

A new scale for measuring Frugal Innovation: The first stage of development of a measurement tool

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A NEW SCALE FOR MEASURING FRUGAL INNOVATION: THE FIRST STAGE OF DEVELOPMENT OF A MEASUREMENT TOOL

RESUMO

Tanto no meio acadêmico quanto na imprensa, a Inovação Frugal vem ganhando mais espaço e atenção de pesquisadores e gestores, principalmente por se mostrar como uma alternativa para competitividade em tempos de crise e de recursos cada vez mais escassos. Apesar do crescente número de artigos publicados sobre Inovação Frugal, ainda faltam instrumentos que permitam a mensuração e quantificação deste fenômeno de modo a permitir que estudos mais precisos e quantificáveis possam ser realizados. O objetivo deste estudo é propor um instrumento de mensuração da Inovação Frugal, apresentando os resultados preliminares das primeiras etapas do processo de desenvolvimento de escalas. Uma ampla revisão da literatura é apresentada, bem como uma análise da dimensionalidade do construto e uma definição para Inovação Frugal são propostos. Foram coletados os dados de 191 empresas brasileiras manufatureiras e através da Análise Fatorial Exploratória (EFA) e Análise Fatorial Confirmatória (CFA), uma escala de segunda ordem formada por três dimensões e composta por 9 itens é apresentada nesta primeira fase, juntamente com o ajuste de todos os índices estatísticos. Outra coleta de dados já foi realizada com 247 empresas brasileiras e outras duas estão em andamento, com 500 empresas americanas e mexicanas para validação final da escala.

Palavras-chave: Inovação Frugal; Mensuração; Escala; Mercados Emergentes; Inovação.

ABSTRACT

In both academia and the press, Frugal Innovation has been gaining more space and attention from researchers and managers, mainly for showing itself as an alternative for competitiveness in times of crisis and increasingly scarce resources. Despite the growing number of published articles on Frugal Innovation, there are still a lack of instruments that allow the measurement and quantification of this phenomenon in order to allow more precise and quantifiable studies to be carried out. The objective of this study is to propose a measurement instrument for Frugal Innovation, presenting the preliminary results of the first steps in the process of scale development. A broad review of the literature is presented, as well as an analysis of the construct dimensionality and a definition for Frugal Innovation are proposed. Data were collected from 191 Brazilian companies and through the Factorial Exploratory Analysis (EFA) and Confirmatory (CFA), a second order scale formed by three dimensions and composed by 9 items is presented in this first phase, together with the adjustment of all statistical indices. Another collecting data was realized with 247 Brazilians firms, and another two surveys are running currently with 500 Americans and Mexicans firms for final validation of this scale.

Keywords: Frugal Innovation; Measurement; Scale; Emerging Markets; Innovation.



1. INTRODUCTION

The global economic crisis of recent years has promoted significant impacts on investment in innovation, both in developed countries (Archibugi, Filippetti, & Frenz, 2013; Filippetti & Archibugi, 2011), and in developing countries, also called emerging markets (Paunov, 2012). Restricting resources impelled companies to rethink their innovation strategies see Zedtwitz, Corsi, Sørberg, and Frega (2015, p. 14), among which, the "Frugal Innovation", which has been gaining more and more social and academic relevance (Bound & Thornton, 2012; Radjou, Prabhu, Polman, & Economist, 2015; Tiwari, Kalogerakis, & Herstatt, 2016). Whereas about eight years ago, a simple search of the term "Frugal Innovation" in Google Scholar returned only 11 relevant results in 2009 (Tiwari, Kalogerakis, et al., 2016, p. 1). Currently (until August 22th, 2017), this same search already results in more than 2,080 results, of which 295 (about 14,18%) are for articles published only in the half year 2017. The term "Frugal Innovation" appeared as a subject of the *Economist* (2009) magazine and gained strength with later studies (*Economist*, 2011; Rong, Liu, & Shi, 2011; Zeschky, Widenmayer, & Gassmann, 2011a, 2011b) gaining the attention of researchers and academics. Frugal Innovation has been so relevant that in 2014, the publisher Nature Springer launched the scientific journal called "Journal of Frugal Innovation" dedicated to the theme.

In response to serious resource-constraints, Frugal Innovation emerged as a solution developed for emerging markets (Weyrauch & Herstatt, 2016a). The focus was on the development of products and services adapted to the special needs of these markets that needed cheap enough products to offer consumer opportunity to resource-constrained consumers (Coimbatore K Prahalad, 2002; Soni & Rishiksha, 2014; Wooldridge, 2010). In short, an innovation focused on the creation of products that presents an extreme cost advantage compared to existing solutions (Zeschky et al., 2011b, p. 39). However, there is growing evidence that "Frugal Innovation" is also becoming relevant in developed countries (*Economist*, 2012), which due to the global crisis have had the long-term competitiveness of the domestic firms affected, both from their overseas subsidiaries and from the headquarter companies in their home countries (Tiwari, Fischer, & Kalogerakis, 2016; Tiwari & Herstatt, 2013).

