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Bibliometric analysis of Information Systems related to Innovation

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Abstract

The purpose of this article is to verify the comprehensiveness of the literature with regard to addressing the issues of Information Systems and Innovation together; with this purpose, a bibliometric research was conducted using the main databases for scientific publications. 127 articles were analyzed and some results were found, such as: predominance of publications from Brazil and the United States; recurrence of the Enterprise Resource Planning (ERP) in comparison to other tools; and predominance of practical researches, which apply concepts from the literature in real situations.

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Keywords: Information Systems; Innovation; Bibliometrics; Technology; Knowledge

1. Introduction

Currently, the issues related to Information Systems (IS) and Innovation have been extensively discussed, but these discussions often occur in a detached way. However, both subjects have a strong bond, since the information systems can make or facilitate significantly the emergence of innovations [1].

In order to verify the completeness and comprehensiveness of the literature regarding the SIs and Innovation altogether, this paper presents a bibliometric survey of terms related to the mentioned areas. The research is conducted through various research databases, using refinements so that the analysis of the results is possible.

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From this analysis, the results are discussed and relevant aspects of research are highlighted, such as number of articles on the two subjects, as well as the main referenced authors.

The objective of this research is to see how issues related to ISs and Innovation have been treated jointly in the literature. Therefore, the paper seeks to analyze several aspects related to the union of these two subjects, such as the number of publications on the topics, the main countries that publish on the issues and information systems which have been most prominent when it comes to innovation.

According to Santos and Urbina [2], the provision of efficient and rapid information services allows the user to keep pace with technological advances and, from this, turn the information obtained, generating innovations. Dahlman [3] supports this idea, saying that "there are growing indications that new technologies - and particularly information and communication technologies - are associated with organizational changes in companies or innovative segments".

Thus, since the ISs allow a better flow and use of information within an organization, they allow these pieces of information to be absorbed and shared among different agents, generating knowledge available to create innovative products and services.

The problematics that drive and justify this paper can be expressed through the following question: "How have Information Systems been associated in the literature with the emergence of innovations?". With the bibliometric research propoposed, the paper seeks to verify the answer to this question, identifying the main aspects regarding the union of the two issues under study.

2. Innovation and Information Systems (IS)

2.1. Innovation

Innovation can be seen as market experiments seeking broad and extensive changes, which fundamentally restructure industries and markets [4]. Thus, this is the fundamental basis of capitalism, since this is a production system that needs constant renewal and reinvigoration of its consumer goods and capital [5].

According to Tidd et al. [6], innovation is seen as a complex, uncertain and risky phenomenon. "Innovation is largely chaotic, involving false evidence, recycling itself between steps, dead ends, discontinuities, etc." However, the same authors [6] also state that "[...] unless organizations are prepared to renew their products and processes continuously, their chances of survival will be seriously threatened."

Economic development is driven by innovation through a dynamic process in which new technologies replace the old ones, a process called "creative destruction." The "radical" innovations engender more intense breaks, while "incremental" innovations continue the process of change [4].

Ulwick [7] reinforces this idea saying that customers only know what they have experienced. They can not imagine what they do not know about emerging technologies or new materials. Thus, the traditional approach to ask customers about solutions tends to limit innovation processes.

According to the Oslo Manual [8], innovation is the implementation of a good, a new process or a significantly improved service, or a new marketing or organizational method.

According to Hsu [9], the innovation process needs different sources, including companies, universities, laboratories, research and development institutes, among others. Technological innovation in companies is a key factor in the maintenance of its activities and for the growth and development of the country [10].

2.2. Information Systems (IS)

According to Stair [11], the concept of a system is related to a set of elements or components that interact to achieve a goal. According to the same author, the SI, representing a specialized type of system, would be those consisting of a series of elements or components that collect, store and manipulate data, disseminating

information and providing a feedback mechanism. Gil [12] reinforces this idea, considering that the information systems comprise a set of human, material, technological and financial resources that, once joined in a logical sequence, allow the processing of data and generate information.

