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Bibliometric analysis for frugal innovation

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Abstract

Bibliometrics is a statistical technique used to measure aspects of academic production that contribute for developing sciences. The purpose of this article is to present research results highlighting in main works on frugal innovation. The research has been based in bibliometric theories, exploring bases to indicate main correlational areas, documents profiles and verify the level of growth these scientific documents. It was possible to generate visual density and Network maps by Vosviewer software, ranking of documents per authors and World ranking papers from Web of Science and Scopus bases. It was possible to identify and highlight main topics related to management area; keywords associated and related topics for this theme, also answering concepts presented by authors for frugal innovation.

Keywords: scientometry; bibliometry; jugaad; visual maps; bibliometric.

Introduction

Periodicals and scientific journals present itself as important media of transmitting knowledge and ways of scientific publication. Evaluating and qualifying publications through indexing is one of the most recognized qualification processes in the scientific community. With this, it is necessary in front of various national and international databases, to investigate with the support of bibliometric techniques the main productions for researcher´s thematic.

To recognize even his object of study, it is necessary to find one vision more complete, and how much it is possible to understand the universe that researcher has at his disposal optimizing processes and resources.

The relevant theme like frugal innovation attract attention to do a bibliometric study when we may perceive that there is an increasing of companies developing new products through emerging markets such as Brazil, India, China, South Africa.

With this, It´s necessary to believe that bibliometric studies linked to frugal innovation may be an important initiative to know scientific production and impact factors drawing a profile of newer studies.

So, It´s possible to investigate: how much and what are the main areas of these bibliometric studies are interested in the concatenation of the variables "innovation" and "frugal". What is the profile of these bibliographic productions by less from two big journal databases?

Therefore, based on these prerogatives that It´s possible to trace the objective for understanding the bibliometric panorama of the frugal innovation exploring *Web of Science* and *Scopus* trying to find countries that currently produce most these studies, understanding that frugal innovation have been usual applied in developing countries.

Method

Subjects

This study may be classified like exploratory using journal databases for getting qualitative and quantitave variables beyond insertion of terms like ‘frugal innovation’ exactly or with masks. (GIL, 2008)

The bibliographic research comprised is an investigation using resources that according to (Gil 2008) results from something that it has already been evaluated or appreciated previously by its respective author, characterizing technically as *ex-post fact*.

The research tested two international academic bases, which were Web of Science and Scopus. Exploring their results, were assessed quantitative and qualitative variables, per example: number of documents and their respective types and period, top authors with more documents, absolute and relative production per country, numbers of documents produced by languages, and main terms related to frugal innovation.

This work accomplished the following steps:

Step 1. Did a query, executed within a works index database (both the Web of Science as Scopus).

Step 2. Reached an application of appropriate filters, search words, types of publication, time lapse, etc., to delimit the sample of works that It was studied.

Step 3. The third stage contemplated the descriptive and temporal analysis of the articles obtained, contextualizing the scientific production (publications and citations) in time and identifying the main works in the area.

Step 4. It was identified the most relevant authors, institutions and countries, using rankings and cocitation maps.

Step 5. It was analyzed where the subject was being published research areas.

Step 6. The sixth step analyzed the keywords in indexing the sample work, as well as the main terms that could be identified in the articles, portraying which concepts are worked together and how they relate. Finally, the results of all these steps were jointly and analyzed with main conclusions about the research produced.

The Frugal innovation presents itself with a broad spectrum of applicability and, in the different areas of knowledge. For this reason, in order to maximize the research horizons for the theme focused on frugal innovation, being investigated using keywords in 4 languages: English, Portuguese, Spanish, and the Indian word of origin that justifies the frugal, known in some cases as "Jugaad", being an intentional choice because they are widely classified like languages of worldwide spectrum. As well as the two main international databases, widely used by researchers, Scopus and Web of Science, adopting the following strategy of according to the Table 1.

Statistics	Database	
	Scopus	*Web of Science*
"Frugal Innovation" OR "Inovação Frugal" OR "Innovación Frugal" OR "Jugaad"	158 docs	95 docs
Document search location	Title, abstract, keywords	Title, abstract, keywords
Document search profiles	All	All
Publication date	All years	All years
Type of search	Advanced	Advanced

Table 1. Research Strategies in Scientific Bases. Source: Scopus, Web of Science (2017).

