation is also known by the expression “doing more with less” (Radjou and Prabhu, 2015; Koerich and Cancellier, 2019).

One of the main strategies for developing frugal innovations is the concept of bricolage (Soni and Krishnan, 2014; Herstatt and Weyrauch, 2016). This term refers to the idea of repairing or producing something using resources and materials already available, without the need to acquire new resources, forcing or encouraging cost reduction in the development and production process (Radjou and Prabhu , 2015; Sarkar and Mateus, 2022; Specht, I. R., Froehlich, C., Bondan, J., and Nodari, C. H., 2024).

With the evolution of studies on frugal innovation, some authors have proposed more structured analysis instruments for the evaluation of innovations that can be considered as frugal innovation, as is the case of the study by Weyrauch and Herstatt (2016), which states that frugal innovations needs to meet three requirements (simultaneously) to be considered as such: (1) Substantial cost reduction; (2) Focus on core functionalities; and (3) Optimized performance level (Weyrauch and Herstatt, 2016; Le Bas, 2020; Reina, Corradi and Rapini, 2021). Given these characteristics, frugal innovation is often considered as incremental or disruptive innovation in relation to the definitions of conventional innovation presented in the previous chapter (Radjou and Prabhu, 2015).

According to research findings by authors Weyrauch and Herstatt (2016), the benefits of frugal innovation, even when they occur in process, need to be perceived by end customers, especially regarding item 1, substantial cost reduction, which needs present a cost or price reduction of at least 30% (compared to other similar or previous products in the process), unless other requirements justify less significant reductions.

In other words, the relationship with customers is a determining factor in conceptualizing any innovation as frugal, as customers need to be the primary receptacles of the benefits of practicing frugal innovation and in some cases even participate in the process of development of frugal innovation (Radjou and Prabhu, 2015; Weyrauch and Herstatt, 2016; Reina *et al*., 2021). In

addition to this close relationship with end customers, studies by Reina *et al* (2021) and Specht, I. R. *et al* (2024) also present the growing importance of collaborative studies between universities and companies in the search for deepening the understanding and development of research on frugal innovation.

Table 1 summarizes the instrument for analyzing and measuring frugal innovation proposed by Weyrauch and Herstatt (2016). This study was later referenced by other research (Schleinkofer, Herrmann, Bauernhansl, and Spath, 2019; Le Bas, 2020; Reina *et al*., 2021).

Table 1. Criteria for identifying frugal innovation in companies

1. **Substantial cost reduction** (at least 30% reduction) in product or process;
2. **Focus on core functionalities** (eliminate what is not necessary and which makes the product or process more expensive);
3. **Optimized level of performance** (without compromising quality). Although frugal innovation reduces costs and functionalities (Items 1 and 2), it cannot do without quality aspects.

Source: prepared by the authors based on Weyrauch and Herstatt (2016).

These three criteria make up the inferential analysis categories that will be presented in the research method in table 2 and are coded as items 4, 5 and 6 and provide the basis for the questions referring to their categories.

Weyrauch and Herstatt (2016) suggest that, for frugal innovation to be characterized according to these criteria, they all need to be met simultaneously. If one of them is not identified, frugal innovation cannot be established. The process to verify compliance with these criteria involves direct evaluation of customers. When this is not possible, the potential frugal innovation must be compared with a similar product (or process) on the market, or with a product or process already developed by the company. It must be checked whether the difference, downwards, is at least 1/3 of the value (-30%) compared to other products or processes.

4. Method

The multiple case study involved the analysis of six companies and eight managers, with one manager in each of the four companies and two managers in each of the other two remaining companies (Eisenhardt, 1989; Cooper and Schindler, 2003; Hair *et al*. , 2005; Yin, 2015).

First, with the help of managers, at least one frugal innovation was identified in each company (Weyrauch and Herstatt, 2016; OECD/Eurostat, 2016), and the subsequent interview with managers (Eisenhardt, 1989; Cooper and Schindler, 2003; Hair *et al*., 2005).

The main instrument for classifying frugal innovations was the study by Weyrauch and Herstatt (2016), which proposes that frugal innovations presents three indispensable and simultaneous characteristics, namely: first, significant reduction in cost or price, of at least 30%, except when important caveats are mentioned; second, focus on core functionalities of the product or process; and third, and last, optimized performance level, which implies not only not compromising the quality characteristics of the product or process, but also, in some cases, even improving the characteristics of the product or process, such as greater resistance and durability, given the fact of unnecessary parts of the innovation being eliminated in the previous process (Weyrauch and Herstatt, 2016).

