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Bibliometric Method for Mapping the State-of-the-Art and Identifying Research Gaps and Trends in Literature: An Essential Instrument to Support the Development of Scientific Projects

Otávio José de Oliveira, Fabio Francisco da Silva,
Fernando Juliani, Luis César Ferreira Motta Barbosa
and Thaís Vieira Nunhes

Abstract

Bibliometric analysis is an indispensable statistic tool to map the state of the art in a given area of scientific knowledge and identify essential information for various purposes, such as prospecting research opportunities and substantiating scientific researches. Therefore, the objective of this chapter is to present a method of bibliometric analysis for mapping the state of the art and identifying gaps and trends of research. The method encompasses instruments to identify and analyze the scientific performance of articles, authors, institutions, countries, and journals based on the number of citations, to reveal the trends of the field studied through the analysis of keywords, and to identify and cluster scientific gaps from most recent publications. This method enables to expand in a scientific way the boundaries of science by investigating and identifying relevant and avant-garde research topics. It is an essential element that provides researchers means to identify and support paths towards the development of scientific projects.

Keywords: bibliometric method, bibliometric analysis, research gaps, trends in literature, scientific projects

1. Introduction

The scenario of intense competitiveness is a reality that has led many countries to increasingly invest in their scientific and technological development, which is an essential pillar for the construction of a sustainable economy [1].

One of the consequences of this development is the large volume of scientific articles published daily in international databases for the dissemination and sharing of contributions and advances resulting from academic research of different groups of researchers from various universities and countries [1, 2].

In light of this, the importance of bibliometrics is worth noting, which is a method for measuring, monitoring, and studying scientific outputs [3, 4]. Bibliometrics enables the mapping and expansion of knowledge on a particular area of research, evidencing connections between the main publications, authors, institutions, themes, and other characteristics of the field under study [3, 5].

An important application of bibliometric methods is its use as a tool for research evaluation [2, 4]. Outstanding papers in bibliometric studies are considered as reliable and relevant sources of results and are often used to justify decisions on research policies, funds, job offers, and promotions and also to direct and support research projects on the basis of what is most relevant in the scientific literature [2, 6].

The evolution of knowledge is something that occurs all the time, and the novelty of the researchers' proposals is the basic premise for the development of scientific research with great scientific and applied contributions. Therefore, the analysis of the state of the art of the field studied is an indispensable step to choose a no table research problem, since it can reveal gaps that need to be filled in the literature and important studies to underpin the researchers' proposals [6].

In this sense, it is important to emphasize that research funding bodies have increasingly required evidence that the research they support has potential to impact society with innovations, advances, etc. [2, 4, 7, 8].

Bibliometric methods involve the use of several tools that can help researchers to identify a relevant and current research problem, thus making clear the potential impact of the research in case of it being developed [4, 6].

Information technology (IT) tools can be used to assist the process of searching for relevant scientific contents, collecting scientific data, and summarizing the results obtained. These tools may be extremely important in clarifying the direction of a particular field of study and what advances and developments this may still present [4, 6].

Bibliometric indicators, if properly analyzed, can give more consistence to the research project, since they use statistics from different bibliographic databases that differ in terms of scope, data volume, and coverage [4].

Thus, the researcher who develops the research project based on bibliometric analysis has the possibility of presenting the objectives and methods of his work clearly and concisely by illustrating which scientific gaps in the field will be filled with the development of its study.

Hence, the purpose of this chapter is to present a method of bibliometric analysis for mapping the state of the art and identifying gaps and trends of research in literature. Throughout the sections some important bibliometric tools and analysis to justify the development of research projects will be set out.

The proper use of the presented method allows the understanding of the gaps and research tendencies from the mapping of the state of the art of a field studied, being a path to be followed by researchers in the phase of elaboration of their research project in order to ensure that the studies present real scientific, applied, and social contributions.

2. Mining and analysis of bibliometric data

The application of this method is oriented to map the state of the art of a scientific theme through the characterization of bibliometric parameters. The bibliometric parameters used are those with greater availability in scientific research platforms. For this characteristic, the presented method has universal application in the different fields of knowledge, concerning the researcher to adapt it adequately to meet their demands of study.

Another relevant characteristic of the method is that it was primarily designed to be applied in the initial phase of the development of a new study. Through the mapping of the state of the art, the bibliometric analysis reveals to the researcher essential information to base his study. The application of bibliometric analysis in the initial phase of a study can ensure that relevant references of the literature were considered for the construction of the new research. In addition, the results of the bibliometric study sheds light on the gaps of the literature, what can substantiate the scientific demand and originality of the study proposed.

The expected results of conducting the bibliometric analysis proposed in this method can be achieved by performing the macro-steps presented in **Figure 1**.

After defining the field studied, with which it is advisable that the researcher has some affinity, the first challenge in the bibliometric study is the choice of the scientific research platform to be used.

The choice of the scientific research platform is one of the actions that has a significant impact on the bibliometric analysis and, therefore, must be well planned in order to obtain assertive results and avoid reworking. In practical terms, research
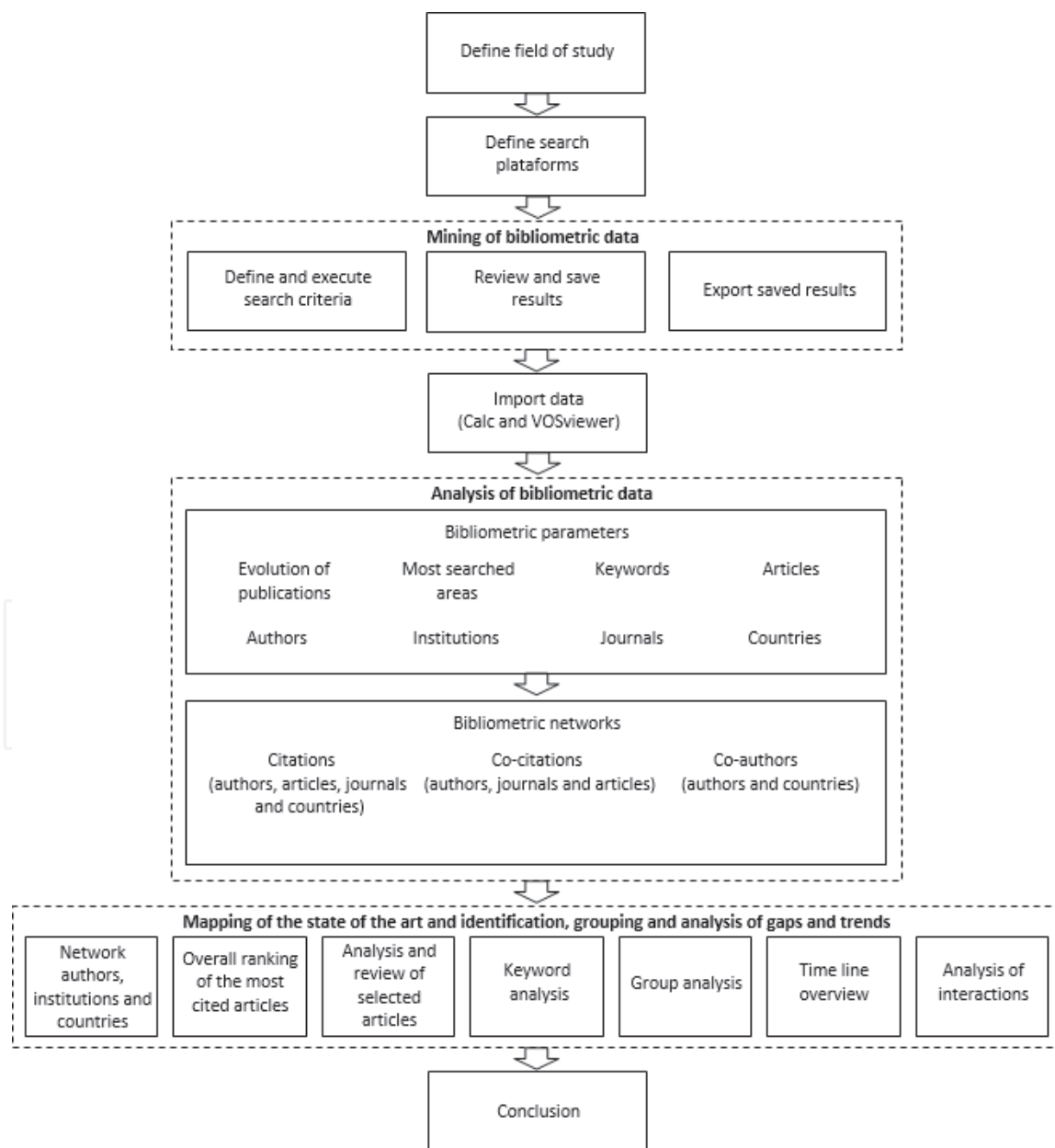