This recent rise in the phenomenon of Frugal Innovation initially led to the emergence of several articles for the understanding of the construct. Several studies already made proposals of criteria and conceptualizations on frugal innovation (Agarwal & Brem, 2012; Bhatti, 2012; *Economist*, 2009; Le Bas, 2016; Rao, 2013; Soni, 2013; Tiwari, Fischer, et al., 2016; Tiwari & Kalogerakis, 2016; Tiwari, Kalogerakis, et al., 2016; Weyrauch & Herstatt, 2016a; Zeschky et al., 2011b). There are still those who have rules and principles for Frugal Innovation (Kumar & Puranam, 2012; Coimbatore Krishnarao Prahalad & Mashelkar, 2010; Radjou, Prabhu, & Ahuja, 2012). However, the literature is still based on case studies, since there is no scale to measure frugal innovation. Thus, the purpose of this article is to propose a scale for the measurement of frugal innovation, presenting the first phase of data collection and the refinement of the items through Exploratory and Confirmatory Factor Analysis.

It is important to note this study is underway and we are currently carrying out a second more extensive data collection with Brazilian companies, and then we will do a 3rd data collection with Mexican, American and Indian companies for final validation of the scale.

The measurement activity of a phenomenon is central to the process of scientific investigation (Tucker, Viswanathan, & Walford, 2010). In other words, doing science involves the measurement process, precisely so that it is possible to verify and compare results. Likewise, for there to be control and management mechanisms, it is essential that there be quantification. Thus, the development and validation of a frugal innovation scale contributes to innovation studies by allowing (1) to describe the characteristics of certain groups of companies, organizations or the orientation that these companies have for Frugal Innovation; (2) estimating



the proportion of elements in a specific population that behave in a certain way, accurately identifying organizations that effectively innovate frugally; and (3) make specific predictions, that is, discover or verify the existence of a relationship between variables. In addition, from the managers' point of view, the importance of the measurement of Frugal Innovation is given by the potential source of information that can be obtained, above all, in the segmentation of organizations and in the adjustment of the offers of each organization, based on the level of Frugal innovation, as well as in measuring the level of frugality achieved by the organization, allowing the company to monitor and optimize the use of resources.

2. THEORETICAL BACKGROUND AND LITERATURE REVIEW

Since the publication of the Economist (2009), academics and researchers have started to investigate the phenomenon of Frugal Innovation. One of the earliest scholarly studies was published by Zeschky et al. (2011b) in which he made a case study presenting Frugal Innovation and associating this innovation with the case of Matter Toledo, a multinational company of Swiss origin that manufactures precision scales. In this paper, Zeschky et al. (2011b) addressed the application of the phenomenon to emerging markets and presented the different concepts and conflicts that exist in the conception of Frugal Innovation - as accessible, "good enough" products that meet the needs of resource constrained consumers, centered on the concept of Christensen (1997) disruptive innovation of low-level, which approaches the concepts of resource-constrained innovation (Ray & Ray, 2010), and cost innovation (Williamson, 2010).

To contribute to the understanding of the phenomenon of Frugal Innovation, Agarwal and Brem (2012) also present a case study of German Siemens and its performance in China and India, also exemplifying the performance of Frugal Innovation and Reverse Innovation in Emerging Markets, and indicating that in these markets innovation can take place through imitation (Shanzhai Innovation) because the inherent differences in local needs and the lack of infrastructure lead to new paradigms of innovation such as Frugal Engineering, Reverse Innovation or based-restricted Innovation (Agarwal & Brem, 2012; Saraf, 2009).

From 2012, the publication of studies grew with the aim of stabilizing the understanding of the meaning of Frugal Innovation, especially seeking a clearer and objective definition different from other kinds of innovation. Among them, the study of Bhatti and Ventresca (2012) which initially seeks to demonstrate the association of the word "Innovation" with the word "Frugal", indicating the rise of "Frugal Innovation". The same author presents another study (Bhatti, 2012) which aims to conceptualize "Frugal Innovation". Both studies assume Frugal Innovation is oriented to emerging markets, in addition to indicating the need to understand Frugal Innovation so that it can be differentiated from other phenomena such as Social Innovation, Reverse Innovation, Bricolage, Reverse Engineering, Innovation by Improvisation, or Jugaad Innovation, among others (Bhatti, 2012; Bhatti & Ventresca, 2012).

An article published in the Economist (2012) has given rise to evidence that Frugal Innovation can also suit developed countries, attracting the attention of researchers and academics to existing conceptual limitations and the need for further research to define more appropriately this phenomenon, as well as to the urgency of the need for differentiation of Frugal Innovation from other kinds of innovations. This paved the way for a new crop of more comprehensive and consistent studies (e.g. Basu, Banerjee, & Sweeny, 2013; Bhatti & Ventresca, 2013; Brem & Wolfram, 2014; Cunha, Rego, Oliveira, Rosado, & Habib, 2014; Radjou et al., 2015; Soni & Rishikesha, 2014; Tiwari, Fischer, et al., 2016; Tiwari & Kalogerakis, 2016; Tiwari, Kalogerakis, et al., 2016; Weyrauch & Herstatt, 2016a; Zeschky, Winterhalter, & Gassmann, 2014).



2.1 The paradigm of the development of measurement scales

The process of scale development is a subject of interest to many academics and scholars in many fields and has classic works (see Devellis, 2003; Netemeyer, Bearden, & Sharma, 2003; Nunnally & Bernstein, 1978) that elucidate all the steps and procedures to be followed for the development of a scale. Some papers were seminal for establishing new paradigms in the process of development of scales in the applied social sciences, as is the case of works that Churchill (1979), Rossiter (2002), Devellis (2003), Netemeyer et al. (2003), Diamantopoulos, Siguaw, and Cadogan (2008) and Rossiter (2008) are oriented to the development and measurement of formative constructs, and the work of development and measurement and reflexive constructs Diamantopoulos and Winklhofer (2001).