Apparatus

The data processing for the comparative analyzes and their subsequent modeling of figures were performed by Microsoft Excel Student 2013 version, the production of the map with the ranking of countries that produced the most scientific papers were performed with support of free online tool mapinseconds.com and later worked with aid of the graphic application Coreldraw Student version 17. The students tools were acquired with own resources of the researcher. About the generation of network and density map, we chose the *software* Vos Viewer 1.6.5, free version, and It can be downloaded freely at http://www.vosviewer.com.

Design

The design shows like independent variables: *Annual documents production, document type classification, production per language, production per author, main related topics to frugal innovation, associated keywords, ranking of countries with the highest bibliometric production, semantic and network visual maps. All of these for answer the dependent variable: Bibliometry for Frugal Innovation in agree with Web of Science and Scopus database.*

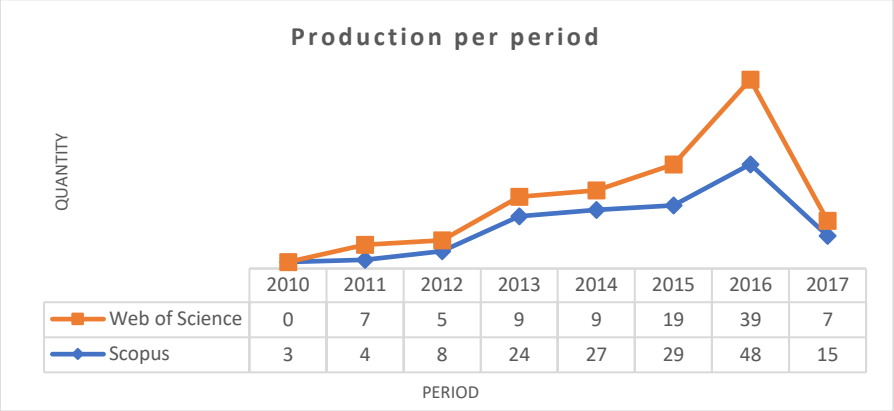
Procedure

The method applied for ranking the 10 most published countries on frugal innovation was supported by (Kothari 2010) explanation doing a comparative methodology. It was possible to select the Scopus and Web of Science data, classifying the 10 countries that had the largest sums of each. Among the results that presented the highest quantitative values in common were compared, comparing with the individual results of each of the bases, when the individual values were greater than the sum of both, resulting in Figure 7.

Results

Annual documents production

The bibliographic production of the Scopus and Web of Science databases has increased over the years, starting from 2010 with the lowest indexes, reaching the maximums in 2016 for both bases, as can be seen all the evolution in Figure 2.



	2010	2011	2012	2013	2014	2015	2016	2017
Web of Science	0	7	5	9	9	19	39	7
Scopus	3	4	8	24	27	29	48	15

Fig. 1. Bibliometric evolution of the bases on frugal innovation. Source: *Scopus* (2017), *Web of Science* (2017).

Source: Scopus (2017), Web of Science (2017).

Calculating the linear trend, based on the results obtained over the years, one can reach the value of R^2 = 0.49. While evaluating in the same statistical calculation profile, it is possible to verify for the Web of Science base the value of R^2 = 0.36 demonstrating a growth for both bases.

Quantifying the sum of documentary productions regarding frugal innovation, one can quantify 158 documents for Scopus and 95 for Web of Science, making a percentage of 62.45%, and 37.55%, respectively.

Classification by document type

The largest indicators of bibliometric production categorized by Scopus and Web of Science bases are from scientific articles, representing 86, 59 papers respectively. Summarizing further the other document profiles, stand out Scopus Conference Documents, totaling 37 units and Web of Science Procedure Documents totaling 23 units. Lower quantities produced by other document profiles have been shown in table 2.

Documents	*Scopus*	*Web of Science*
Article	86	59
Press Release	2	1
Brief survey	4	0
Book chapter	13	0
Conference Documents	37	0
Procedural Documents	0	23
Editorial	1	9
Notice	6	0
Review	8	3

Documents	*Scopus*	*Web of Science*
Conference Review	1	0
Total	158	95

Table 1. Profiles of production documents and their quantitative. Source: *Scopus* (2017), *Web of Science* (2017).

Bibliometric language production

Both the Scopus database and the Web of Science produced their largest quantities of documents in the English language, and the metrics can be tracked in Figure 3.