Figure 1.
Stages of the method for mapping the state of the art and identifying gaps and trends of research. Source: Prepared by the authors.

platforms present different tools for mining scientific data. Thus, the researcher should check what data can be extracted from each one of the platforms that best reflect the objectives of the study. This analysis is essential for the bibliometric study to meet the researcher's expectations and produce high-quality bibliometric studies.

Examples of scientific research platforms with robust databases and reasonable availability of search filters include Scopus (www.scopus.com) and Web of Science (WoS) (www.webofknowledge.com). These platforms provide access to thousands of scientific articles published by publishers such as Elsevier (www.sciencedirect.com), Emerald (www.emeraldinsight.com), Springer (www.springerlink.com), Wiley (www.wiley.com), and Taylor & Francis (www.tandfonline.com), among others. EBSCO (www.ebsco.com), Crossref (www.crossref.org), and Google Scholar (scholar.google.com) are other multidisciplinary platforms also used by researchers. In addition to these, there are extensive numbers of platforms specific to the different fields of knowledge.

The combination of one or more platforms for mining scientific data can result in more consistent bibliometric analysis. On the other hand, it will be more difficult to integrate information from platforms with different structures, and although there are computational tools that support the integration of this data, they still require great improvements.

Besides the structural differences between the platforms, there are also differences in the classification of the information adopted by each of them. For example, if the same search criteria were applied to different platforms, the results returned may not be the same. The variation in the number of articles is explained by the different search parameters adopted and also by the particular coverage of each platform.

The difference in the results generated by the platforms is approached in the works conducted by [9–12].

In this way, it concerns the researcher to identify the scientific research platforms that offer the largest collection of articles in their field of study. Throughout this chapter, the scientific platforms Scopus and WoS will be used as reference to operationalize the proposed method and integrate bibliometric data from these two platforms. The main reasons for using Scopus and WoS are the multidisciplinarity of these databases, once they cover a relevant and extensive collection of scientific publications and have available various tools for scientific data mining.

Scopus and WoS enable the extraction of essential data for conducting bibliometric analysis. From these data, it is possible to compare the performance of the literature according to each platform and corroborate, complement, or refute the results.

In addition, the integration of the scientific data provided by these platforms makes it possible to obtain more robust results for the bibliometric analysis. **Figure 2** presents the bibliometric data provided by the Scopus and WoS platforms.

Once the scientific platforms to be used have been defined, it is necessary to establish the search criteria of the articles. In order to obtain high-quality data mining, the search strategy should reliably reflect the research topic, the study objectives, and the limits of the research field. The main search criteria used in the bibliometric analysis are specific terms to the field of study, publication period, document type and language, and area of knowledge.

The specific terms of the field under study should express the subject, its synonyms, and different spellings. For example, the theme "Lean Six Sigma" is often represented by its synonym "Lean Sigma" or "Lean 6 Sigma". For more assertive results, it is recommended to use the Boolean expressions "AND" or "OR" to combine different expressions and increase the theme's specification, thus improving
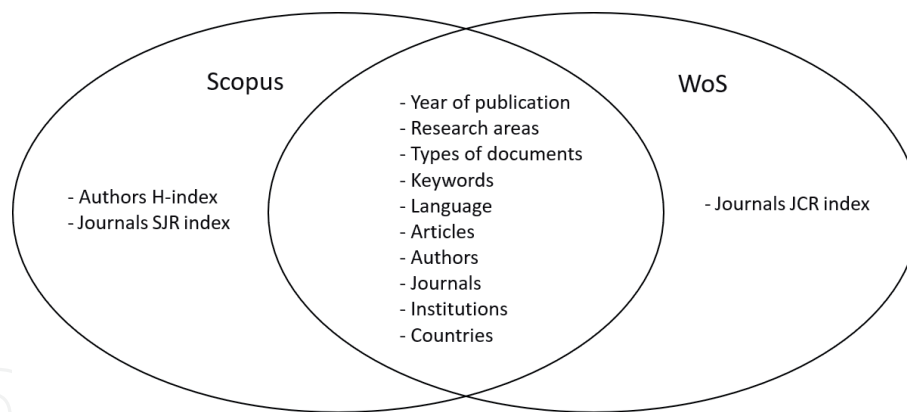
Figure 2.
Bibliometric data provided by scientific platforms Scopus and WoS. Source: Prepared by the authors.

the accuracy of the results returned. Specific terms of the field under study should be primarily sought in the titles, keywords, and summaries of the articles.

The filter of publication period should be defined according to the period in which the researcher wishes to perform the bibliometric analysis. For a complete map of the state of the art, it is suggested that all studies regardless of their year of publication be analyzed. However, when the fields of study have been investigated for many decades and the number of documents published is too high, it is advisable to limit the period analyzed because the subjects approached in the older papers were probably widely explored in the following ones. It should be highlighted that the analysis of gaps and trends for future research (discussed later in details) in general needs to be developed based on recent publications [13].

Among the different types of documents available on scientific platforms, articles and reviews published in journals are the most reliable source to review the literature, since they are peer-reviewed in their full version [14]. It is recommended not to include conference papers, notes, letters, books, book chapters, editorials, doctoral theses, master's dissertations, and nonscientific publications, except in cases where these types of documents are indispensable and relevant to the field studied. However, when it comes to the medical field of research, it is also necessary to take note of letters to the editor and case reports. The letters to the editor are documents that report important discussions for the development of medical research, being not so common in other scientific fields. Further, the case reports present the most recent findings or the limits to which modern medicine and technology are progressing and can be a channel for dissemination of best practices and solutions.

It is also suggested that only studies published in English be selected, since this is the universal language of the science.

The definition of the area of knowledge allows to limit the research to specific fields. However, if the researcher wishes to know the state of the art as a whole, it is recommended that the study be carried out considering all the areas of knowledge. If the amount of data found is extensive, the researcher may limit the investigation to only one area. **Table 1** presents an example of application of the search criteria to the study field on Lean Six Sigma.

The results that meet the previously established criteria are displayed, and the researcher must analyze the quality of the results. If the quality of the results is satisfactory, the researcher should save it in the user area of the search platform. The user area stores all the results obtained with the different applications of the search criteria. The articles saved in this user area will be the database used for conducting the bibliometric analysis. It is important to emphasize that before starting the data analysis, it is necessary to certify the search results to eliminate articles that do not belong to the field of study, but are included in the results.