The adoption of procedures for measuring and developing the scale presented in this study sought to choose the paradigm of Churchill (1979) by the fact (1) of this scale is widely used and accepted in several studies and publications (2) by generating "adequate results in the production effort of a consistent, reliable and valid scale", despite the existing criticisms, and (3) by giving special attention on the sampling and purification tasks proposed by the author, thus contributing to a final result within the standards necessary for the generation of a suitable and valid measuring instrument.

2.2 Specification of the construct domain

The literature on Frugal Innovation (Zeschky et al., 2011b), although recent, involves concepts already long known, such as the concept of innovation (Oecd, 2004), added to the concept of Frugality (Henderson, 1978), originating innovation in focus in this work. One of the first appearances in the literature on frugality associated with product and service economics arises from the work of Henderson (1978) in which he describes the phenomenon of frugality that has emerged as an anti-economic culture associated with consumer habits that seek to maximize income, in an effort more psychic than material, going against the flow of the industrialized nations. Henderson (1978) describes that the phenomenon of frugality has achieved prominence with the middle class that rejects the high-consumer lifestyle of the industrialized world during the 1950s and 1960s.

From the 1980s to the 1990s, some efforts to measure consumer behavior that incorporate in their assessment some aspects related to the measurement of frugality (e.g. De Young, 1986a, 1986b, 1988, 1993; Lee & De Young, 1994; Lee, De Young, & Marans, 1995). However, it was in the late 1990s that the first specific effort to measure frugality was published by Lastovicka, Bettencourt, Hughner, and Kuntze (1999) where they present a measurement scale of frugal consumer buying behavior. Shortly afterwards, another paper published by De Young (2000) presents an evaluation of the reasons that lead to an environmentally responsible behavior, including an evaluation of several previous works (De Young, 1986a, 1986b, 1988, 1993, 2000; Lee & De Young, 1994; Lee et al., 1995) who present scales, consolidating all constructs, and among them presents a set for evaluation of frugal consumption behavior. Making use of some of these constructs presented by De Young (2000), the authors Ribeiro and Veiga (2011) present a scale proposition for measuring sustainable consumption. Despite all these efforts in building a scale that measures the dimensions of frugality, all focus on assessing frugal consumer behavior. No work so far offers any alternative for the measurement of Frugal Innovation developed by companies, such as the work proposed here.

The literal meaning of the word Frugal, according to the Oxford Dictionary, means saving, economical, prudent or economical in the use of consumption resources - such as food, time or money - avoiding waste, waste or extravagance (Dictionary, 2002; Simpson & Weiner, 1989). In the behavioral sciences, the definition of "frugal" is defined as a tendency or behavior



of buying goods and services in a contained way, using the goods themselves, resources or services economically to achieve long-term goals (Lastovicka et al., 1999).

Frugal's concept of innovation came first with an article in *The Economist* (2010) describing that "it was not just a matter of cheap labor exploitation" (though cheap labor helps), but a question of Remodeling of products and processes to cut unnecessary costs (Wooldridge, 2010), referring to a new form of cheapening or cutting costs in the process of creating new products, thus raising the idea of "Frugal Innovation", the concept which has gained popularity among managers and academics (Bhatti, 2012; Bhatti & Ventresca, 2012, 2013; Radjou et al., 2015; Tiwari & Herstatt, 2012b; Wooldridge, 2010).

George, Mcgahan, and Prabhu (2012, p. 1) defines frugal innovation as a "low-cost, high-quality innovation of product and business models originating in developing countries and exportable to other developing countries or even to developed countries".

This definition is very close to the definition of Reverse Innovation. Others call frugal innovation simply "attenuated innovation" or used to refer to "good-enough products" (Hang, Chen, & Subramian, 2010; Zeschky et al., 2011b), or low cost products (Ramamurti, 2012). In Ernest & Young's report, one of the drivers of frugal innovation is the desire to improvise in the face of resource constraints, giving a powerful advantage to emerging market companies that have long operated in a business environment where resources are scarce, poor infrastructure, and a volatile macroeconomic environment have forced companies to be highly creative in their problem-solving approach, as they are accustomed to developing ingenious and creative solutions to overcoming obstacles (Pitelli, 2011).

Several other definitions are present in the literature. To begin the procedures for the development of the scale for the measurement of Frugal Innovation, it is necessary to establish specifications of the construct domain (which will be presented in the next section), however, before this we need to make some considerations to establish our conception of the definition of frugal Innovation.