The innovations were categorized according to the definitions of innovation and frugal innovation presented in the framework (Weyrauch and Herstatt, 2016; OECD/Eurostat, 2018), and the interviews were designed and conducted in a semi-structured manner, and the transcriptions generated by the TEAMS program were subsequently analyzed using Bardin's inferential analysis method (Bardin, 2016).

The semi-structured questions were prepared based on the theoretical framework on innovation and frugal innovation and were designed, from the beginning, to represent Bardin's categories of analysis (Bardin, 2016) that would be subsequently carried out. The questions were validated by three doctoral researchers in administration. Based on the observations highlighted by the researchers, the necessary adjustments were made to meet the requirements. Table 2 presents the

analysis categories and questions from the interview guide.

Table 2. Interview with shoe managers

Categoria da inovação frugal	Perguntas
1. Limited Resources (Not explicitly mentioned in the question)	1. What are the factors that stimulate innovation?
2. Limited Resources (Explicitly mentioned in the question)	2. What are the main barriers/difficulties (Le Bas, 2020) in the product development processes, work process, and search for innovation?
3. Bricolage	3. How important is it to use resources available in the company itself (bricolage) in innovation processes?
4. Substantial cost reduction	4. What are the factors that forced the reduction of costs and prices?
5. Focus on core functionalities	5. What defined the need to focus on core functionalities (removing unnecessary and expensive features) from the process or product?
6. Optimized performance level	6. What determined that the need to achieve an optimized level of performance was maintained, without compromising quality, even focusing on frugal innovation?
7. Relationship with customers (Open question)	7. How do customers participate in product/process development?
8. Relationship with customers (Focus on costs)	8. Did customers have access to the production costs of the frugal innovation?
9. Innovation Management	9. What are the innovation mechanisms used by the company (tools, procedures or training)?

Source: prepared by the authors based on the theoretical construction of this research and guidance from three researchers in administration, innovation and frugal innovation.

NVivo 12 tool was used to analyze quantitative data to count the frequency of the most repeated terms in the interviews. The use of this type of tool (NVivo 12) is also predicted by studies by Bardin (2016). The program was adjusted to eliminate words with three letters or less, in order to avoid over-counting articles (a, the, etc.) and words such as “of”, “if”, “that”, etc., which do not represent any interpretative meaning as isolated words. This type of analysis maintains the qualitative study characteristic of this research, not giving rise to a quantitative research method.

5. Results

Neither the companies nor the managers were identified at the request of the participants, since this research deals with strategic and competitive information for companies. Companies and managers were identified by coding. The decision not to identify companies or managers allowed investigations to be carried out with more freedom and transparency.
Table 3 below presents general data and coding of the eight companies analyzed.

Table 3. Summary of the companies analyzed

Company	Market activity	Time of existence	Aproximate quantity of employees	Aproximate daily productivity
A	Footwear production. Own and third-party brands.	Between 75 and 100 years.	10 thousand.	25 thousand pairs
B	Footwear production. Own and third-party brands.	Between 50 and 75 years.	25 thousand.	50 thousand pairs
C	Footwear production. Own brands, third-party brands and licensed brands.	Between 25 and 50 years.	30 thousand.	60 thousand pairs
D	Printing for shoes. Outsourced production.	Between 25 and 50 years.	50 thousand.	5 thousand pairs
E	Footwear production. Own brands, third-party brands and licensed brands.	Between 10 and 25 years.	5 thousand.	25 thousand pairs

F	Footwear production. Own brands, only.	Between 25 and 50 years.	9 thousand.	80 thousand pairs

Source: Prepared by the authors.

The table below presents general information and coding about the eight managers.

Table 4. Profile of the managers interviewed

Respondent	Job description	Time of work experience with shoes	Quantity of shoe companies worked for	Education Background	Gender	Age
A1	Industrial Engineering Executive Manager	34 years	1 company	Degree: Mechanical Engineering; Post: Production and Logistics Management	Male	52 years
A2	Product Pricing Manager	17 years	1 company	Graduation: Administration; MBA: Administration and Finance	Male	35 years
B1	Product Development Manager	42 years	5 companies	Graduation: no; Technical course: Electronics	Male	61 years
C1	Product Development Manager	21 years	4 companies	Graduation: Footwear Design; Technical Course: Footwear Specialist (SENAI); Modeling (SENAI); CAD software (SENAI)	Male	39 years
C2	Product Development Manager	33 years	5 companies	Degree: Footwear Technologist; Technical Course: Modeling	Male	47 years
D1	Financial Manager and Owner	15 years	1 company	Graduation: no; Technical Course: Administration, Finance, Human Resources	Female	47 years
E1	Product Development Assistant	13 years	5 companies	Graduation: Administration; MBA: International Business	Male	35 years
F1	Product Designer	25 years	4 companies	Graduation: Production Management; Administration. Master's Degree: Environmental Quality	Male	43 years

Source: Prepared by the authors.