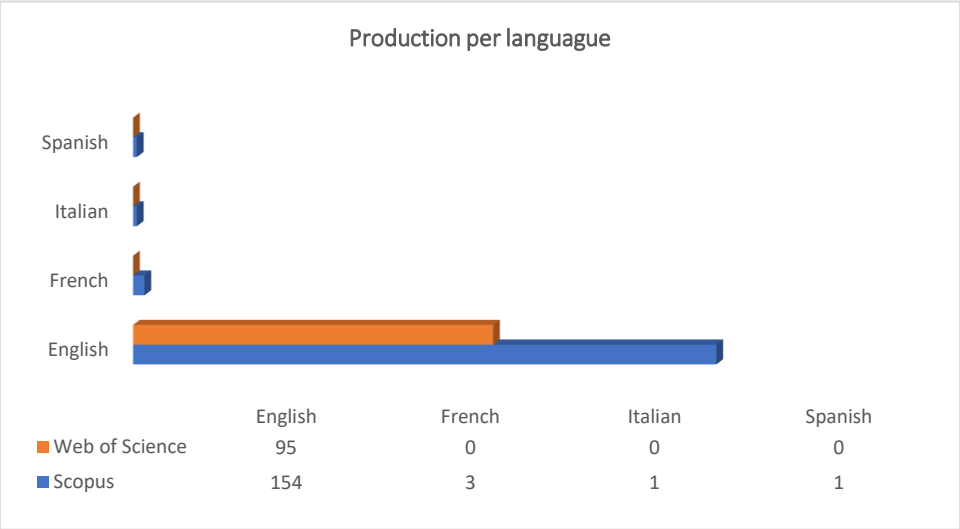


Fig. 2. Language-related metrics. Source: *Scopus* (2017), *Web of Science* (2017)

Accounting for the total of Scopus database, it can be found 159 documents, however it was verified that the base only counted 158 units, since 1 of the articles were disconsidered in the metric because there was duplicity of content, being differentiated only by be written in 2 different languages.

Authors with greater productions in documents for the theme involving Frugal Innovation

By tracing the metric comparison of higher productions by authors, it was found that in the sum of the bases, in common, there were authors Baekelandt, with (9) documents representing the largest metric, followed by Belkadi, Halme, Mourtriz and Vlachou representing 8, 8, 7 and 4 documents respectively. See Figure 4.

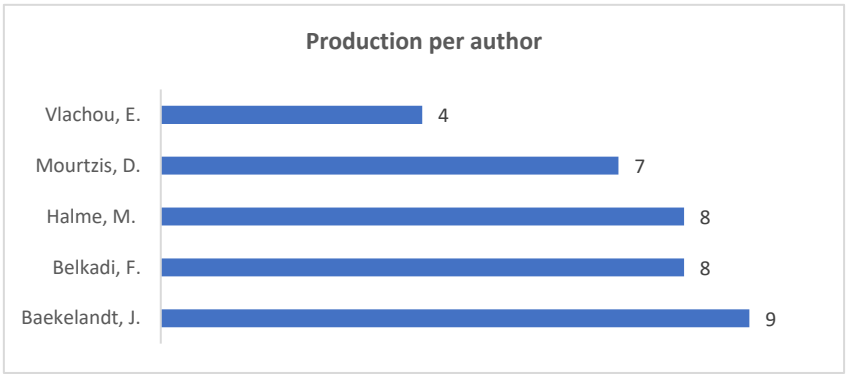


Fig. 3 . Quantitative representation of bibliographic production per top authors amounted in both bases. Source: *Scopus* (2017), *Web of Science* (2017).

Topics related to Frugal Innovation by Scopus Base

The Scopus database presents a trend of interdisciplinary publication with the large areas of knowledge, since they are present in the Exact, Social and Health Sciences, as can be observed publications categorized as: Business, Management and Accounting, Engineering, Computer Science, among others. See Figure 5.

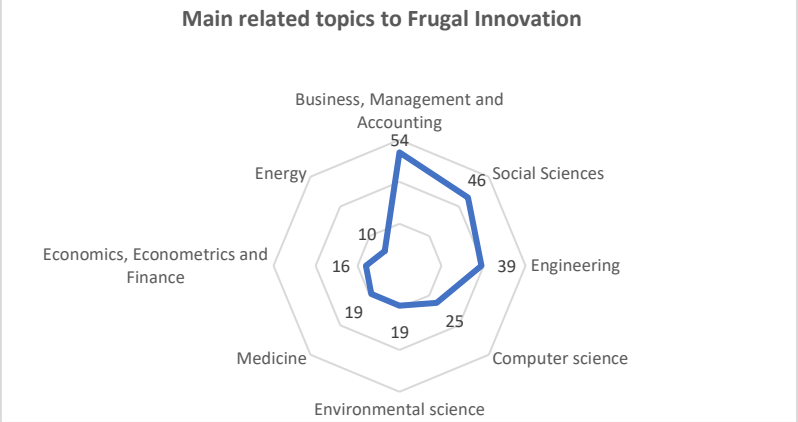


Fig. 4. Interdisciplinarity of Frugal Innovation. Source: *Scopus* (2017).