Firstly, to define Frugal Innovation, the need to exist in the definition is undisputed, the dimension in which Frugal Innovation offers the purchase price, or considerably lower initial costs, which is practically unanimous in the literature (Agarwal & Brem, 2012; Bound & Thornton, 2012; Doz & Wilson, 2012; Economist, 2010; Radjou et al., 2015; Zeschky et al., 2011b), and is pointed out in the definition of Tiwari and Herstatt (2012a), that reinforced the idea in 2014 (Tiwari, Kalogerakis, & Herstatt, 2014), and in 2016 (Tiwari, Fischer, et al., 2016). In addressing this dimension "substantial cost reduction", Weyrauch and Herstatt (2016a) included other attributes or characterizations that could be included in the definition of academic articles, such as: "*Accessible, affordable, affordability, avoid needless costs in the first place, cheaper, cost discipline, cost effective, extreme cost advantage, fulfil the requirements of access, fulfil the requirements of affordability, low budget, low cost, low prices, low priced, minimizing non-essential costs, minimum cost, more affordable prices, much lower price, reducing cost, trying to reduce the cost, significantly lower costs, ultra-low cost*". These attributes or characterizations were essential for Weyrauch and Herstatt (2016a, p. 5; 2016b, p. 5) to define "substantial cost reduction" as one of their criteria for defining Frugal Innovation. Secondly, to define "Frugal Innovation", it's essential that there be in the definition, another dimension that says that Frugal Innovation focuses only on the essential and / or functional functions of the offer, which this is also a unanimous characteristic in the academic literature of this theme (Agarwal & Brem, 2012; Basu et al., 2013; Bhatti, 2012; Bound & Thornton, 2012; Brem & Ivens, 2013; Cunha et al., 2014; Economist, 2012; Radjou et al., 2012; Soni & Rishikesha, 2014; Tiwari & Herstatt, 2012c, 2012d; Tiwari & Kalogerakis, 2016; Tiwari, Kalogerakis, et al., 2016; Zeschky et al., 2014), because it's common to find among the definitions of Frugal Innovation in the academic literature that one of its most striking



characteristics is the offer of essential or limited functionalities. Besides, Tiwari et al. (2014); Tiwari, Kalogerakis, et al. (2016) in the same sense, already introduces to the definition of Frugal Innovation the concept of "*minimizing the use of material and financial resources throughout the chain in order to meet or exceed certain predefined criteria of acceptable quality standards*", indicating the possibility to adapt the offer by removing or adding features that are essential to make the offer unique and of acceptable quality. For this dimension of "concentration on core functionalities", Weyrauch and Herstatt (2016a, p. 5; 2016b, p. 5) also listed a group of attributes and characterizations that may appear in the definitions of Frugal Innovation found in academic articles, such as:

"Bare essentials, core benefits, cut corners, taking exception to some of the requirements, de-featuring, eliminating unessential functions, entirely new applications, provide the essential functions people need, fulfil the requirements of awareness, fulfil the requirements of availability, good enough, light, limited features, new functionality, do not have sophisticated technological features, portability, reduced functionalities, reducing the complexity, tailor made, unnecessary frills stripped out".

Following this set of attributes or characterizations that Weyrauch and Herstatt (2016a, 2016b) used to define the "concentration in the core functionalities" as the second criterion for defining Frugal Innovation.

However, within the main theoretical currents that contribute to a better understanding about Frugal Innovation, are some authors who maintained the roots of the meaning of the word Frugal, defend the idea that a Frugal Innovation must have a concern for the environment and sustainability. The very word "frugal" has in its concept the idea of saving resources, which leads to something frugal being ecologically correct, without aggression to the environment or something related to sustainability (Henderson, 1978).

In this sense, two recently published studies (Tiwari, Fischer, et al., 2016; Tiwari, Kalogerakis, et al., 2016) pays the virtue of frugality has begun in the developing world, it is spreading steadily to the developed world because of the growing (global) demand for excellence sustainability and affordable (Tiwari, Kalogerakis, et al., 2016). In addition, in the studies of Weyrauch and Herstatt (2016a, 2016b) the authors do not make clear the reason why it is not necessary to create a specific category or criterion for the environmental/sustainable aspect. They mention in the text that in the discussion section they will explain the details, but they do not make any explanation about it (Weyrauch & Herstatt, 2016a, p. 7; 2016b, p. 6). However, the authors indicate a set of attributes or characterizations that can be used to define the sustainability dimension, such as: "*Eco-friendly, ecological, little environmental intervention, low carbon footprint, meets green marketing objectives, service ecosystem, sustainability*" what corroborates with the idea of creating a frugal ecosystem, that is, an organizational environment focused on promoting Frugal Innovation, which is geared towards frugality, seeking at all stages (before, during and after) the optimization of resources to achieve The fullness of resource savings to optimize the delivery of results.

In this way, we decided to support the proposition of a new definition of Frugal Innovation based on the arguments presented by Tiwari, Fischer, et al. (2016); Tiwari, Kalogerakis, et al. (2016), and in the Sustainability attributes indicated by Weyrauch and Herstatt (2016a, 2016b), we propose the following dimensions for the definition of Frugal Innovation:

1. Substantial cost reduction (Tiwari, Fischer, et al., 2016; Tiwari, Kalogerakis, et al., 2016; Weyrauch & Herstatt, 2016b)
2. Concentration on core functionalities and performance (Tiwari, Fischer, et al., 2016; Weyrauch & Herstatt, 2016a, 2016b)
3. Creation a Frugal Ecosystem (Tiwari, Fischer, et al., 2016; Weyrauch & Herstatt, 2016b)



Based on the previously presented dimensions, we propose the following definition of Frugal Innovation for the present study, adapted from the definition of Tiwari, Fischer, et al. (2016, p. 17) with the purpose of guiding the process of development of the measurement scale as the objective of this study:

“Frugal Innovation consists of creating a value proposition that is attractive to the selected target audience, focusing on the essential functionalities and performance of the offering, thereby minimizing the use of material, financial and organizational resources throughout the value chain. It provides a substantial reduction in usage and / or property costs while meeting or even exceeding the prescribed quality standards, without losing sight of the quest for creation a frugal ecosystem.”