5.1 Frugal innovations identified in the companies

11 frugal innovations were identified in the eight companies surveyed. All were selected based on the 3 categories defined by Weyrauch and Herstatt (2016): significant price reduction; focus on essential characteristics; optimized performance level. In addition to these three characteristics, Weyrauch and Herstatt (2016) also reinforce the need for the item "significant price reduction" to be perceived by customers.

Each innovation was identified by a unique code, such as: IF1A1. This code is composed of "IF" (for "Frugal Innovation"), a number from 1 to 11 representing the sequential order of innovation, the acronym of the company to which the innovation refers, and the number 1 or 2 that refers to the sequential order of innovation within the same company. Table 5 summarizes the descriptions and information about the frugal innovations found.

Table 5. Detailed description of the identified innovations

Company	Innovation	Code	Market Price*	Frugal Innovation Price*	Percent of Reduction	Type of Innovation	Intensity of Innovation
	Description						
A	Beveling Machine	FI1A1	R$ 15,000.00 US$ 2,956.00	R$ 500.00 US$ 98.55	96.66%	Product (Equipment)	Incremental
	Equipment for chamfering cuirass and buttress developed through DIY (Bricolage).						
A	Kids' Shoe	FI2A1	R$ 129.90 US$ 25.60	R$ 38.00 US$ 7.48	70.70%	Product and Process	Incremental
	Children's shoes with leftover material used through DIY (Bricolage).						
A	Sports Shoe	FI3A2	R$ 63.00 US$ 12.41 (Production Cost)	R$ 49.00 US$ 9.65 (Production Cost)	22.22%	Product	Incremental and Disruptive
	In-house development of frugal sports footwear design. Focus: compete with leading brands and serve the poorest customers.						
B	Product reengineering	FI4B1	R$ 349.90 ~ 399.90 US$ 68.96 ~ 78.82	R$ 299.99 US$ 59.12	14.28% ~ 25%	Product e Marketing	Incremental
	The client set a target of 20% cost reduction to produce a product.						
C	Frequency Matrix	FI5C1	Not informed	Not informed	25%	Process and product	Incremental
	Reduction of parts and color option on the upper. From three pieces to just one, with a frequency matrix that imitates sewing. Reduction of color options from 8 to 4 and negotiation.						
C	Dubbing plate replacement	FI6C1	R$ 80.00 US$ 15.76	R$ 9.06 US$ 1.78	88%	Process	Incremental
	Replacement of the silicone plate in the upper dubbing with a polyurethane plate.						
C	Reduction in sole quality	FI7C1	Not informed	Not informed	15% (shoe sole value)	Product	Incremental
	Reduction in the quality of durability and resistance of the sneaker's sole.						
C	Disruptive Innovation	FI8C2	R$ 349.90 ~ 399.90 US$ 68.96 ~ 78.82	R$ 237.49 US$ 46.80	32.12%	Process and Product	Incremental and Disruptive
	Sneakers developed with reengineering to compete with cheaper brands. Reuse of tools from other collections. Product simplification.						
D	Ornament Innovation	FI9D1	R$ 16.00 US$ 3.15	R$ 11.30 US$ 2.22	29.37%	Process and Product	Incremental
	Final product component accessory. Outsourced Production Article.						
E	Sneakers Developed to Reduce Price	FI10E1	R$ 189.90 US$ 37.42	R$ 121.19 US$ 23.88	36.18%	Process and Product	Incremental and Disruptive
	Product without eyelets. PVC instead of PU. No lining on the tongue. Application of screen printing to reuse leftover material.						
F	Women's Footwear for Class C and D	FI11F1	R$ 299.99 US$ 59.12	R$149.90 ~ 189.90 US$ 29.54 ~ 37.42	40%	Product and Process	Incremental and Disruptive
	Private label women's products aimed at classes C and D.						

*Quote date used: 05/06/2024 - Rate: 1 Real/BRL = 0.1971337 United States Dollar/USD
Source: Prepared by the authors.

These innovations were considered frugal because they met the three requirements of Weyrauch and Herstatt (2016). All of them had a significant price reduction in comparison either with similar products on the market, or with the product or process previously carried out by the companies themselves. Some innovations did not achieve a 30% reduction, such as IF3A2, IF1A1, IF7C1. However, they were considered frugal, as they had previously undergone cost reduction.