Topics related to Frugal Innovation by Web of Science

Web of Science presents in its results the linkage of frugal innovation with Management, Business, Industrial Engineering, Environmental Sciences, management research culture of operations research, demonstrating some similarities with Scopus Base. See Figure 6.

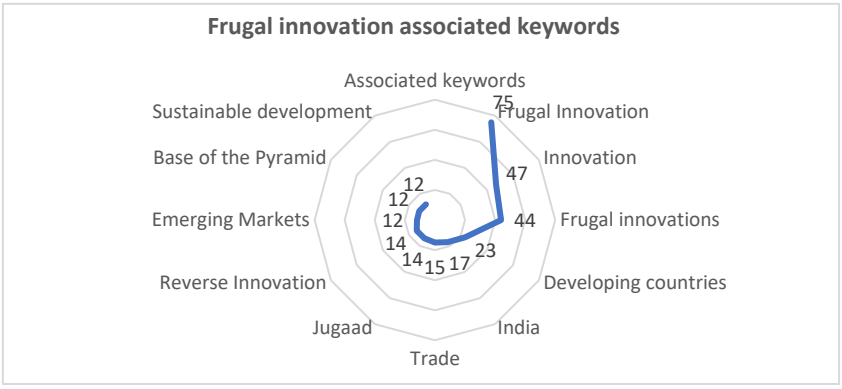


Fig. 5. Interdisciplinarity of the frugal innovation. Source: *Web of Science* (2017).

Ranking of Countries with the Highest Bibliometric Production for Frugal Innovation.

The world's largest scientific bibliographic production for the Frugal Innovation theme can be seen in countries of the Mid-West and with the greatest economic development, accounting for a total of 24% of production for the countries of the East, while around 76% of publications are concentrated in the United States, United Kingdom, France, Germany, Belgium, Finland, Greece and Canada. See Figure 7.

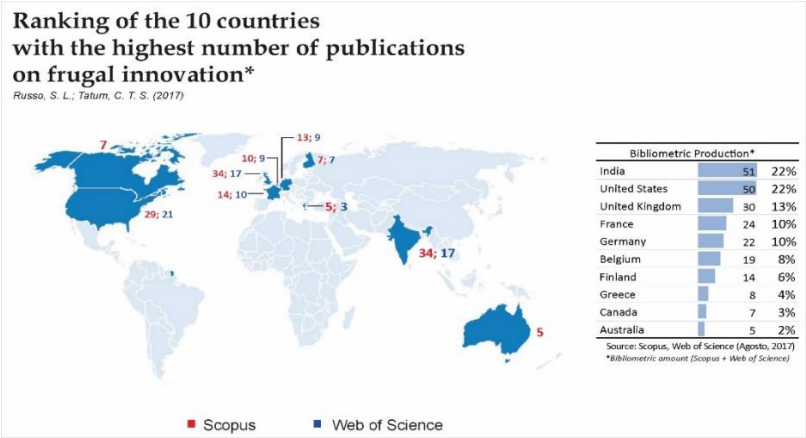


Fig. 6. Countries with greater productions for frugal innovation. Source: *Scopus*, *Web of Science*.

Density Visualization and Network Map on Scopus Base

Making the elaboration of the Network map based on the Vosviewer algorithm beyond words extracted from the Scopus base, can observe an intensity of connections with the terms reverse innovation, sustainability, business, pyramid. In a second cluster, one can observe stronger semantic relations between market and companies. In the third cluster, It was observed a better relation with Science, with more emphasis on periodic terms, institutes, management, marketing and public health. In more isolated clusters we can perceive information and health systems. With this, It´s inferred that frugal innovation has a strong relationship with health, management, science, information, economics, education and society. See Figure 8.