2.3 Dimensionality analysis of the construct

For a better understanding of the "frugal innovation" construct, it is necessary to verify if the construct in question is homogeneous in itself, or if it has significant parts or components that form it (Devellis, 2003). For this, it is important to follow the guidelines of Devellis (2003) that gives three indications for the definition of the dimensionality of a construct: (1) bibliographical research; (2) the exploratory analyzes; And (3) the factorial tests, the last two procedures being more appropriate for constructs still little known, as in the case of "frugal innovation".

In this way, in addition to the bibliographic research for the survey of the dimensions of the constructs, in this work also was conducted in-depth interviews with specialists for the judgment of the constructs and for face validation, content validation and the descriptive capacity of the items. We also carried out exploratory and confirmatory factor analysis tests and cleaning of the constructs and definition of the scale for the final validation collection. All of these procedures are detailed in the following sections of this work, however it has already been possible to define that the latent construct "frugal innovation" will be defined 'initially' in three dimensions: (1) Concentration in the core functionalities and performance; (2) Substantial cost reduction; And (3) Creation a Frugal Ecosystem. The definitions of each of these dimensions are presented in Table 1.

Table 1: Definitions of the dimensions of "Frugal Innovation"

#	Dimensions	Definitions
1	Concentration on Core Functionalities and Performance	<i>This dimension brings together the items that seek to measure the attractiveness of the offered value proposition, seeking to associate the central functions of the offer with the performance, preferentially fulfilling or even exceeding the prescribed quality standards</i>
2	Substantial Cost Reduction	<i>This dimension brings together the items that seek to measure the effort to reduce the use of material, financial and organizational resources in order to achieve a substantial reduction of use and / or property costs to transfer this economy to the final consumer.</i>
3	Create a Frugal Ecosystem	<i>This dimension brings together the items that seek to measure the company's effort in its search for Sustainability, Sustainable development, the development of a relationship throughout the value chain in order to create a frugal ecosystem, that is, with a view to creating a Environment that promotes Frugal Innovation.</i>

3. METHODS

3.1 Items Generation and Face Validation and Content Validation

To ensure greater consistency in the development of this scale for the measurement of "Frugal Innovation", the literature review process sought to sweep all existing literature published to identify the largest possible number of constructs that could compose this first phase of item



generation. As there are still no scales developed for the measurement of "Frugal Innovation", in the first phase it was necessary to generate items only from the literature review, which resulted in 66 items, 26 items for dimension 1 (Concentration on core functionalities and performance), 23 items for dimension 2 (Substantial cost reduction) and 17 items for dimension 3 (Create a Frugal Ecosystem). These initial items were reviewed in detail, with the exclusion of 36 items due to similarities or inadequacies to the concept or dimensions of the constructs determined in this study, leaving at the end 30 items to be reduced through Content Validation with specialists.

In the selection of the set of final items, it was observed that all items maintained a condition of recipients of influence on the variation of the construct or the dimension, to enable the operationalization of the construct as formative. Subsequently, all these items were adapted to the affirmation format, precisely because this is the most usual form of research of this type (Costa, 2011; Devellis, 2003).

3.2 Procedures for validation of face, content, descriptive and translational ability

The 30 items were submitted to a set of judges for the validation of content, face and the descriptive capacity of each item, being that (Nunnally & Bernstein, 1978; Walford, Tucker, & Viswanathan, 2010):

- **Content validation** is understood as the degree to which the individual items, formed by the answers and instructions to the interviewees of the instrument are relevant and representative of the construct under analysis.
- **Face validation** is related to the practicality, pertinence and representativeness of a set of items in relation to the construct to be measured.
- **Descriptive capability** is related to the ability of the item to describe the construct that is to be measured.

The body of judges was composed of eight renowned members with noted knowledge in their areas of work, being three professors' doctors of the area of innovation, 3 doctor professors of quantitative field and specialists in construction of scales, 1 professor doctor of the area of administration of operations and one professional market specialist in the area of innovation. For all the judges a questionnaire was applied in person, where the latent construct definition "Frugal Innovation" was adopted, followed by the set of respective items.

For the validity of content, all were invited to mark in a scale of five points the degree of adequacy of each of the items to the definition of Frugal Innovation presented, going from (1) Very inadequate to (5) Very adequate, thus indicating how appropriate each item was to measure Frugal Innovation.

For face validity, all were asked to mark on a five-point scale the level of clarity of the utterance for each item, indicating if the item comprehension was satisfactory, using a scale ranging from (1) Very poor to (5) Very good, thus indicating how clear and understandable each item was to measure Frugal Innovation.

The instrument also contained a space for comments after each item, to enable the annotation of all recommendations or suggestions for improvement.