	Inclusion criteria	Exclusion criteria
Database	Scopus and WoS	Others databases
Publication period	Up to 2017	Articles published in 2018
Document type	Articles and reviews	Conference papers, book chapters, books, notes, letters, editorials
Source type	Journals	Books, websites, conference proceedings, trade publications, doctoral thesis, masters dissertations
Subject area	Physical, life, social, health and humanities sciences	—
Language	English	Other languages

Source: Prepared by the authors.

Table 1.
Example of application of the search criteria for the study field "Lean Six Sigma".

One of the errors in the mining of bibliometric data is the use of a word that has various meanings. For example, if you search for the term "Lean" many articles that belong to "Lean Manufacturing" search field will be selected. However, many articles that contain the word "Lean" to refer to a characteristic of the human body will also be returned.

For this reason, it is essential that the author be attentive to this analysis on the search results. It is recommended that the title of the article be analyzed first to verify its suitability for the purposes of the study. If there is any doubt after the examination of the title, it is necessary to read the article abstract. If the doubt persists, it is fundamental to analyze the full text to decide if the bibliometric data of this article will be exported to the software of bibliometric analysis.

Scientific platforms provide various bibliometric data, and among the most relevant to perform the bibliometric analysis are title of the article, authors, journal, year of publication, number of citations, institutions, countries, keywords, and bibliographic references. The choice of exporting all these data should be specified in the scientific platform itself, as shown in **Figures 3** and **4**.

Scientific platforms offer different options of file formats to be exported. The most suitable file formats for export are ".csv" and ".txt". These formats allow the bibliometric data to be analyzed in spreadsheets and/or bibliometric softwares.
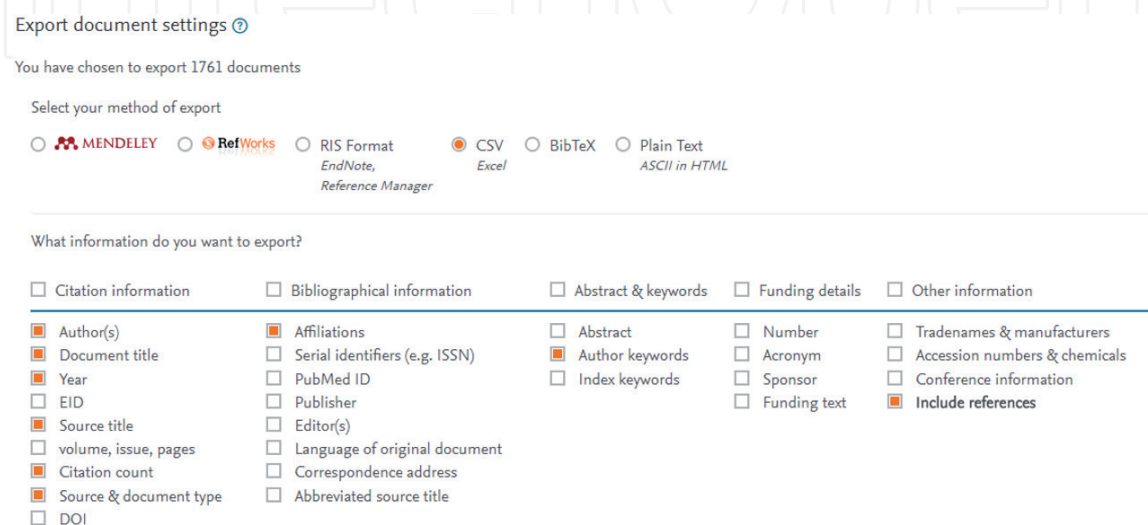

Figure 3.
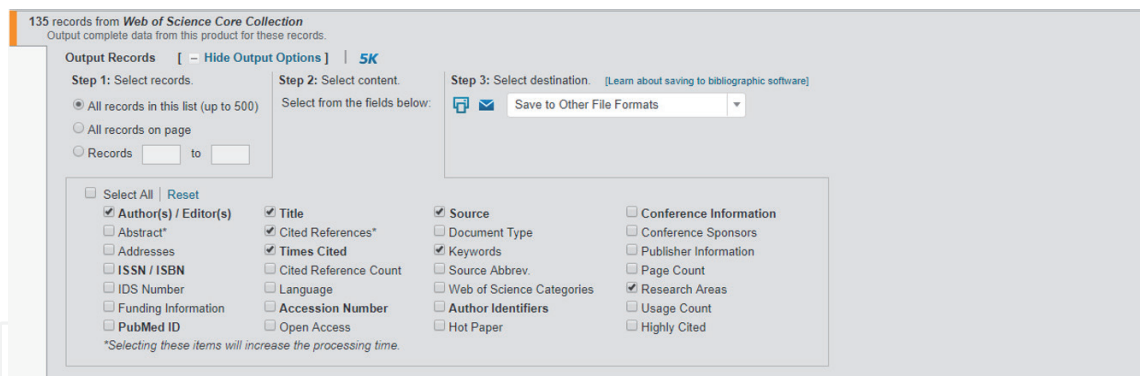*Selecting the data to be exported on the Scopus platform [15].*

Figure 4.
Selecting the data to be exported on the WoS platform [16].

Bibliometric data	Bibliometric parameters
- Year of publication	- Evolution of publications
- Research areas	- Most searched areas
- Keywords	- Most used keywords
- Article title	- Most cited articles
- Authors	- Most cited authors
	- More productive authors
- Institutions	- Most cited institutions
	- More productive institutions
- Journals	- More productive journals
- Countries	- More productive countries

Source: Prepared by the authors.

Table 2.
Imported bibliometric data and bibliometric parameters generated.

In order to make bibliometric analysis more accessible to the scientific community, the presented method recommends the use of open source software such as Calc (LibreOffice), Sci2 Tool (CNS), and VOSviewer (Leiden University).

Calc is a spreadsheet, and its use covers two main purposes: to integrate bibliometric data from different scientific platforms and analyze them. The bibliometric data imported in the Calc spreadsheet and the respective bibliometric parameters generated are presented in **Table 2**.

Importing data into the spreadsheet will only occur when the files are exported in the correct format. For the Scopus platform, the file should be exported in the ".csv" format. On the WoS platform, the data should be exported in the ".txt" format ("tab-separated" option). With the data imported into separated worksheets, the researcher must organize them into a single worksheet and classify according to the title of the article. This activity will allow the identification of duplicate files, making possible their elimination.

The bibliometric parameter "evolution of publications" is based on the publication year of each article. To obtain this parameter, the spreadsheet must be operated to quantify the number of articles published per year. This parameter reveals the dynamics of the publications, whether the topic has been widely explored by researchers or if there is a reduction in the interest of the scientific community.

The bibliometric data of research areas are used to quantify which areas are the most researched ones. The information obtained by this bibliometric parameter

allows to verify in which areas the researchers have directed their efforts and those that are still underexplored.

Keywords are concise representations of a given text that allow readers to identify its content in advance [17]. The keywords bibliometric data can be used to construct frequency charts of the most used keywords, as well as to elaborate "word clouds".

It is important that the researcher pay attention to keywords similar to terms or expressions already used in the search filtering process. Since these keywords represent obvious information regarding the topic addressed, it is recommended to disregard them to not analyze them in the subsequent analysis. This avoids inconsistencies in the analysis and wasting time and effort of the researcher.

In the case of publications that do not use keywords (something very common in administration journals, for example), the researcher must review the titles (and even the abstracts, in the case of inaccurate titles) to identify terms or expressions that define the main topics covered therein [11, 18].