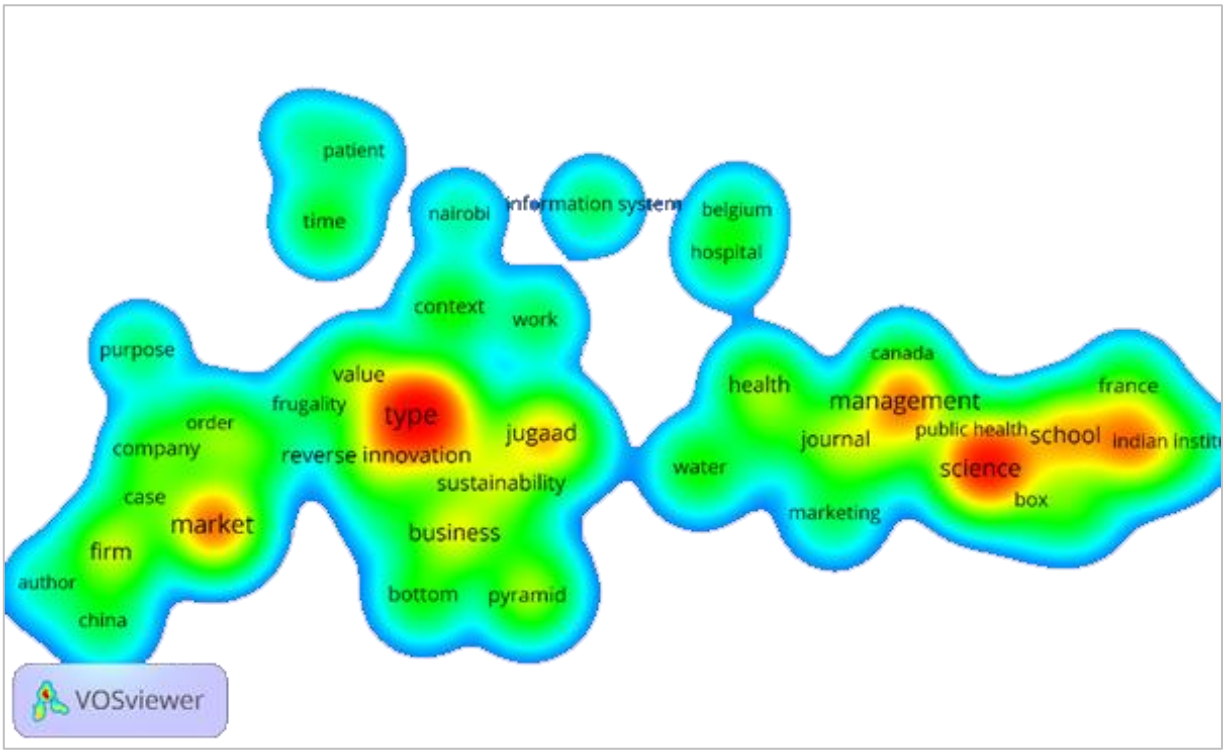


Fig. 7. Scopus network map for the Frugal Innovation theme.Source: *Scopus*, *Web of Science* (2017).

The relationship in the network map demonstrates the link between the main topics of each cluster, involving management in relation to the types of innovation. As well as like the business class, it presents a connection between the market and companies, as well as a link between business and academia, through science, management and academies. See Figure 9..