At the end, the analysis of the averages attributed by the judges, with a subsequent classification of the items according to the score attributed to the Validity of Content and Face, was performed, so that the evaluation by the average of the 30 items evaluated, both in the aspect adequacy (Content Validity), and for the aspect clarity (Face validity), generated a value for the general average of the 30 items. This average value for each of the aspects (adequacy and clarity) was used as criterion for cutting the items, eliminating all items that obtained an average value equal to or less than the average value for each of the aspects. Thus, for the item suitability (content validity), the mean total value for the 30 items was 3.7, and of the 30 items,



only 12 obtained individual scores greater or equal to 4.3, with the rest discarded. The same procedure was performed for the clarity criterion (face validity), and the mean total value for the 30 items was 3.8. With this, of the 30 items, only 14 obtained individual scores greater or equal to 4.3, so that all items with lower values were eliminated. In general, 15 items were left available for the first data collection.

The validity of translation was guaranteed by translating the items from English into Portuguese by a skilled translator with knowledge in the business area and following the back-translation procedure through a different translator, responsible for returning the items again for English, to ensure correct understanding of all items.

3.3 Decisions about scale for responses

In order to follow the steps for the development of scales adopted in this study, based on the model proposed by Walford et al. (2010), it was chosen to present the items as affirmations for a verification using a seven-point Likert (1932) verification scale. The use of the 7 (seven) point scale was established to avoid any types of problems or difficulties that may exist during the procedure of applying the questionnaire, both in the collection procedures with the companies, thus allowing a wider range of variation in results (Devellis, 2003; Rossiter, 2002).

3.4 Questionnaire development and data collection procedures

For the construction of this first instrument of data collection, all the recommendations suggested by Walford et al. (2010) to proceed in the preparation of the questionnaire in two forms: (1) Questionnaire printed for personal application; And (2) online questionnaire adapted to the self-response, allowing the application and data collection through the Internet. This online questionnaire was used by the Survey Monkey platform.

In both versions, the questionnaire was presented with the title "Study about Frugality and Business Practices". For the printed version of the questionnaire, explanatory text was dispensed, since the application was carried out personally by the authors, and explanations and clarifications occurred during the application of the instrument.

For the application of the online questionnaire, an EMIS database was used, with the contact of 2800 Brazilian manufacturing companies, products, and services, where e-mails were sent to the managers and decision makers of the company. After sending the e-mail inviting managers to participate in this study, a follow-up by telephone was conducted presenting the research and requesting participation of each contact. At December, 215 (7,67%) responses were obtained, of which only 191 (6,82%) were valid and complete answers.

Initially, we present five questions associated with the general characterization of the company as size, (1) Company's capital of origin; (2) Number of employees; (3) Company name; (4) Position / Function; And (5) Operating time of the company; And (6) E-mail to contact. All these preliminary questions are quantitative, serving as data of characterization of the companies, and as a filter.

Next, the 15 items from previous stages were presented. In the application of the questionnaire in the online version, the order of the questions was alternated in order to avoid that the items of the same construct were kept together in sequence, thus avoiding typical errors like "Halo Effect" (Leuthesser, Kohli, & Harich, 1995; Nisbett & Wilson, 1977) or the "Carry-over Effect" (Macfie, Bratchell, Greenhoff, & Vallis, 1989).

At the end was added a final phrase of thanks. All of the instructions (Walford et al., 2010) were followed for formatting to address the issues in just two pages.

3.5 First sampling activity and data collection procedures

For the first sampling activity, it was defined that the questionnaires would be applied to industrial companies (with manufacturing activities) in general, without any geographical



restriction, and should only be a Brazilian company, in order to enable the application of the collection instrument developed in the Previous step, either personally by the authors or online. It was defined as a requirement for this first collection to be composed of companies that produce some product or service.

The questionnaire was applied at December 2016 and all the work was developed by the authors, who were responsible for identifying the companies, contact, visit, interview with the application of the questionnaires and any clarifications during their application, not with the need for training or monitoring of field activities.

After the collection of 215 questionnaires, all were submitted to a verification and screening, being necessary the exclusion of 24 questionnaires that contained some problem, either for being incomplete, to present the majority of the answers in a single item, or for the profile of the respondent to be Inadequate, not corresponding to a managerial or decision-making position in the company. Subsequently, the data was inserted into the computer in an IBM SPSS v23 spreadsheet.

In total, 191 valid questionnaires were obtained in this first data collection. The sampling was for convenience and accessibility since the collection was only possible in the companies that were previously contacted by phone and accepted to contribute participating in this study, with the online application of the questionnaire or a schedule in sequence so that the authors could visit the company for the application of the questionnaire.

4. PRELIMINARY RESULTS

First, an exploratory factorial analysis was performed to verify the disposition of the required variables. From the sample of 191 companies, the results of the factor analysis presented a KMO index of 0.8 ($p < 0.01$), which can be considered an optimal value (Hair Jr, Hult, Ringle, & Sarstedt, 2014). In Table 2 the anti-image matrix shows the fit of the model with all diagonals greater than 0.500. Moreover, none of the commonalities, which explain total variance explained by the factors in each variable, was lower than 0.500. This indicates that the variables have a strong or reasonable relationship with the retained factors.