All innovations focused on the essential characteristics of their products, removing everything that was not necessary to perform the function of the product or process. For example, the IF7C1 innovation, reducing sole quality, was carried out because, at the end of the product's useful life, the sole was still in excellent condition, compared to the other components. This superior component quality did not add value. It just makes the product more expensive. The cost of this product was thus reduced by 15% without compromising its quality, which is the third characteristic presented by Weyrauch and Herstatt (2016).

The main action taken by companies to achieve these two characteristics of frugal innovation was bricolage (Soni and Krishnan, 2014; Herstatt and Weyrauch, 2016), which means using material and knowledge resources available within the company itself to develop its innovations. In the case of the IF1A1 innovation (chamfering machine), the cost reduction was 96.66%. The company reached this result when it found itself financially limited to purchase machines worth US$ 2,956.00 (R$15,000.00). Industrial management, in the form of manager A1, asked the technical team to study the possibility of finding a solution using only resources already available in the company itself. The technicians met this demand by consuming only US$ 98.55 (R$500.00) per machine, eliminating the need for new equipment and maintaining the quality of the processes and the final product.

Another finding in this study, which presented the characteristic of bricolage, is the frugal innovation IF2A1, children's footwear, in which scraps of fabric not used in the production of other products, and which would have been discarded, ended up being used in an innovative way to produce children's shoes priced at US$7.48 (R$38.00) and a comparative difference with other similar products on the market of less than 70.70%. This innovation also meets the bricolage and affordable price requirements, identified as possible to be implemented by the feasibility analysis for this type of frugal innovation, proposed by the instantiation of the *design science research* study by Specht *et al* (2024). Furthermore, the frugal innovation IF2A1 was awarded by the company's leadership for reusing materials, avoiding material and financial waste, and also creating a profitable product for sale under one of the organization's brands.

The innovations also met the “optimized performance level” criterion, related to the quality of the product or process. However, for frugal innovation, this criterion encompasses a wider range of characteristics, such as performance, resistance, durability, among others (Rao, 2013; Radjou and Prabhu, 2015; Weyrauch and Herstatt, 2016).

Despite the findings are representative of frugal innovations, some concerns about adherence to the concept were raised. This is the case of the innovations IF1A1, chamfering machine, and IF6C1, dubbing plate replacement, with cost reductions of 96.66% and 88%, respectively. These innovations did not, at first observation, have any relationship with the end customer, which is one of the requirements of frugal innovation (Radjou and Prabhu, 2015; Weyrauch and Herstatt, 2016; Hossain, 2022). These concerns are discussed below, in section 4.2.6.

5.2 Inferential analysis of interviews

The interviews were conducted online using Microsoft Teams and the transcriptions were generated by Teams itself and later used in the NVivo v12 software for inferential analysis and word counting. Each interviewee was assigned a code consisting of a letter that refers to the company to which the interviewee belongs followed by the sequential number of the interview.

The interview with interviewee A1 was the only one that took place in two moments, due to the need to revisit some points for clarification and further elaboration, as well as the availability and engagement of the interviewee himself to participate and contribute to the research.

Table 6 summarizes some data from the interviews.

Table 6. Profile of interviewee

Code	Job Description	Time working for the company	Interview date	Length of interview

A1	Industrial Engineering Executive Manager	34 years	03/nov/2023 and 24/nov/2023	2h 15min
A2	Product Pricing Manager	17 years	08/nov/2023	1h 25min
B1	Product Development Manager	3 years	07/nov/2023	1h 3min
C1	Product Development Manager	1 years and 10 months	08/nov/2023	59min
C2	Product Development Manager	9 years	04/dec/2023	1h 09min
D1	Financial Manager and owner	15 years	29/nov/2023	56min
E1	Product Development Assistant	2 years	09/nov/2023	1h 21min
F1	Product Designer	13 years and 6 months	06/dec/2023	1h

Source: Prepared by the authors.

The inferential analysis was carried out based on the seven categories shown in Table 2. Each of these categories will be explored in the following sections.

5.2.1 Limited resources

The first category of inferential analysis, entitled limited resources that stimulate innovation, is based on the frugal innovation literature for its definition, and refers to the fact that limitations on limited resources, instead of blocking innovation, can, on the contrary, encourage it (Le Bas, 2020). According to interviewee A1, "for me, the main factor that stimulates innovation is the lack of resources" and he adds "the lack of resources helps you in what is called creativity".