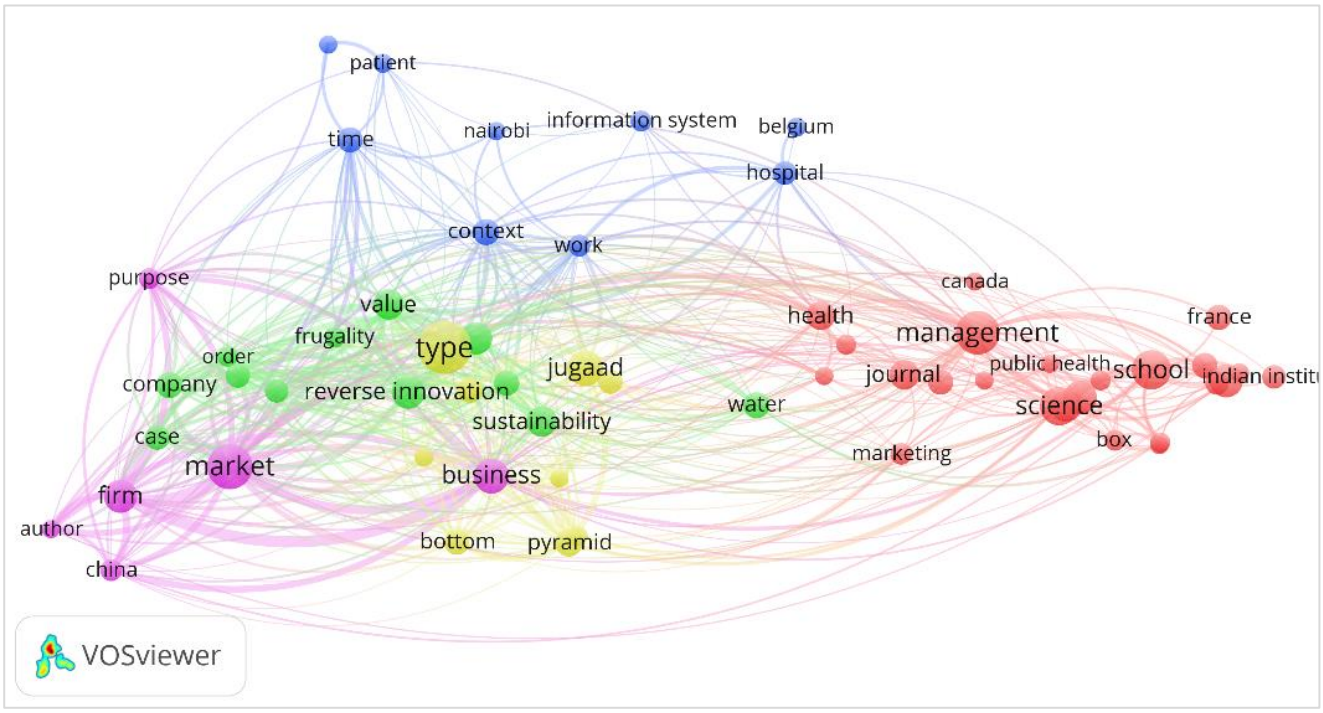


Fig. 8. Map of semantic link for frugal innovation in the base Source: *Scopus*, *Web of Science* (2017).

Density visualization at the Web of Science Base

Verified that there were strong links with terms: pyramid, which it is related to the economic base of society and the low cost of innovation, linking to companies, health, administration and development processes in innovation, with isolated clusters in health issues focused on patients and scarce resources. See Figure 10. Visualization of overlapping in network maps, one can perceive a fairly cohesive group of clusters getting involved between companies, economy and businesses and with the binding element, health through the term patients. See figure 11.

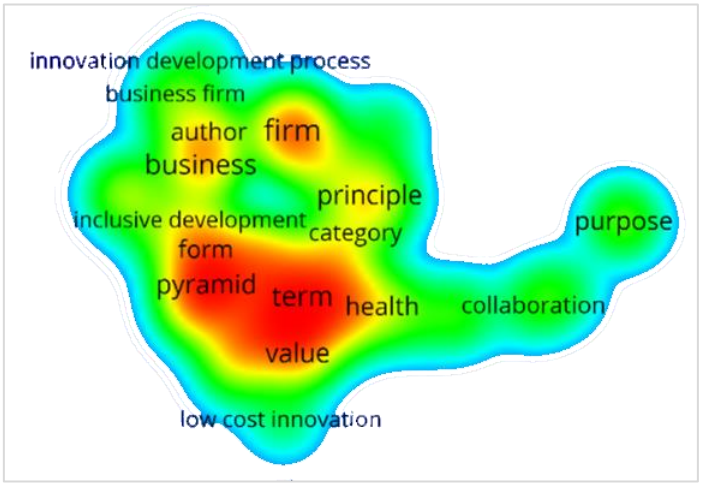


Fig. 9. Cluster desity by *Web of Science.* Source: *Web of Science*.

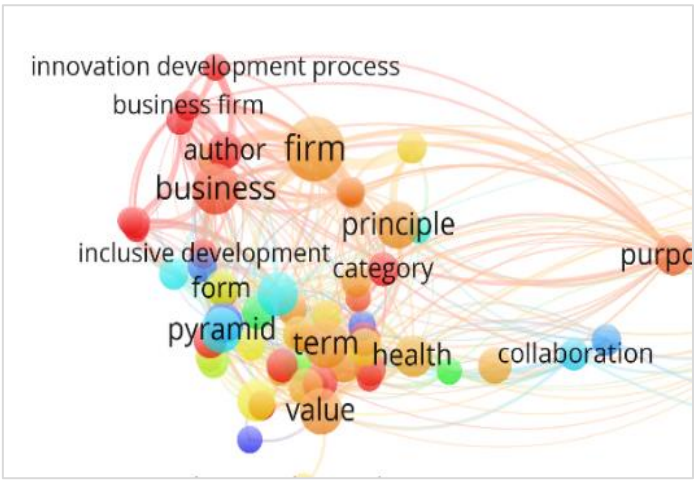


Fig. 10. Network map by *Web of Science.* Source: *Web of Science*.