Stair [11] points out that the main advantage provided by technology to IS is the ability to process a huge number of data simultaneously. The author mentions some benefits of the Information System on businesses, including increased security and quality of products and services, reduced errors, increased accuracy, greater productivity, increased efficiency, reduced costs and time saving. In addition, according to Moresi [13], information systems let you optimize the information flow within an organization, facilitating the process of knowledge and decision-making.

2.3. Information Systems (IS) associated with Innovation

The use of IS offers business benefits including cost, productivity, quality, flexibility and innovation, each use having its own composition of these benefits [14].

The adoption of innovation can be in products, processes and administrative activities [15]. The product innovation involves the introduction of a new product or service, including new applications of existing products or the offering of the product for a new customer segment. The innovation process affects the production process in all its ramifications, including the transformation from raw material to finished product and all support activities associated with it. Innovation in administrative activities is the one that involves the administrative components and affects the social system of the organization, which includes social structure, rules, procedures, information and communication systems and structures of authority and relationship between its members. In all these types of adoption of innovation, the information technology (IT) is present and contributes significantly [16].

Garrod [17] proposes an information strategy structure consisting of two dimensions, both with two vectors. The first with the value of the exploitation of information and environmental uncertainty; the other with value of information processing and the complexity of the environment. This structure contributes to the understanding of the use of IT and their contributions, ranging from the more efficient processing of information to the innovation that information allows, contributing to a better view of the benefits of IT use.

There is a strategic alignment between business and IT within a company [18]. For example, information sharing contributes, through instruments and behavioral aspects, for risk management in software projects, playing an important role in the organization [19]. But despite aligning and meeting the basic demands of business, IT management still needs to move forward according to the changing nature of business models [20].

Organizations are increasingly investing in complex technological innovations, such as information systems for the company, with the aim of improving the operation of the business and gaining competitive advantage [21]. Moreover, information systems contribute to generating innovation, especially due to its ability to better use and manage the information and knowledge. According to Jiang [22], the so-called knowledge management allows us to identify, acquire, develop, decompile, store and transfer knowledge in order to improve and increase innovation, agility, productivity and skills, whether in individual, departmental or organizational level. Hence, it is obvious the importance of an effective information system which facilitates knowledge management and the emergence of innovations.

3. Methodology

According to Gil [23], this study is descriptive and exploratory with a quantitative approach, using a bibliometric study with descriptive statistics tools.

A bibliometric research was conducted using the databases ISI Web of Science, Scopus and Scielo accessed from the Capes Journal Portal on September 10, 2014.

More specifically, this study was structured into the following steps:

1. Literature review: a research on books, theses, dissertations and journals was conducted, regarding Innovation and Information Systems, using the Capes Journal Portal. Some of these references were selected to compose the literature review.

2. Bibliometric Survey:

   - Research Refinement;
   - Keywords Research;
   - Analysis of the articles origin and type;
   - Identification of journals with more published articles;
   - Identification of the authors with more publications;
   - Identification of the authors with more citations;

3. Comparative study between Brazil and other countries: a comparative analysis was made between Brazil and other countries, in order to identify the differences between the Brazilian articles and the others.

4. Bibliometric Survey

4.1. Research Refinement

In the ISI Web of Science, the term "innovation" was used as the search term, generating 99,918 papers, and then refined by "management information system" OR "business information system", resulting in 54 papers. As the objective was the analysis of articles only, a new search was done by selecting the term "articles", which generated 33 articles for analysis.

In Scopus, due to the large number of publications, it was decided to select only the ones from the last 5 years; thus, the search was filtered with publications from 2010 to 2014. The research in Scopus had the following structure: "innovation" AND ("management information system" OR "business information system"); Furthermore, filtering the research for "articles" only and discarding other materials, the research resulted in 58 articles.

For articles research in Scielo Base, the following search algorithm was used: "innovation" AND "information" AND "system"; all the words were investigated in all search indexes, generating more 42 articles for analysis.

After doing researches as described above, an analysis was done to identify duplicate articles in different bases. As a result, it was identified that one of the articles found in Scopus was also found in Scielo, and 5 articles found in ISI Web of Science were also found in Scopus. Thus, disconsidering the duplicates, 127 articles were analyzed.