Table 2: Anti image Matrix

	1	2	3	4	5	6	7	8	9
1 VAR7_1 SMEAN (VAR7)	,849 ^a	-,211	-,080	-,139	-,172	,032	-,122	,025	,069
2 VAR8_1 SMEAN (VAR8)	-,211	,848 ^a	-,078	-,264	-,091	,057	-,169	-,035	,017
3 VAR2_1 SMEAN (VAR2)	-,080	-,078	,749 ^a	,142	-,009	-,377	-,220	,051	-,133
4 VAR9_1 SMEAN (VAR9)	-,139	-,264	,142	,843 ^a	-,075	-,200	,001	-,141	-,051
5 VAR6_1 SMEAN (VAR6)	-,172	-,091	-,009	-,075	,807 ^a	-,074	,066	-,511	-,078
6 VAR1_1 SMEAN (VAR1)	,032	,057	-,377	-,200	-,074	,801 ^a	-,201	-,021	-,050
7 VAR3_1 SMEAN (VAR3)	-,122	-,169	-,220	,001	,066	-,201	,858 ^a	-,207	-,035
8 VAR4_1 SMEAN (VAR4)	,025	-,035	,051	-,141	-,511	-,021	-,207	,776 ^a	-,339
9 VAR5_1 SMEAN (VAR5)	,069	,017	-,133	-,051	-,078	-,050	-,035	-,339	,861 ^a

Sampling adequacy measures (MSA). **Source:** The authors

Thus, varimax extraction reduced the variables to three factors, which explains approximately 66% of the variance (COST = 24%, CORE = 21%, ECOSYS = 21%). Note that the three factors have a similar explanatory power. This shows that the three have equal weight and importance for the construct of frugal innovation. Namely the three factors obtained are shown in Table 3. All with loadings greater than 0.500.

Table 3: Factors Extracted by Exploratory Factor Analysis (EFA)

Variables	Rotated component matrix		
	1	2	3
(VAR4) Environmental sustainability	,83	,17	,26
(VAR5) Partnerships	,78	,26	-,04
(VAR6) Customers' social/environmental needs	,74	,10	,36
(VAR2) Significant cost reduction	,06	,86	,06
(VAR1) "Good value" products/services	,24	,75	,12
(VAR3) Significant reduction of the final price	,23	,63	,34
(VAR7) Core functionality of the product/service	,04	,16	,77
(VAR8) Ease of use of the product/service	,17	,17	,75
(VAR9) Durability of the product / service (does not spoil easy)	,41	,05	,60

Obs.: Extraction Method: Principal Component Analysis. **Rotation Method:** Varimax with Kaiser Standardization. The converted rotation in 5 iterations. **Source:** Authors based on search data

Factor 1 (ECOSYS) is associated with "Create a Frugal Ecosystem" of frugal innovation. This is reflected both in the environmental and social /sustainability of the process (VAR4) and product/service (VAR6) to serve customers. It also reflects the inclusive and shared aspect of frugal innovation with local agents (VAR5).

Factor 2 (COST) is associated with "substantial cost reduction" as the foundation of frugal innovation. A cost reduction of the final price of the product/service (VAR2 and VAR9) coupled with the cost reduction of the operational process (VAR3).

Factor 3 (CORE) is associated with "Concentration on the core functionalities and performance" of frugal innovation. The factor expresses the question of functionality (VAR7) and performance through durability (VAR9), as well as the product accessibility expressed in ease of use (VAR8).

Once the factors were extracted through the Exploratory Factor Analysis (EFA), we started the

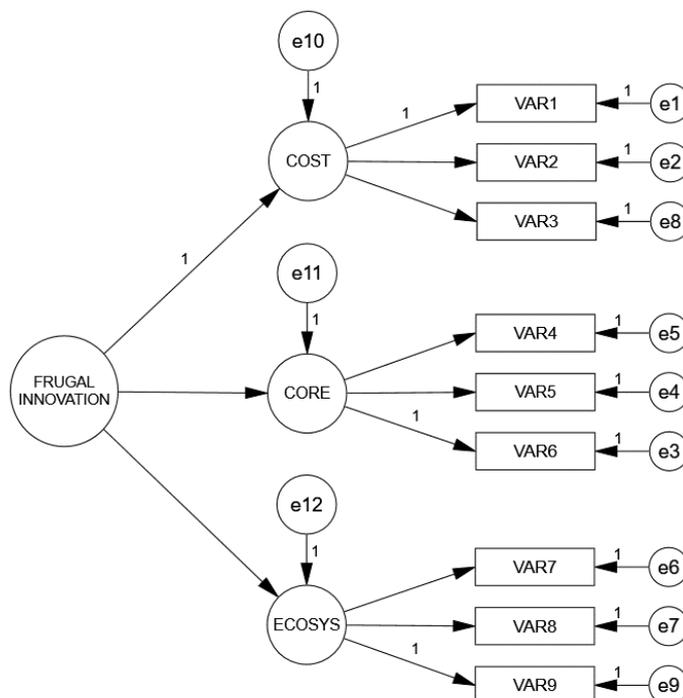


Figure 1: Frugal Innovation Measurement Model

second stage, which is the verification of the second order construct of frugal innovation through confirmatory factorial analysis (CFA). The model to be tested is the resultant from Exploratory Factor Analysis (EFA) and presented in Figure 1 below.

The model adequacy tests show the suitability of the model for AVE ($x > 0.500$), CC ($x > 0.700$) and Cronbach's Alpha ($x > 0.700$) (Hair, 2010) as expressed in Table 4, except alpha of "ECOSYS", which however is very close to the goal. The appropriate discriminant validity (Fornell & Larcker, 1981) presented in Table 5 completes the model fit.