The frugal innovation in the view of the authors of greater production by top authors

Extracting the authors of the larger quantitative metrics presented in item 4.4, it was possible to obtain relevant knowledge about the topic, exposing them through Table 3.

Authors	Papers	Results
Mourtzis, Vlachou, Boli, et al. (2016)	*Manufacturing Networks Design through Smart Decision Making towards Frugal Innovation*	Algorithmic construction for local market adaptation providing solutions for cost reduction efficiency and solutions for customer appreciation.
Mourtzis, Vlachou, Giannoulis, et al. (2016)	*Applications for Frugal Product Customization and Design of Manufacturing Networks*	Support integration in product designs and its industrialization network.
Hart, Sharma, e Halme (2016)	*Poverty, Business Strategy, and Sustainable Development*	Evaluates management theories due to business integration, poverty alleviation and sustainable development.
Hossain, Simula, e Halme (2016)	*Can frugal go global? Diffusion patterns of frugal innovations*	It explores a diffusion of frugal innovation knowledge in geopolitically routing globally.
Levänen et al. (2016)	*Implications of Frugal Innovations on Sustainable Development: Evaluating Water and Energy Innovations*	Evaluates the frugal innovation applied to sustainable development based on case studies on water and energy matrix.
Reynders e Baekelandt (2015a)	*Adnexectomy by poor man's transvaginal NOTES*	The study demonstrates the feasibility and safety of transvaginal natural orifice transluminal endoscopic surgery (vNOTES) for benign adnexal masses.

Authors	Papers	Results
Reynders e Baekelandt (2015b)	*Low-cost total laparoscopic hysterectomy by single-incision laparoscopic surgery using only reusable standard laparoscopic instruments*	Evaluates the viability and safety of total laparoscopic hysterectomy (TLH) through a simplified frugal device.
Belkadi et al. (2016)*	*Co-Definition of Product Structure and Production Network for Frugal Innovation Perspectives: Towards a Modular-based Approach*	It proposes a conceptual approach based on the selection of product modules that influence supplier selection and order allocation in a global production network.
Colledani et al. (2016)	*Technology-based product-services for supporting frugal innovation*	Case study applied to the machinery, household appliance and aeronautical industries with a view to the implementation of a formal structure in the context of frugal innovation.
Simula, Hossain, e Halme (2015)	***Frugal and reverse innovations - Quo Vadis?***	**It does a concept analysis and presents a conceptual framework for frugal innovation and reverse innovation.**

Table 3. Main works developed by authors of higher innovation metrics. *Source: Scopus*; *Web of Science*

From the understanding of frugal Innovation it was possible to understand by means of Mourtzis, Vlachou, Boli et al. (2016) that frugality presents the attributes of: functionality, robustness, accessibility, ease of use and growth. It emphasizes the aspect of observing a huge paradigm between the concept of innovation, its regional application and the demands of the local market, while on the one hand the State demands more social laws and environmental responsibility. On the other, there is a need to apply a product or service design with characteristics to serve local markets.

In the vision of Mourtzis, Vlachou, Boli et al. (2016) which is consistent with a great deal of research on frugal innovation being a producer of sustainable solutions and results. They conclude that it is possible to introduce new business models to reduce the complexity and total lifecycle costs of innovation, providing value and solutions that are accessible to customers in developing markets. Even, technological tools of information and communication have allowed better economic, social and attending environmental challenges.

Hart, Sharma and Halme (2016), based on studies of the minimization of the impacts of poverty on society, present a conceptual analysis on frugal innovation with regard to the relationship of poverty alleviation through business and entrepreneurship; still mentions the idea that frugal innovation resembles the Pyramid Base Theory of Radjou et al. (2012)

In the diffusion patterns studies of frugal innovation, (Hossain et al. 2016b) point out that innovation is important in the growth of countries. They also serve quite a lot for developed countries with stagnant

economies, influencing the market with the practice of reducing prices. In terms of the profile of frugal innovation customers, they prove to be different, as they seek affordable prices and good products that meet their needs.