The word cloud is a practical tool for dimensional visualization of the most used keywords that represent the articles. The Wordle website (www.wordle.net), for instance, provides this tool. When elaborating the word cloud, the researcher should note that expressions such as "Lean Six Sigma" can be understood as three distinct words. To correct this interpretation in the website suggested, the researcher must use the "~" symbol so that the expression will be understood appropriately.

The titles of the articles are bibliometric data used to expose the most cited articles by means of the number of citations received. A simple classification of the articles according to the number of citations can reveal which are the most relevant in the researched literature. Besides the classification of the most cited articles, it is also useful to generate a chart with the evolution of the citations received by the articles over the years. This chart can clarify which articles have increased its importance in the scientific world.

To identify the authors, institutions, journals, and countries most cited in the literature, it is recommended to apply the following steps: (1) visit the Scopus and WoS platforms (logged into your respective accounts) and check in the researcher's list of the authors, institutions, journals, and countries with a minimum number of publications; (2) select the authors, institutions, journals, and countries that meet the requirement set out in step 1; (3) count in the spreadsheet the number of citations received by authors, institutions, journals, and countries; and (4) classify the authors, institutions, journals, and countries according to the highest number of citations received.

It is important to clarify the reason for filtering a minimum number of publications from authors, institutions, journals, and countries applied in step (1). If this filter is not applied, authors who had one or two publications that had a high number of citations will be included in the ranking of the most relevant authors in the literature. This often occurs with researchers who are not specialists in the field of study. For example, one author co-authored two articles that had a high impact on the literature, but the analysis of his research profile reveals that he does not act in the field of study investigated. Therefore, the author of this example may have contributed punctually to the research, but is not a specialist in the subject study.

Tables containing the top 10 authors, institutions, journals, and countries should be generated. In addition to the number of citations received, these may contain other performance information, as presented in **Table 3**.

After obtaining the bibliometric parameters, it is recommended that the bibliometric networks of the research be generated. In this chapter, it is recommended to use VOSviewer software, which will allow the construction of bibliometric networks referring to articles, authors, journals, institutions, and countries based on

Table	Table columns
Most cited articles	Position in the citation ranking, title of the article, authors, journal, year of publication, number of citations, evolution of citations over the years
Most cited authors	Position in the citation ranking, name of the author, institution, H-index, number of publications, number of citations, evolution of citations in the field of study over the years
Most cited institutions	Position in the citation ranking, institution name, country, number of publications, number of citations
Most cited journals	Position in the citation ranking, name of the journal, publishing area, SJR or JCR, ISSN, number of publications, number of citations
Most cited countries	Position in the citation ranking, country name, number of publications, number of citations

Source: Prepared by the authors.

Table 3.
Proposal of additional data for citation ranking tables.

citation, co-citation, co-authorship, and bibliographic coupling. The software also allows quantifying terms, a useful tool to characterize the occurrence of keywords [19]. Examples of networks will be presented and explained in more detail in the next section.

3. Mapping of the state of the art and identification and analysis of gaps and trends of research

The main objective of the analysis of gaps in the literature is to provide the researcher ways to identify opportunities for exploring new relevant topics of a given field of research, as well as studies that have not been fully explored and which require the development of further studies in order to advance the state of the art of a particular theme. Therefore, in this section some types of analysis that may converge in the identification of scientific gaps and research trends will be presented.

3.1 Analysis of authors, countries, institutions, articles, and keywords

The analysis of most cited authors is helpful to the researcher to know the authors who are reference in the area under study and then always be attentive to new studies published by these authors. In this analysis, it is recommended that authors with a minimum number of publications be selected, as this will avoid the selection of authors who are not experts in the field. This type of analysis may indicate to the researcher opportunities for co-orientation partnerships, participation in international research groups, etc.

The analysis of the most cited authors in a theme and their most recent articles on this topic is a way of guiding the development of a bibliometric article that aims at the identification and analysis of gaps and trends. The selection of authors with a minimum number of publications can be done manually in the main research platforms or it can be done by means of the software VOSviewer, which performs the analysis of most cited authors with the option to select the filter of minimum number of publications of a given author.

The analyses of most cited countries and institutions are other possibilities of bibliometric analyses that can help the researcher to direct his academic plans,

since the researcher who intends to carry out a research internship must know in advance the countries, institutions, and research centers of excellence in your area. Therefore, the analyses of countries, institutions, and research centers most cited can help researchers to justify possible proposals for research abroad and may also open doors for the establishment of cooperation agreements between students, professors, research groups, and also between universities.

In order to perform these types of analyses, the use of the VOSviewer software is also recommended, since it automatically counts the number of occurrences and citations of each country or institution in a portfolio of documents. In addition, the software is capable of creating several types of networks, such as co-citation and co-authorship, citation of articles, institutions and countries, co-occurrence of keywords, etc. **Figures 5**–**7** show three forms of visualization of an example of a co-citation network of authors elaborated with the aid of the software VOSviewer, using the data exported by the Scopus platform in ".csv "format type.

Notice in **Figure 5** that the "network visualization" is the simplest display mode, which shows the iterations of co-authorship and formation of some clusters. The second display mode "Overlay visualization" (**Figure 6**) returns a network that brings iterations of co-authorship and formation of clusters and, in addition, brings information of chronological type (see the legend in the bottom right corner of **Figure 6**). Finally, the third display mode (**Figure 7**), although does not show iterations and clusters as the other modes, clearly allows to verify the different densities of the information shown in the network. In this way, it is emphasized that the three display modes are interesting; however, it is important that the researcher knows how to identify the one that can best help the execution of the analyses taking into account the objectives to be reached.

The analysis of the most cited and relevant articles is an important step to help the researcher to develop a theoretical framework of quality for your research project. The researcher needs to be aware of which articles are prominent in the area under study so that documents with important contributions are not left out of the reading portfolio. Likewise, the analysis of the recent articles published by the most cited authors on a given topic can make the identification and analysis of gaps and trends more robust, since it can indicate if the identified gaps have been filled and if there are opportunities for developing new studies.
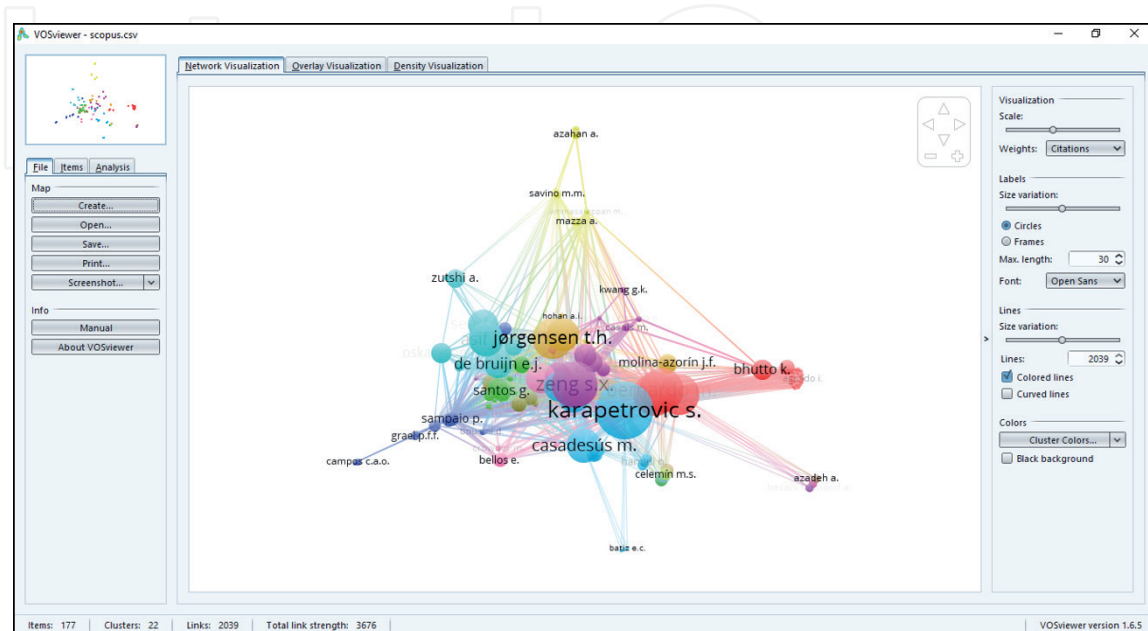