Table 4: Adequacy measures

DIMENSIONS	AVE	CC	Cronbach's Alpha
COST	0,70	0,87	0,79
CORE	0,63	0,83	0,71
ECOSYS	0,59	0,81	0,65

Table 5: Discriminant validity

DIMENSIONS	COST	CORE	ECOSYS
COST	0,84		
CORE	0,47	0,79	
ECOSYS	0,50	0,43	0,76

With the appropriate pre-model adjustments, the statistical significance of the parameters is verified, using the Maximum-Likelihood Estimation (MLE) method. Table 6 shows the parameter estimates. In estimate we have the estimated value of the parameter, followed by the standard error (S.E.) and the value of the critical ratio (C.R.). As can be seen, all estimates are significant at 0.01.

Table 6: Model's Parameters

Regression Weights: (Group number 1 - Default model)							
			Estimates	S.E.	C.R.	P	Label
COST	<---	Frugal	1,000				
CORE	<---	Frugal	,975	,21	4,46	***	
ECOSYS	<---	Frugal	,856	,19	4,32	***	
VAR5_1	<---	COST	1,000				
VAR4_1	<---	COST	1,340	,15	8,55	***	
VAR3_1	<---	CORE	1,000				
VAR1_1	<---	CORE	1,080	,17	6,24	***	
VAR8_1	<---	ECOSYS	1,045	,17	5,87	***	
VAR9_1	<---	ECOSYS	1,263	,22	5,56	***	
VAR6_1	<---	COST	1,134	,14	7,95	***	
VAR7_1	<---	CORE	1,000				
VAR2_1	<---	ECOSYS	1,011	,16	6,15	***	

Finally, and more important, it is necessary to investigate the adequacy of the second-order confirmatory model of frugal innovation. The adjustment results are adequate (Hair, 2010; Marôco, 2010) since the indices obtained meet the references suggested by Hair Jr et al. (2014) and Marôco (2010), Our results are as follows: $X^2/df = 1.668$; CFI = 0.968; GFI = 0.955; AGFI = 0.916; TLI = 0.951; NFI = 0.925; IFI = 0.968; RMSEA = 0.059 and SRMR = 0.046.

These results show the suitability of the construct and allow us to propose that the second-order Frugal Innovation scale is formed by three first order dimensions, resulting from 9 observable variables that compose the proposed scale as below:

Table 7: Proposed Scale for Measuring Frugal Innovation

In the last 3 years, in the development of products/services your company has assigned great importance to ...

COST	Substantial cost reduction
VAR1	solutions that offer "good and cheap" products/services
VAR2	significant cost reduction in the operational process
VAR3	the significant reduction of the final price of the product/service
ECOSYS	Create a frugal ecosystem
VAR4	environmental sustainability in the operational process
VAR5	partnerships with local companies in the operational process
VAR6	efficient and effective solutions to customers' social/environmental needs
CORE	Focus on core functionality and performance
VAR7	the core functionality of the product/service rather than additional functionality
VAR8	ease of use of the product/service
VAR9	the question of durability of the product / service (does not spoil easy)



4.1 Development of rules and recommendations

Following recommendations by Churchill (1979) for the development of scales for measurement, it is essential to indicate rules and recommendations at the end of the process of creating a scale, to contribute in the future with other researchers and scholars in the application or replication of the scale developed. However, in this article, we bring only the first part of the process of developing a new scale for the measurement of Frugal Innovation. This is a study in progress and soon we will have the result of the other data collections to further validate the scale proposed here.

However, it is possible to anticipate some rules and recommendations for the application of this scale in future studies. Firstly, we recommend the random arrangement of scale items, and a number of points from 5 to 7 points on the verification scale and that the aggregation method is by the mean of the scores by size.

Other recommendations are related to the context of use, given the need to perform this scale to measure whether the level of frugal innovation is performed by a particular company, or to identify the level of the frugality of the innovations developed by a particular company. However, this scale can be applied in any company, regardless of its size, type of product, service or industry.

5. FINAL CONSIDERATIONS

This study presents a first phase of the development process of a measurement instrument, proposing a preliminary scale for Frugal Innovation. We present a broad literature review, as well as the main studies on Frugal Innovation, its emergence and how it occurred as attempts to measure the phenomenon of frugality, given the lack of scales for the measurement of Frugal Innovation, specifically. Above all, we also present as main concepts about Frugal Innovation present in the literature and the different meanings attributed by each author, as well as different definitions and criteria for an identification of Frugal Innovation. From there, we also present a new definition for Frugal Innovation

to aid in the process of specification of the construct domain to allow the creation of the scale proposed here.

Although preliminary, the scale presented here consists of three basic dimensions (1) Focus on core functionalities; (2) Substantial cost reduction; And (3) Creation of a frugal ecosystem. A view differentiated by us in this study is a proposal of a Frugal Ecosystem, there is no global vision of sustainability, a social vision with updates with partnerships and with a value chain, to this way, we suggest that companies seek the development of a Frugal Ecosystem that promotes Frugal Innovation in processes, in product/service development, in relationship with partners, customers, and suppliers, stakeholders, etc. enabling a generation of an environment that involves a company for business development opportunities that generates benefits For all involved.

At present, we are performing as data collections so that this study can be complemented and to obtain a final validation of the scale proposed here.

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