Levänen et al., (2016) point out that frugal innovations are receiving increasing attention from scholars, practitioners, and policy makers. Just as they are being applied in multinationals, social enterprises, startups and individuals from developed and developing countries. They are considered a solution to approach sustainability concerns in low-income countries, using accessibility and availability as important points, especially in developing countries.

Reynders, Baekelandt (2015a) proves in practice that frugal innovation is possible to be applied in the provision of health services through reusable laparoscopic instruments, determining as characteristic low cost, proving once again the attribute of this innovation.

Discussion

Bibliometry

Perceiving the relevance of measuring bibliographic quantification was that Otlet (1934) wrote the Documentation Treaty, making his later study, recognized as a "statistical bibliography" by Hulme in 1923, and being inspired by Alan Pritchard's article, which he called "Statistical Bibliography or Bibliometrics?" in 1969, also showed by MANUEL *et al.* (2015).

According to contemporary theorists such as Andrade, Dominski and Coimbra (2017); Koseoglu et al. (2016); Santos et al. (2015), infer by acquirements that bibliometrics may have been comprehended as a statistical technique for quantification and qualification of bibliographical materials. 2005), adopting bibliometrics as a set of laws and empirical principles that contribute to establishing theoretical foundations of Information Science.

Oliveira and Russo (2017) *apud* Fonseca (1986) Bibliometrics is a technique for measuring production rates and disseminating scientific knowledge.

According to (Mueller 2013), this tool has the following objectives: analysis and mapping of authorship and co-authorship, collaboration and networks; evaluation and description of the literature, impact and indicators; production and productivity, visibility of authors and institutions; and citation and co-citation studies

Frugal Innovation

Among several concepts of innovation, contemporaries agree that innovation is: to do something new or different Cambridge Dictionary (2017), English Oxford Living Dicitionaries (2017), Nair et al. (2015) with that, It is possible to claim that is the word that supports the generation of new products, processes, services and marketing, as recommended by Schumpeter (1982) and (OECD 2005).

(Prahalad & Hart, 2002) presented approaches on innovation and poverty, affirming: "innovative actions tend to create opportunities for the poor by offering them choices and encouraging self-esteem."

Still, Prahalad & Hart (2002) claim: "The distribution of wealth and income-earning capacity in the World can be captured in shape of an economic pyramid. At the pyramid top stand the rich, with numerous opportunities to generate high levels of income.".

The frugal innovation, classified as open innovation, flexible and disruptive in agree with Mazieri (2016); Radjou (2016); Euchner (2016) becomes the focus of attention because it seeks to preserve the environment by reducing costs, materials, and is being widely accepted in business organizations. Since this innovation is an inspiring source for price cutting in the market competition, characterizing like an innovation to base of the pyramid, reaching the great masses of population, producing higher revenues for corporations.

Frugality was born in India, a country that suffered too much from the largest low-income population, but it was hurled enough inspiration for Radjou, Prabhu and Ahuja (2012) to affirm that "Less is more in the construction of Riches and Results", appearing later the bibliography known by "The innovation of the improvise".

It is motivated as innovation of improvisation with Radjou, Navi et al. (2012) explanation, which mentions in Hindu origin its word Jugaad, whose meaning can be explained like "an innovative repair, an improvised solution, based on ingenuity and intelligence."

Therefore, statements of (Navi Radjou et al. 2012) was that (Prahalad e Hart 2002) presented approaches about innovation and poverty, stating that: "Innovative actions tend to create opportunities for the poor people, offering them choices and encouraging self-esteem." In addition, "The distribution of wealth and the ability to income generation in the world can be captured in shape of an economic pyramid.

The Bibliometric study demonstrates to be an effective resource for the construction of knowledge, maximizing efficiency in the scientific production process, guiding the author to the focus of the best results for research.

The theme of frugal innovation is in the process of expanding the production of scientific documents linked to the various segments, demonstrating a flexible use of this innovation in the major areas of knowledge, such as: Exact and Technological Sciences, Social Sciences, Health Sciences, and Environment. Just as, it is possible to understand that the greatest metrics of the World production are found in developed countries, although frugal innovation has shown strong conception in India, China, Brazil, and still on the African continent.

Among the bases explored, it is predominant in the English language, and along with this profile of innovation, according to the authors of higher metrics in the theme, observe links to keywords that can be highlighted by: sustainability, affordability, cost reduction, simplicity.

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