Interviewee A1 himself, spontaneously, proposes an inferential analysis of what he had just answered by pointing out that "because people often think that innovating is technology, it is spending money" to alert to the understanding that in order to innovate it is not always necessary invest a lot of money and that simple solutions can also be considered innovations, understandings that converge with studies on frugal innovation, which advocate that limited resources force frugal innovators to seek simple, low-cost solutions, as opposed to more expensive strategies of innovation (Agarwal, Oehler and Brem, 2021; OECD/Eurostat, 2018).

This same interviewee contributed two examples of frugal innovation, one with 96.66% cost reduction and the other with 70.70% cost and price reduction. Interviewee A2, from the same company, but product pricing manager, also identified the need as the most important driver for innovation, because, according to interviewee A2, year after year inflation forces companies to find increasingly cheaper solutions to remain competitive in terms of prices. In other words, companies find the financial barrier (limited resources) the reason that forces them to look for cheaper solutions.

Two other limitations that stimulate frugal innovation that were identified in this category were competition with other companies and customer demand, which forces a constant search for increasingly lower costs and prices. In order to meet this demand, while maintaining profitability margins, companies are forced to innovate frugally.

Both testimonials and examples of frugal innovation reveal that limited resources can be a catalyst for frugal innovation, as it forces people to think of innovative solutions. However, this does not explain how it was possible for these companies to achieve frugal innovation results like those of the empirical examples identified. The next chapter will help clarify this question.

5.2.2 Bricolage

Bricolage is the ability of frugal innovators to innovate using the resources available in their companies or homes, without the need to acquire new tools or raw materials, in other words, it is the creative ability to innovate using only, or mainly, resources available (Agarwal *et al*., 2017).

All eight interviewees converge on the understanding that DIY is important for their work and innovation processes. Additionally, everyone is enthusiastic when discussing DIY. This enthusiasm was evident in expressions such as "Man, that's easy for me to answer [...]" (A1); "Man, it's very important [...]" (C1); "[...] it is a very important point [...]" (C2); "Hmm, that's an interesting question, because we managed to do this several times [...]" (D1). Bricolage was particularly present when F1 spontaneously mentioned its essence when saying that "[...] we try to

encourage this search by each employee to ‘do more with less’, to seek to have a solution”. This leads us to believe that these professionals practice DIY with motivation and understanding of its importance for the business, seeking to take this practice to the entire company.

The identified innovations themselves empirically support the interviewees' speech, such as, for example, the IF1A1 innovation, a chamfering machine, with a cost reduction of 96.66%, and the IF11A1 innovation, footwear for classes C and D, with a reduction in final price of 40%, reinforcing the observation that DIY is an important way to achieve frugal innovations.

The behavior of frugal innovators was characterized by E1 with a term used in some footwear companies: “Professor Pardal” (in English the term is Gyro Gearloose). Professor Pardal is a Disney comic and animation character created in 1952 and characterized as an eccentric genius inventor (Ramone, 2017). Today, this term is used to denote people with an inventive capacity to solve everyday problems. According to E1, this expression is not used in a pejorative way in companies, but rather to praise and admire the work of professionals with this characteristic. This term was also recognized by the interviewed managers A1 and F1.

In the frugal innovation literature, other terms are also used to refer to the creative professional in organizations. For example, *Jugaad* alludes to an Indian creative inventor (Hossain, 2018; Koerich and Cancellier, 2019). Similarly, Macgyver, a television series character with the ability to solve problems with simple resources, is used to refer to the frugal innovator (Radjou, Prabhu and Ahuja, 2012). In Brazil, the bricolage process is also referred to colloquially as “gambiarra” or “jeitinho brasileiro” to describe alternative ways of solving a problem (Hossain, 2018).

In view of the above, it is possible to observe the relevant role that DIY plays as a means of achieving frugal innovations and how the stance of the frugal innovator plays a relevant role in this process and result, recognized here as Gyro Gearloose.

5.2.3 Substantial cost reduction

The analyzes of this and the next two subsections are directly interconnected as they are the three main points of analysis of the article by Weyrauch and Herstatt (2016) and which deal with the significant reduction of costs and prices; focus on core functionalities; and optimized level of product performance and frugal innovation processes.

The study by Weyrauch and Herstatt (2016) suggests that frugal innovations must have a cost reduction of at least 30% in the first innovation attempt or that such a difference is the result of comparison with other similar products in the market where the innovative product is sold. .

Two points were predominant in all responses as factors that determine the need to reduce costs and prices of innovations, and these factors were customers and competitiveness with other companies. These elements had already appeared in the limited resources category, thus reinforcing the findings of this research.