Figure 5.
Author co-citation network in the "network visualization" display mode [15,19].
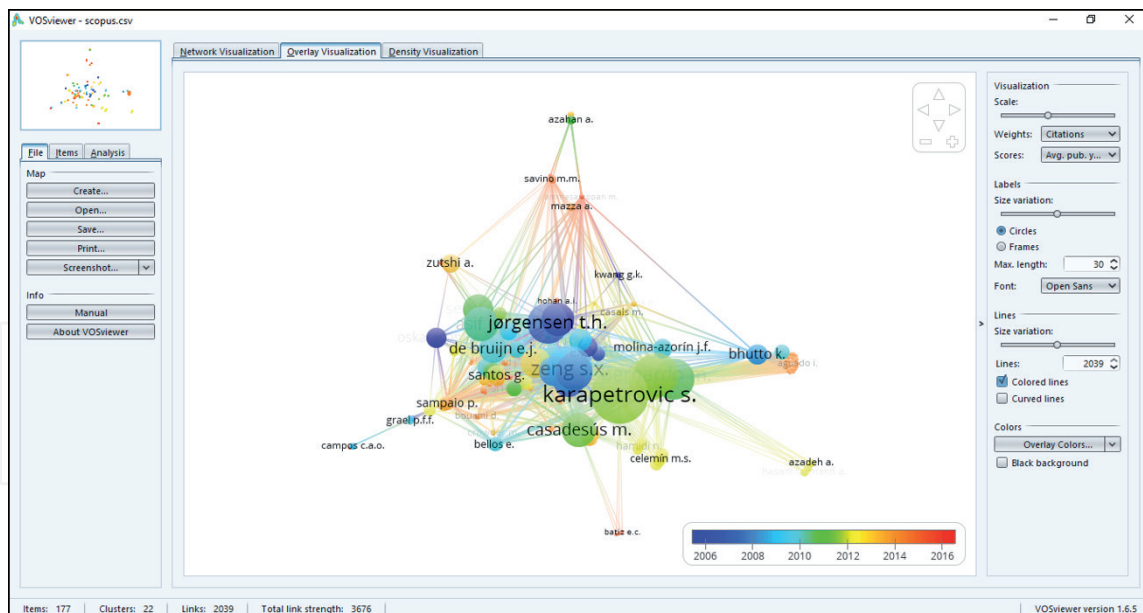
Figure 6.
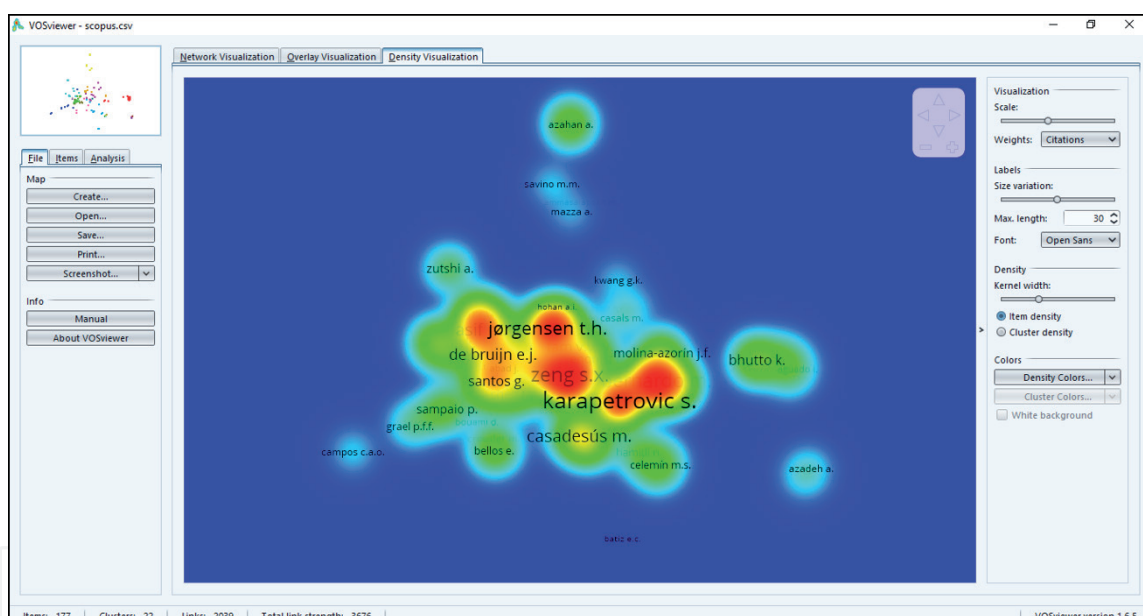*Author co-citation network in the "overlay visualization" display mode [15,19].*

Figure 7.
Author co-citation network in the "density visualization" display mode [15,19].

Researchers are also advised to filter, select, and analyze articles that are most relevant to the topic studied. The option to search for articles by relevance is available on the main research platforms. The results returned in this type of search are in general articles with few citations, since they are commonly newly published. However, to select these articles, the research platforms carry out a projection that identifies the relevant articles based on an evaluation that takes into account the journal in which it was published, research area, average number of citations of similar previous works, etc. Thus, it is important to include the relevant articles in the bibliometric analysis, because they have great potential of impacting on the academic community.