As it can be seen in Fig. 1, with the researchers conducted in the databases Scopus, ISI Web of Science and Scielo, articles from different periods were analyzed, highlighting the articles of the last five years.

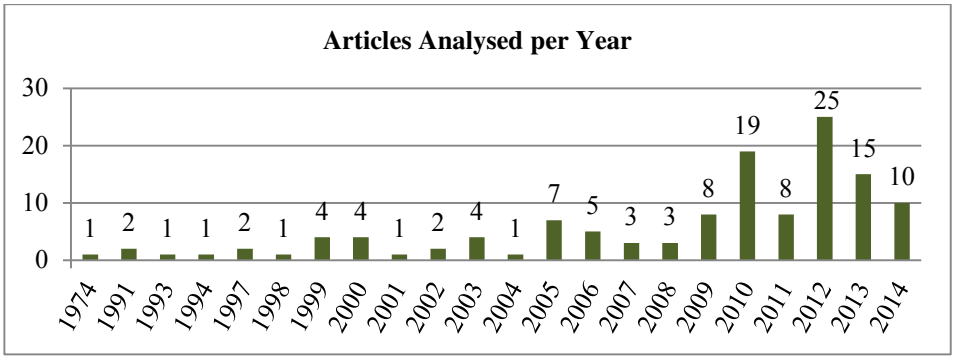

Fig. 1: Articles Analysed per Year

4.2. Keyword Research

From the analyzed articles keywords, 587 terms were found, which were used to form a cloud of words, as it can be seen in Fig. 2.

Fig. 2: Cloud of words (http://www.wordle.net)

The cloud of words shows the magnitude in which the terms above appeared isolated among the keywords of the analyzed articles. The terms "Management", "Systems", "Information" and "Innovation" were cited more often when compared to the other terms and, therefore, they are highlighted in Fig. 2. In respect to the compound expressions or most cited keywords, Table 1 shows the five most frequent keywords.

Table 1: Most cited keywords

MOST CITED KEYWORDS	
Keyword	Citations
Innovation	24
Information Systems	12
Management Information Systems	11
Technology	10
Information Management	5

4.3. Analysis of origin and type

As shown in Fig. 3, among the articles analyzed, 31% of the articles are from Brazil and 27% from the United States. The other 42% of the articles are divided by several countries, such as Taiwan (5%), United Kingdom (4%) and Australia (4%). So Brazil stands out against other countries, according to the quantity of articles analyzed in this paper.

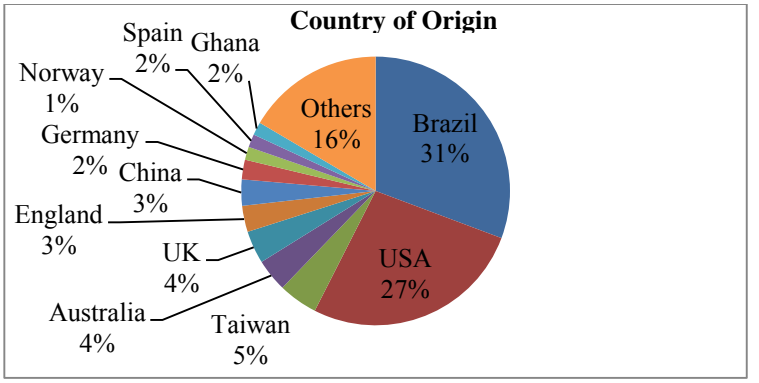

Fig. 3: Country of Origin

In Fig. 4, it can be observed that most of the analyzed articles related to innovation and information systems are of practical nature (64%), concerning real applications of the theory, whereas 36% of the articles are concerned only with theoretical aspects.