Interviewee D1 makes these observations explicitly when she states that “The customer determines the price and cost and the competitor determines the fight over costs”. Interviewee B1 considers this dynamic a matter of survival for the business when he warns that “The survival of the business, right? The competitor is the biggest stimulus for you to innovate [...] otherwise you will set the price you want”. And she also adds (B1) “Either you innovate or you get run over by the competition [...] and the end customer always wants new things”.

All eight interviewees had the same perception regarding the cost reduction category being a demand arising from competition and customer expectations and none of the interviewees presented any other observation that could explain the search for significant cost reduction.

In addition to the evidence found in the responses of all interviewees to the fact that competitiveness and customers force the search for price reductions, the empirical examples of frugal innovations reinforce the proof that the companies studied here in fact work in the search for reduction significant increase in prices and costs.

5.2.4 Focus on core functionalities

The focus on core functionalities makes up the second characteristic that needs to be present in the analysis by Weyrauch and Herstatt (2016) and concerns removing from the product everything that is not essential for its functioning. This characteristic may be a natural consequence of the search for cost reduction, but not necessarily, as reducing functionality in a product may also mean improving it to make it less complex and prone to failures, for example (Radjou and Prabhu, 2015).

As with the search for cost reduction, the focus on core functionalities was reported by all interviewees as motivated by the market. Customers act as motivators for companies to seek to reduce costs, when they show sensitivity to prices, which forces companies to seek strategies for this reduction, such as, for example, removing unnecessary components from the product, and also shows companies that changes were approved when they accept to purchase products that have gone through a process of reducing items that are superfluous to the product's performance.

The interview with experts identified that the strategy of focusing on core functionality of products and processes in companies is mainly due to market demand, be it competitors or customers.

It was not evident that this search for focus on core functionalities had any relationship with another objective, such as improving product performance, for example. Interviewee A1 even mentioned the lack of resources as one of the reasons; interviewee C2 cited the company's initiative in removing elements that are not necessary for the products; and interviewee F1 observed that this strategy brings more practicality to the product.

However, these observations were isolated and did not prove to be as significant a driver as reducing costs. In other words, it is not evident that these statements are not motivated by the greater objective of reducing costs, as had already been unanimously identified in the interviewees' responses.

5.2.5 Optimized level of performance

The Optimized Performance Level category refers to the third of the three categories presented by Weyrauch and Herstatt (2016) that need to appear simultaneously in a frugal innovation so that it can be characterized as such. Optimized level of performance means that the product is developed to fulfill its function in the best possible way, as in the example of car horns in India, which are designed to last longer, due to constant use (Weyrauch and Herstatt, 2016).

For all interviewees, this category is intrinsically related to quality. Quality itself can give rise to different interpretations, but in the interviewees' understanding it is always associated with the performance requirements of the product produced, the quality standard of materials used in production, internal quality control systems and the comfort and satisfaction that the product is capable of providing to the customer.

The interviewees' level of concern and understanding of the importance of the Optimized Performance Level can be exemplified by B1's statement: “People always say, 'if I make 100,000 (one hundred thousand) pairs and have a sneaker that has a problem, I'll have it there 0.001% quality problem'. But, for those who bought this defective product, it is 100% dissatisfaction”.

All interviewees demonstrated that concern for the optimized performance level of products and processes is indispensable and non-negotiable in the relationship between producing companies and customers purchasing these products. Client companies that contract the work of production companies work with standardized quality standards that cannot be compromised. For C1 “Quality always comes first”. D1 stated that he values “total responsibility with regard to quality”. According to interviewee E1 “the brand (client company) does not compromise on quality”.

An example found in this research that illustrates the fact that the optimized level of performance does not necessarily mean making the product more expensive or adding more features to it is the case of the IF7C1 innovation (Reduction in sole quality). The company's decision was to reduce the quality of the sole, which had a useful life much longer than was necessary for the useful life of the product as a whole. This decision helped to reduce the price of the product and

maintained the quality of the footwear at an acceptable standard, without going beyond what was required by the customer or for the duration of the shoe's use.

In other words, it can be inferred that understanding the importance of quality, of the level of optimized performance, is not just an isolated interpretation within the production process, but it permeates the awareness of the impact that quality controls and their eventual failures can have in terms of impact on the perception of end customers.

5.2.6 Relationship with clients

One of the prerogatives of studies on frugal innovation is the relationship with customers (Radjou and Prabhu, 2015; Weyrauch and Herstatt, 2016). For example, of the six fundamental principles presented by Navi Radjou and Jaideep Prabhu (2015), four make direct or indirect reference to the importance of customers in frugal innovation processes.