Figure 8 illustrates a possible ranking of the most cited articles for the "business strategy" topic, while **Table 4** presents the objectives, methods, results, and proposal of future studies presented in a selected article for later identification and
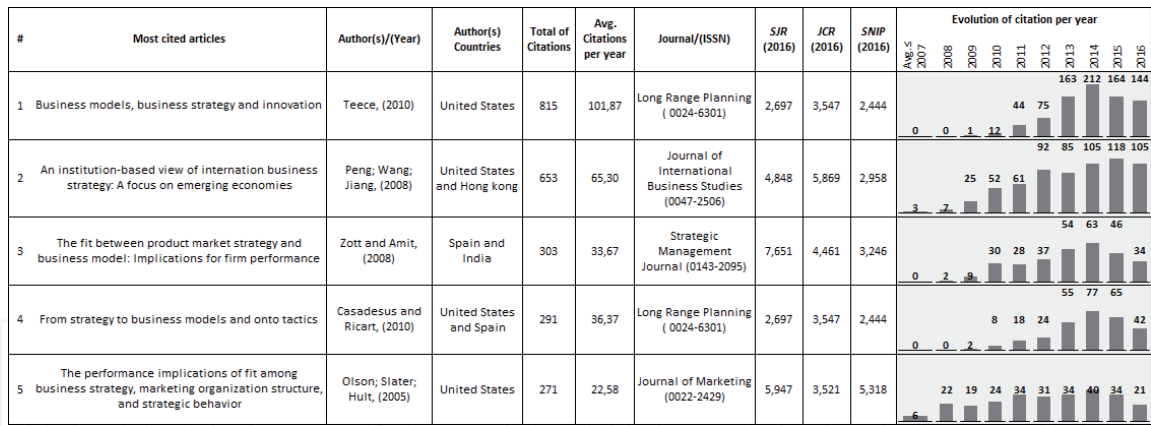
#	Most cited articles	Author(s)/(Year)	Author(s) Countries	Total of Citations	Avg. Citations per year	Journal/(ISSN)	SJR (2016)	JCR (2016)	SNIP (2016)	Evolution of citation per year
1	Business models, business strategy and innovation	Teece, (2010)	United States	815	101,87	Long Range Planning (0024-6301)	2,697	3,547	2,444	0 0 1 12 44 75 163 212 164 144
2	An institution-based view of internation business strategy: A focus on emerging economies	Peng; Wang; Jiang, (2008)	United States and Hong kong	653	65,30	Journal of International Business Studies (0047-2506)	4,848	5,869	2,958	3 7 25 52 61 92 85 105 118 105
3	The fit between product market strategy and business model: Implications for firm performance	Zott and Amit, (2008)	Spain and India	303	33,67	Strategic Management Journal (0143-2095)	7,651	4,461	3,246	0 2 9 30 28 37 54 63 46 34
4	From strategy to business models and onto tactics	Casadesus and Ricart, (2010)	United States and Spain	291	36,37	Long Range Planning (0024-6301)	2,697	3,547	2,444	0 0 2 8 18 24 55 77 65 42
5	The performance implications of fit among business strategy, marketing organization structure, and strategic behavior	Olson; Slater; Hult, (2005)	United States	271	22,58	Journal of Marketing (0022-2429)	5,947	3,521	5,318	6 22 19 24 34 31 34 40 34 21

Figure 8.
Example of classification of the most cited articles according to the total number of citations. Source: Prepared by the authors.

analysis of gaps and trends. **Table 4** can also help to develop a general perception of a possible timeline and its groups and interactions, which are analyses that will be discussed in the next section.

The classification of the most cited articles in **Figure 8** is in decreasing order, and the ranking was based on the total number of citations accumulated in the period from 2002 to 2016. The search filters were used to return the articles that contained in their titles the word "business strategy" in the "business, management, and accounting,", "social science," "engineering," "environmental science," and "economics, econometrics, and financial" areas.

As the articles of the example in **Figure 8** can be classified in different ways, it is advisable for the researchers to choose to categorize the articles according to their own needs. It should be noted that the list would have another sequence, for example, if the articles presented in **Figure 8** were classified according to the average of citations that the article receives per year or, even, if they were classified based on the impact factors of the journals to which they were published, etc.

Another way to identify gaps in the literature is by means of analyzing the most commonly used keywords in articles on a given topic. The relevance of a particular topic can be measured by the frequency with which the keywords appear in the portfolio of documents analyzed in the bibliometric study. In this way, it is possible to identify whether a topic has already been sufficiently explored and whether there is still the possibility of its further exploration. For example, if a topic is in evidence due to the frequency of a keyword, it may be easier to characterize the existence of gap in the literature, depending on the researcher's experience.

On the other hand, the researcher should be attentive if a keyword that was often used in the articles is today no longer observed with such frequency and regularity, because it can be a sign of a possible exhaustion of a theme in the literature. In order to perform these types of analysis, the use of the software VOSviewer is also recommended, since it automatically counts the number of occurrences of the keywords in the selected articles.

Concerning the identification of gaps by reading the articles, it should be noted that there are two ways to accomplish it. The first one is by analyzing the gaps that are explicit in the text, that is, those that are usually at the conclusion of the articles and, therefore, are easier to identify. Besides, sometimes it is possible that difficulties faced with the conduction of a study can be also considered an explicit gap that may originate new researches.

Among the explicit gaps may also be, for example, those arising from geographical limitations, which are consequences of the natural limitations of the studies.

Author(s)	Objective	Findings	Research method	Literature gaps
Teece [20]	The purpose of this article is to explore the mechanisms by which managers can gauge the required level of organizational agility, deliver it cost-effectively, and relate it to strategy	"Organizational agility" is often treated as an immutable quality, implying that firms need to be in a constant state of transformation. However, this ignores that such transformations, while often essential, come at a cost. They are not always necessary and may not even be possible. This article explores agility at a more fundamental level and relates it more specifically to dynamic capabilities. It demonstrates that it is first essential to understand deep uncertainty, which is ubiquitous in the innovation economy. Business models, dynamic capabilities, and strategy are interdependent. The strength of a firm's dynamic capabilities helps shape its proficiency at business model design. Through its effect on organization design, a business model influences the firm's dynamic capabilities and places bounds on the feasibility of particular strategies	Theoretical; in-depth review of your own literature, based on the new practices and needs of modern markets	While these relationships are understood at a theoretical level, there is a need for future empirical work to flesh out the details. In particular, studies that provide a better understanding of business model innovation, implementation, and change will also shed light on important aspects of dynamic capabilities. Uncertainty is very different from risk, which can be managed using traditional tools and approaches. Strong dynamic capabilities are necessary for fostering the organizational agility necessary to address deep uncertainty, such as that generated by innovation and the associated dynamic competition

Source: Prepared by the authors.

Table 4.
Example of main information to be analyzed in an article and/or review.

In this sense, it is common for researchers to point out in the conclusion of their articles that the expansion of the area of application of the study proves to be a research opportunity. In order to emphasize the relevance of this type of gap, it is recommended to check whether other researches with similar objectives are equally geographically limited. If the geographical limitation is confirmed, a research can be justified by the need to apply the study in other regions, countries, or continents.

The second way to identify gaps in the literature by reading is identifying the implicit gaps in the text. These gaps are harder to identify because they are not highlighted in an explicit manner in the text. Thus, in order to identify implicit gaps, it is important to consider the reader's experience and familiarity with the topic, since researchers with more experiences in a given topic are more likely to identify gaps related to it than less experienced researchers.

3.2 Grouping, timeline, and analysis of interactions

Grouping the topics approached in the bibliometric study in research subareas, conducting the timeline analysis, and searching for similarities between the various groups are important steps to be followed in order to identify gaps and trends of research. The procedures to accomplish this step of the method are presented in this section.

After performing the analysis of gaps in the selected articles and reviews, it is possible to group the main issues addressed in the studied universe. The purpose of this analysis is to identify the structure of the state of the art of the theme, highlighting how its research subareas have evolved over time, how they are developing, and where they are going.

Grouping the various topics into research subareas is a task that requires some degree of mastery on the state of the art of the field studied. For this reason, it is important to develop the analyses of most cited authors and articles, countries and research centers in evidence, etc., because through them it will be possible to extract a rich set of information that will help the perception of similarities, the formation of groups, and the identification of trends of research.

The recommended technique for performing groupings is content analysis, which seeks to identify in a document the frequency with which categories of a given subject are addressed [21]. To determine the categories (or groups), the researcher must identify the most recurring topics (or elements) and account for the frequency that they are addressed directly or indirectly in the articles and reviews analyzed.

To facilitate the visualization of this analysis, a radar chart can be developed. It will show the frequency of occurrence of the elements in the literature and will show the ones that are most recurrent and that, therefore, should lead the formation of the groups. **Figure 9** illustrates the grouping process proposed in this chapter.