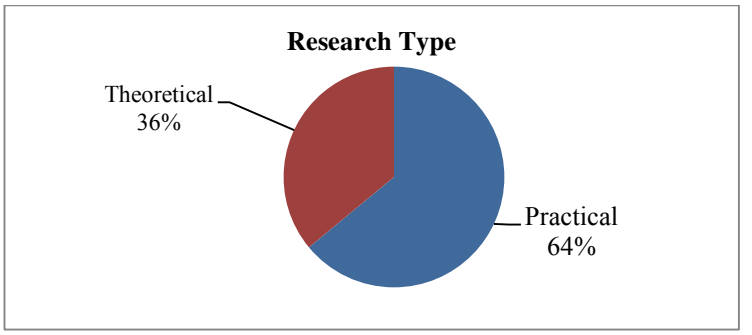

Fig. 4: Research Type

Regarding the models and tools related to Information Technologies and Innovation, the "Enterprise resource planning system" (ERP) is the one with higher recurrence from the articles analyzed, according to Table 2:

Table 2: Models, Systems and Tools used

MODELS / SYSTEMS / TOOLS	Citations
Enterprise resource planning (ERP)	5
Management information system (MIS)	2
Technology Acceptance Model (TAM)	2

4.4. Identification of journals with more published articles

In the analysis of the journals with more publications, the result is shown on Table 3.

Table 3: Journals with more publications

Journals with more publication	Quantity
Cadernos EBAPE.BR (ISSN: 1679-3951)	4
Ciência da Informação (ISSN: 1518-8353)	3
Gestão & Produção (ISSN: 0104-530x)	3
International Journal of Project Management (ISSN: 0263-7863)	3
International Journal of Technology Management (ISSN: 1741-5276)	3
*Revista de Saúde Pública (*ISSN: 1518-8787)	3

In general, most of the articles were published in Brazilian journals, with highlight for the publications in *Cadernos EBAPE* from Getulio Vargas Foundation (FGV), *Revista Ciência da Informação* from Brazilian Institute of Science and Technology Information (IBICT) and *Revista Gestão & Produção* from the Federal University of São Carlos (UFSCar).

4.5. Identification of the authors with more publications

In Table 4, the main authors of the analyzed articles are shown, with no distinction between authorship and co-authorship.

Table 4: Authors with more publications

Authors with more publications	Quantity
BASTOS, F.I.	2
COPELAND, D.G.	2
MASON, R.O.	2
MCKENNEY, J.L.	2

The authors cited in Table 4 had publications in Mis Quarterly, except the author Francisco Inácio Bastos (Bastos, FI), who has two publications in *Revista de Saúde Pública*.

4.6. Identification of the authors with more citations

The authors with more citations were highlighted in Table 5, in order to identify those who have more relevance in the literature in terms of bibliographic reference. According to their curriculum vitae, the most cited authors work especially in the areas of Information Systems, Technology, Innovation and Health, and they are mostly non-Brazilians.

Table 5: Authors with more citations

Authors with more citations	Citations
ROGERS, E. M.	13
DAVIS, F.D.	6
ALBUQUERQUE, E. M	4
ANDERSON, R.E.	4
BANDURA, A.	4
BLACK, W.C.	4
HAIR, J.F.	4
TATHAM, R.L.	4
FISHBEIN, M.	3
FREEMAN, C.	3
KAPLAN, R.S.	3
NONAKA, I.	3
SCHUMPETER, J. A.	3
YIN, R.K.	3

5. Comparative study between Brazil and other countries

After doing a general analysis of the articles, a comparative study was conducted between Brazilian and foreign articles. From the 127 analyzed articles, 31% are Brazilian and 69% refer to foreign studies. Also, regarding the areas of knowledge found in the articles, it was observed that only 23.1% of the Brazilian papers were related to the Information Systems field, whereas the number of foreign articles in this area was 44.3 %. Among Brazilian articles, 15.4% were related to Public Health and 10.3% to Regional and Urban Economics; for the foreign papers, the numbers were 8% on Public Health and 6% on Economics.

Regarding the type of study found on the papers, it was possible to identify a significant difference between Brazilian and foreign articles. While 70% of foreign articles consisted of practical studies, only 46% of Brazilian articles had the same nature. This shows that, among Brazilian papers, the difference between theoretical and practical studies are not that significant, whereas in other countries this difference has become more remarkable.