This finding, although enlightening for the development and analysis processes of frugal innovations, also generated an analytical doubt for this research, more specifically regarding the interpretation of frugal innovation to the innovations IF1A1, chamfering machine, and IF6C1, replacement of dubbing board, with cost reductions of 96.66% and 88%. These innovations, despite having presented considerable cost reduction, did not present clear evidence, in this research, of having generated a noticeable benefit for the customer.

The concern to better understand this question led the authors of this work to make use of some data and information analysis techniques from Bardin's (2016) analysis method, such as word counting, to try to identify elements of information and empirical findings that are not evident only in a first analytical approach. This analysis was not intended to prove that the customer perceives the impacts of frugal innovation, but rather to reinforce the understanding that the customer is one of the main motivators for companies to seek innovation strategies that end up giving rise to frugal innovations.

After the evidence found in the interviews that customers are one of the elements that promote the search for cost and price reduction, we sought to study the recurrence count of the most repeated words in the interviews. This analysis found that the word client was the third most repeated word in this research, after eliminating words without meaning in themselves, such as articles, interjections and names, which might appear more often. The following table presents the results of the ten most repeated words in the interviews.

Table 7. NVivo v12 word repetition frequency

Order	Word	Frequency
1	Product	290
2	Innovation	274
3	Client	214
4	Company	204
5	Quality	184
6	Market	154
7	Process	111
8	People	110
9	Material	95
10	Frugal	78

Source: produced by the authors.

This inferential analysis shows how the concept of customer plays a fundamental role in product development processes in footwear companies and that financial benefits in terms of price are perceived by customers.

Even in the case of the innovations IF1A1 (chamfering machine) and IF6C1 (dubbing plate), which did not have an immediate impact on customer perception, they help in the cost reduction process that ultimately affects customer perception in terms of product prices. developed products

and are, therefore, relevant practices in the development process of developing frugal innovations.

This happens because customers demand products with increasingly lower and competitive costs and prices. By being able to offer products to the market at prices that meet customer demands, these producing companies are able to guarantee their commercial relationship with customers. Without this, the relationship would be interrupted.

It was also identified that in five of the eight companies studied, customers had access to the companies' costs regarding the production of their products. This arises from the fact that some client companies have offices within the producing companies, as mentioned by A1, A2, B1, C1, C2 and E1. In these cases, representatives of client companies participate in the decision-making process of checking production processes and product quality. This practice of accessing costs and production processes not only allows for the purpose of checking and analyzing the actions of producing companies, but also contributing with suggestions for improvements.

Thus, it appears that the relationship between producing companies and contracting companies is based not only on control and surveillance, but also on joint and collaborative work. According to the words of interviewee C1 "The client ends up being, in quotation marks, our co-worker, right". For interviewee A1, this is a relationship of "exchange of knowledge and contribution". Interviewees A1 and A2 used the term transparency to refer to this relationship. Interviewee A2 calls this type of relationship with client companies an "open cost sheet policy".

This analysis allows us to observe that customers seem to benefit from the processes and products developed by the companies in this study, reinforcing the understanding that the innovations presented here are frugal innovations. If the products developed did not meet the characteristics of significant price reduction; focus on core functionalities; and optimized performance level, then the products would not be accepted by customers, or returned to the development process.

5.2.7 Innovation management

This category aims to analyze the formal innovation processes implemented by footwear companies based on both the innovation literature (OECD/Eurostat, 2018) and the frugal innovation literature (Weyrauch and Herstatt, 2016; Hossain, 2022).

All interviewees confirmed that the companies in which they work implement some type of program that aims at some form of procedure aimed at developing innovation, even if such action is not necessarily called an innovation project.

This was the case of company D1, which did not explicitly demonstrate innovation process practices or quality improvement, working mainly with the notion of unstructured and sporadic courses and training. However, these sporadic actions seem to help the company find innovative solutions. Furthermore, the example of frugal innovation presented by the company and the interview statements in the other questions demonstrate that the company practices routine and simple innovation actions, even if the interviewee does not consider them as such.

The main improvement and innovation programs mentioned were Green Belt and Lean System (with the exception of interviewee D10. Programs such as the Lean System (downsizing and process simplification program) seem to be closer to the practices observed in the literature on frugal innovation with regard to the simplification of processes and mainly, and this applies to all actions found in companies, in terms of maintaining optimized performance levels of processes and innovations (Radjou and Prabhu, 2015; Hossain, 2018; Bhatti, 2018).