It is recommended that the elements with about 70% of occurrence in the portfolio of articles and reviews lead the formation of the groups, since these represent subjects that have been widely discussed in the literature. Once the key elements are
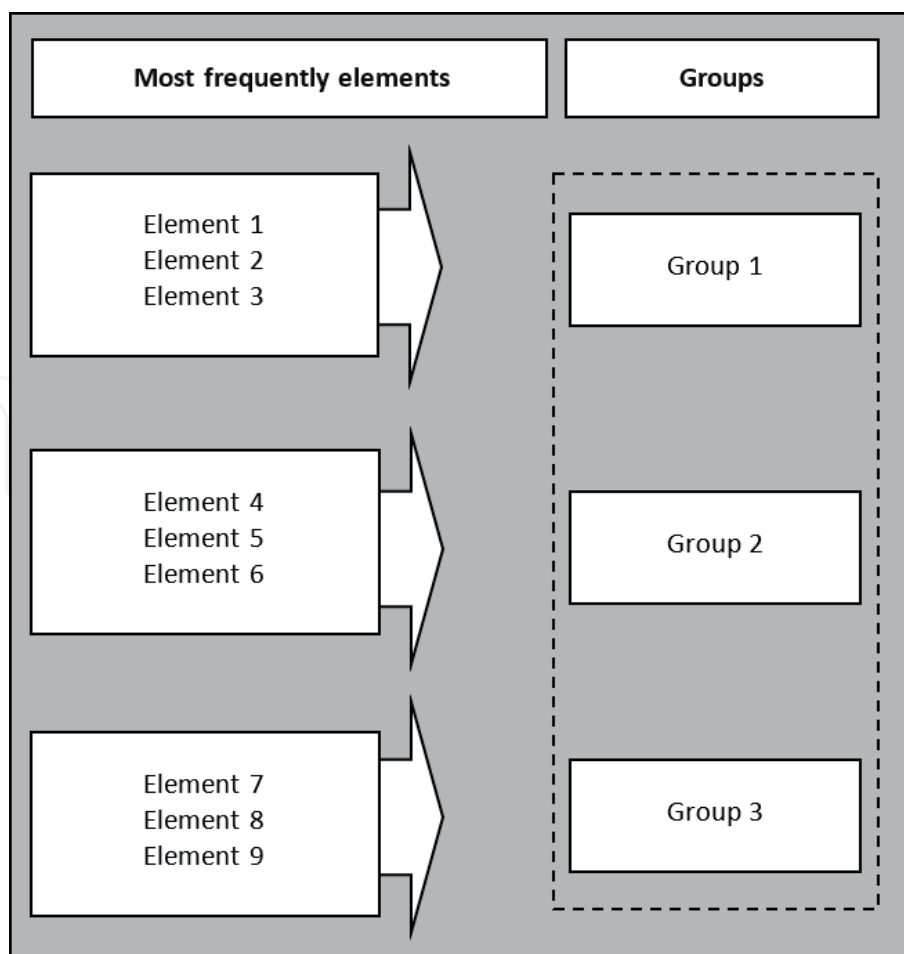

Figure 9.
Grouping process. Source: prepared by the authors.

identified, the other elements should be grouped together based on an analysis of similarities.

It is important to emphasize that the grouping may be led by elements mentioned directly or indirectly in the studies analyzed. Therefore, the group formed from the grouping of elements directly addressed in the texts will be a more mature group, that is, several papers involving the subject have already been published, which shows that the group has already reached a significant degree of development in the state of the art analyzed. On the other hand, the group resulting from the grouping of elements indirectly addressed in the texts may indicate the need to better develop a line of research that, although frequently addressed in the literature, does not yet have specific papers published in this regard.

Once the groups have been created, one must try to understand the evolutionary process of each of them over the years, what are their contributions to the state of the art, and where is the research going in each subarea, evidencing the gaps and trends of each group. The timeline is a tool of analysis that can illustrate from a temporal point of view the general evolution of each group over the years. It also allows the evaluation of the maturity of the research subareas. **Figure 10** shows an example of timeline for the "Integrated Management Systems" search field.

As can be observed in **Figure 10**, the timeline allows researchers to better visualize the contributions of each group for the building of the state of the art, allowing even the comparison of the evolution between the different groups by tracing transverse lines to the horizontal axes of the timeline.

The maturity of each group can be observed according to the volume and distribution of the publications fixed in the axes. In this way, axes with a higher density of work represent the more developed groups, while the more vague axes represent the groups that need more research to be developed.
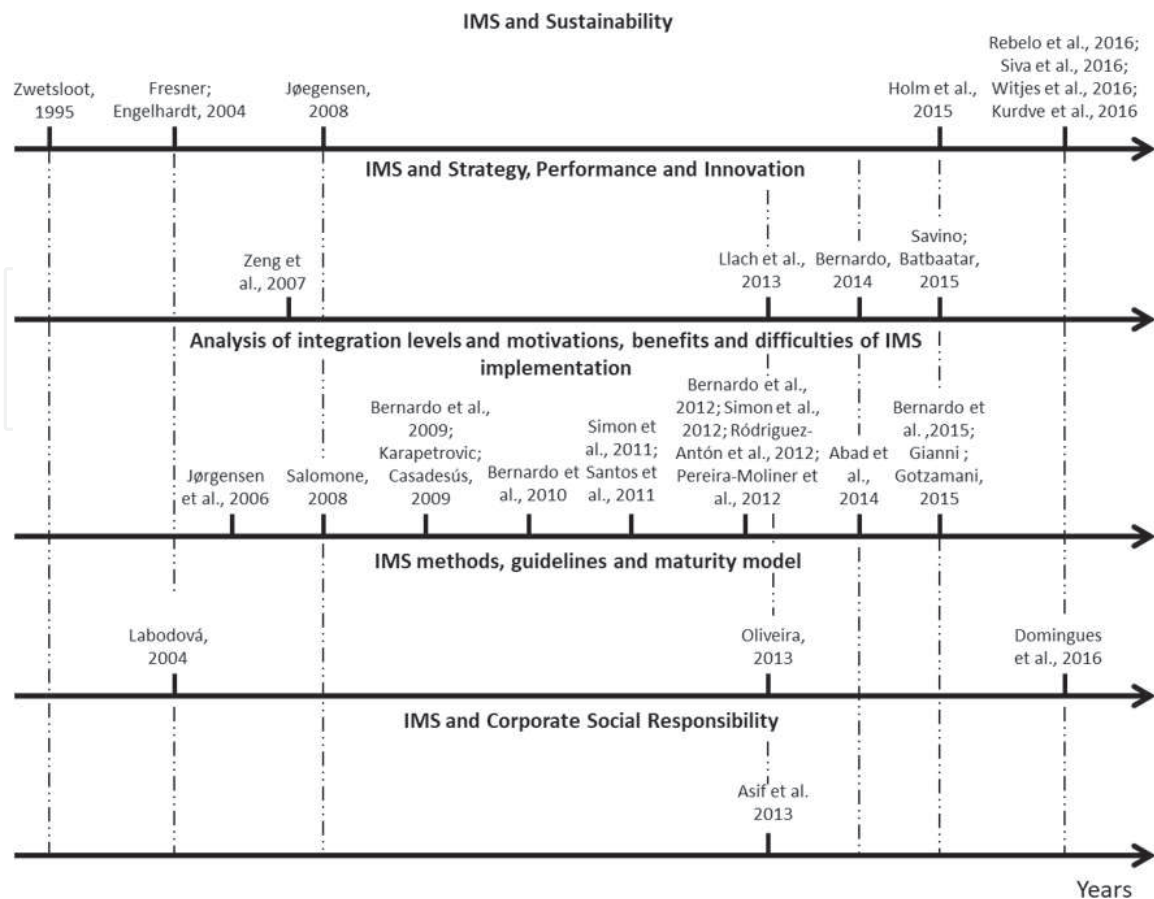

Figure 10.
Timeline to the "Integrated Management Systems" study field [13].