Another important aspect from the analysis is that Brazilian articles have a very high concentration in few institutions. The 39 Brazilian papers were written by members of 29 different institutions. However, eight institutions had more than one publication analyzed and, when considered altogether, these eight institutions were responsible for more than half of the analyzed articles (Table 6).

Table 6: Brazilian Institutions

Institution	Publications
Universidade de São Paulo	4
Universidade Federal do Rio de Janeiro	3
Fundação Oswaldo Cruz	3
Universidade Federal do Paraná	3
Universidade Presbiteriana Mackenzie	2
Universidade Federal de Minas Gerais	2
Universidade Federal de São Carlos	2
Universidade de Campinas	2

Among the 88 articles published by members of foreign institutions, it was observed that only five institutions have more than one publication in the analysis, and these five were responsible for the publication of 11 articles (Table 7).

Table 7: Foreign Institutions

Institution	Publications
Auburn University	3
Copeland & Co	2
Georgia State University	2
Harvard University	2
So Methodist university	2

After the bibliometric analysis, it was observed that the analyzed articles have generated important information, which helps the understanding of how Innovation and Information Systems have been discussed in the literature in a connected way. In addition, it was possible to make a final analysis of the results, which is presented in the next section.

6. Conclusion

After raising and briefly discussing the main information obtained from the bibliometric survey, it is possible to do a final analysis on the results found in the previous sections and the general goals of this paper.

The analysis of keywords, for example, showed the most recurrent terms related to the topic in study, and these terms included "Systems", "Information", "Innovation" and "Management". Since these terms composed the research structure, it was expected that these words would appear more often than the others.

From the analyzed articles, it was observed that most of them consisted of Brazilian and American papers, and other countries had a less significant participation. This can be explained, in particular, due to the research databases that were used in the study (like Scielo, for instance, which reflects a larger amount of Brazilian publications). With regard to foreign publications, it is observed that Americans have handled the topics of Information and Innovation Systems in a more connected way than the others. Although other countries may have been discussing one topic or the other massively (such as India, with recurrent publications on Information Systems), Americans seem to be publishing more intensely on the interaction among the subjects discussed, not only one topic or the other in a detached way.

Regarding the journals in which the articles were published, it is important to remark that other journals that are not specifically on Technology and IS also had good relevance, as is the case of the "Revista de Saúde Pública" ("Journal of Public Health") which, despite being related to a very different area, had the same number of publications as other journals on Innovation and Information Systems. These results are consistent with the information analyzed before on the areas of knowledge; after all, both in other countries and in Brazil, journals showed greater prominence in the area of Innovation and Information Systems; however, both Brazil and other countries have shown that Public Health is an area to which many articles were related, especially in Brazilian articles.

Regarding the models and tools related to Information Technologies and Innovation, Enterprise resource planning (ERP) is the one with higher recurrence among the articles analyzed. Other systems or models showed a very similar frequency, indicating that there may not be a significant preference in the literature for these models.

In terms of practical and theoretical research, it was observed that practical studies were more recurrent (64% of total); however, the subsequent analysis between Brazil and other countries showed that most of this emphasis is, in fact, in other countries, whereas in Brazil the difference between surveys of practical and theoretical nature

proved to be insignificant. In other countries, there are a greater number of papers which seek not only to discuss the concepts and the existing theories, but also to apply these concepts in real situations.

It is noticed that this paper reached its initial goal, since it was possible to verify in the literature how the issue of Innovation and Information Systems have been linked and discussed altogether, and different aspects of this interaction were analyzed, generating statistic information and making it possible to do a further analysis. Thus, this study allows to explore how both issues are connected, facilitating the understanding of each subject and the development of future research on the issues.

For future researches, the use of other databases is suggested, covering journals from different countries and allowing to increase the analyzed sample, which was one of the limitations of this research. In addition, it is recommended to use other search terms that were not used in the search structures presented on this article, which will help gather new information and allow other analyses that were not covered in this paper.

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