In addition to these quality and process improvement programs, which highlight the importance of searching for innovations, companies A, C and F also demonstrated programs specifically structured to stimulate thinking and innovative practices that involve awards for the best innovation propositions.

The analysis of the responses allows us to infer that a practice of innovation permeates footwear companies, and that this practice appears even in the case of company D, which did not demonstrate structured innovation processes. Both the Oslo Manual (OECD/Eurostat, 2018) and the literature on frugal innovation (Brem, Wimschneider, Dutra, Cubas and Ribeiro, 2020; Agarwal, Oehler and

Brem, 2021; Rossetto, Borini, Bernardes and Frankwick, 2023) , recognize the explicit and tacit processes of a company as an environment that stimulates the search for innovation, and this inventive environment is evident in the answers to all the questions and categories presented in this research, and especially in this category on innovation processes.

In the literature on frugal innovation, the context that stimulates innovation is mainly related to an environment of limited material resources and limited financial resources on the part of consumer customers (Bhatti, 2018; Agarwal, Oehler and Brem, 2021). For reasons other than economic situations of poverty, the footwear industry deals with limited resources due to the fierce competitiveness of this industry.

6. Final considerations

This research aims to analyze how frugal innovation appears in companies in the footwear sector in Rio Grande do Sul, in the South of Brazil, through multiple case studies with six companies analyzed and eight footwear managers from these companies interviewed.

In total, 11 empirical examples of frugal innovations in companies were found. All innovations were found using the selection criteria proposed by Weyrauch and Herstatt (2016). Therefore, this article contributes to ongoing studies on the topic.

From the inferential analysis of the interviews, it was possible to observe that limited resources, instead of blocking the innovation development process, which would be expected when resources are not available, actually stimulate (force) companies to think of creative solutions, as studies on frugal innovation suggest (Radjou and Prabhu, 2015).

One of the actions observed to generate frugal innovations was bricolage, identified as a characteristic behavior of frugal innovators in companies. This behavior seems to be the result of a practice in companies that allows the search for simple innovations.

In addition to all the frugal innovations identified meeting the three characteristics proposed by Weyrauch and Herstatt (2016), it was also possible to observe that the customer represents a fundamental factor in the search for solutions and reduction of prices and costs in companies. This is a relevant finding, as studies on frugal innovation advocate that the main recipient of the results of frugal innovations needs to be customers (Weyrauch and Herstatt, 2016; Hossain *et al*., 2022).

This research contributes to studies on frugal innovation mainly in terms of showing how frugal innovation happens within a development process that is not restricted to just showing the results of frugal innovation (Weyrauch and Herstatt). In other words, not only were frugal innovations and their characteristics presented, but the processes that led to such innovations were also presented.

This study presented three social contributions that can be divided into three areas of impact: people, environmental and economic. In terms of people, this study reinforces the importance of people for the good operational and financial results of companies; From the customers' perspective, social contribution refers to the potential that frugal innovation presents to offer quality products at affordable prices, thus generating the opportunity to provide a social service by offering products to the poorest classes of society.

Regarding the social contribution in terms of the environment, this is perhaps the point with the greatest promise of impact when it comes to studies on frugal innovation, even though this was not the focus of this research. The reason for stating this is the current concern with the environmental impacts of human action and especially those arising from business practices (Bai *et al*., 2016; Rockström, Bai and deVries, 2018; Le Bas, 2020).

And the third, and final, contribution within the social contribution category is the economic perspective. Frugal innovation is recognized as a search for innovation with the potential to reduce costs and prices, while managing to maintain interesting profit margins for companies (Weyrauch and Herstatt, 2017; Specht *et al*., 2024).

Another contribution of this study is the connection with other studies on the topic of frugal innovation in terms of the importance of the relationship and contribution between universities and companies (Reina *et al*., 2021; Specht *et al*., 2024); and the empirical evidence of the possibility of

frugal innovations in producing shoes with reused material with an accessible price for the final customer, as proposed by the study of Specht *et al* (2024).

One of the limitations of this research is the fact that it only evaluated the perspective of the companies in the form of their representatives, the footwear experts interviewed. Although a multiple case study and the strategies used in this research help to resolve this problem, it still presents only one perspective in a relationship in which the customer's perception is relevant.

Therefore, for future studies, it is suggested that this research be advanced from the perspective of customers in the footwear environment, and that, in addition, there is also more interaction between universities and companies in studies on frugal innovation that are not just punctual, but that are unfold over time in longitudinal research, as other studies also suggest (Radjou and Prabhu, 20105; Reina *et al*., 2021).

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