Group	Contribution	Author(s) (year)
IMS and sustainability	The IMS is a driver that can conduct companies to achieve the sustained success	Author1 et al. (2016), Author2 et al. (2016), Author3 et al. (2016), Author4 et al. (2016), Author5 et al. (2015), Author6 (2008), Author7 and Author8 (2004), Author9 (1995)
IMS and strategy, performance and innovation	The IMS is a strategic asset that has positive impact on innovation, financial, operational and marketing firm performance	Author10 and Author11 (2015), Author12 (2014), Author13 et al. (2013), Author14 et al. (2007)
Analysis of integration levels and motivations, benefits and difficulties of IMS implementation	There are different levels of integration (normally three) which characterize the nature of motivations, benefits and difficulties of implementation	Author12 et al. (2015), Author15 and Author16 (2015), Author17 et al. (2014), Author12 et al. (2012), Author18 et al. (2012), Author19 et al. (2012), Author20 et al. (2012), Author18 et al. (2011), Author21 et al. (2011), Author12 et al. (2010), Author12 et al. (2009), Author22 and Author23 (2009), Author24 (2008), Author6 et al. (2006)
IMS methods, guidelines and maturity model	Methods, guidelines and a maturity model are proposed in order to facilitate and/or "normalize" the integration process	Author25 et al. (2016), Author26 (2013), Author27 (2004)
IMS and corporate social responsibility	The IMS structure provides the integration of CSR	Author28 et al. (2013)

Table 5.
Group analysis [13].

In addition to the time line, the groups and their respective contributions can be presented as shown in **Table 5**.

It can be seen in **Table 5** that the 30 articles analyzed were classified into 5 groups, each one adding value to an important area of the state of the art on "Integrated Management Systems."

After grouping the topics and understanding the particularities of each group, it is recommended to identify if there is any relation between them, that is, if there is a structure of evolution according to which one group gave support to the development of another. **Figure 11** shows a map of interactions with the interactions between the research groups on "Integrated Management Systems."

As shown in **Figure 11**, it is common for the more mature groups to influence the development of more recent ones, as the publications of a group can add important contributions and indicate gaps that may create trends of research to advance the state of the art of a given study field as a whole. It is important that the synergies between the groups and the pathway of formation and development of the state of the art are indicated in the map of interactions.

The analysis of interactions is a final analysis that must be conducted with a systemic view, because from it the researcher can perceive interaction relationships with potential to give rise to groups with original research proposals. Upon reaching this point of application of the method, the researcher is expected to know the particularities of the field under study and the main groups belonging to it, so that the analyses performed previously will provide support for the identification of relations of interactions between the various groups.
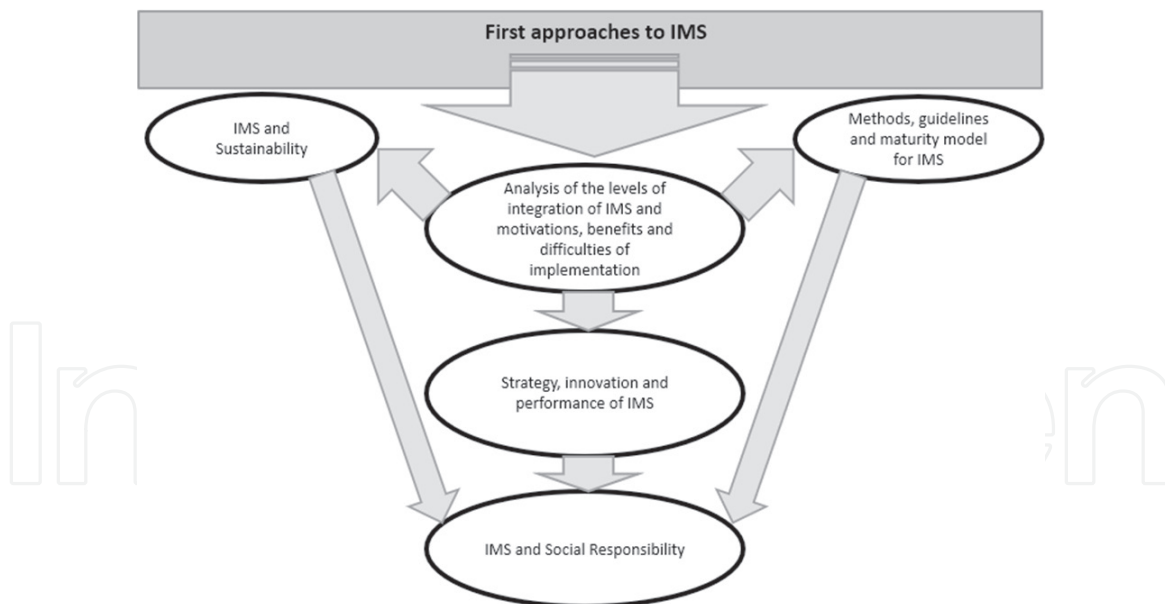
Figure 11.
Map of interactions. Adapted from [13].

4. Conclusions

In this chapter, a method of bibliometric analysis was proposed in order to help researchers develop a relevant research project based on the mapping of the state of the art of a given topic and the identification, grouping, and analysis of gaps and trends of research.

It was observed that the choice of the scientific research platform to be used in the study is one of the actions that has a significant impact in the bibliometric analysis and, therefore, must be careful and well planned so that the research will return assertive results and reworking will not be necessary in the subsequent stages of the analysis. In addition, it was verified that it is necessary to establish criteria to perform the search of the articles, which must take into account the research topic, the objectives of the study, and the limits of the research field.

In the proposed method, the mapping of the state of the art should be initiated with the definition of the bibliometric parameters by the researcher, which has to be consistent with those available in the scientific research platforms. By analyzing the data mined, it is possible to compare the performance of the literature according to each platform to corroborate, complement, or refute results.

It is concluded that the use of data extracted from two or more platforms can result in a more robust and consistent bibliometric analysis. However, it is possible that the researcher faces difficulties in the integration stage of the data. In this sense, it is important to highlight that although there are computational tools that help the integration of this data, these still need great improvements, demanding extreme attention of the researcher in the process of mining and analysis of the data.

The analyses presented in this chapter are important elements to expose and explain the scientific gaps present in the literature that can base research projects. Therefore, it can be concluded that the method presented is essential to help researchers to develop their research in a way that they actually bring out significant contributions to the literature. It is also concluded that the application of this method can result in the expansion of the frontiers of science by promoting the investigation of relevant and avant-garde topics.

The main scientific contribution of this chapter is the possibility of using the proposed method to help the development of new studies, based on bibliometric analyses aimed at the identification of scientific gaps and trends, thus encouraging the development and expansion of the state of the art of various fields of research.

It is also worth noting that the mapping of the state of the art and the identification of scientific gaps and trends can lead the researcher to develop studies whose results are important advances in the development of a technology, technique, or scientific area. In this way, it is notorious that the presented method can aid in the process of transformation of a scientific project into a workable product, being this the main applied contribution of this study.

Finally, it should be pointed out that the results achieved with the application of the proposed method may vary according to the experience and familiarity of the researcher with the scientific area under study.

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Author details

Otávio José de Oliveira[1*], Fabio Francisco da Silva[2], Fernando Juliani[1], Luis César Ferreira Motta Barbosa[1] and Thaís Vieira Nunhes[1]

1 São Paulo State University, Guaratinguetá, Brazil

2 Federal Institute of Education, Science and Technology of Goiás, Valparaíso de Goiás, Brazil

*Address all correspondence to: otaviodeoliveira@uol.com.br

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