

Bibliometric Analysis of Citations and Downloads in Information Science Based on the Brazilian Digital Library of Theses and Dissertations

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Abstract: Bibliometric indicators contribute to the understanding of science as a whole, supporting the decision-making process of funding agencies, research and development and postgraduate programs. There are different bibliometric indicators, among them, the rates of citations and downloads. It happens that, sometimes, correlation is attributed to these two indices. This study aims to evaluate, in the light of theses and dissertations registered in the Brazilian Digital Library of Theses and Dissertations of the Brazilian Institute of Information in Science and Technology, whether there is a correspondence between the number of citations and downloads, considering the context of the scientific production of the programs of Information Science in Brazil. Therefore, a research with a quantitative methodological approach is adopted, with bibliometrics and descriptive statistics technique for data analysis. The study found that the number of theses and dissertations downloads is much higher than the number of citations. However, from the data presented, it is not possible to say that theses and dissertations with the highest number of downloads are those with the highest number of citations. Likewise, it is not possible to say that the most cited theses and dissertations are the most sought after in the Brazilian Digital Library of Theses and Dissertations.

Keywords: Information science; Theses; Dissertations; Citation; Download

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1. Introduction

The survey of indicators on research activities, specifically on scientific production, has been strengthened in the country, highlighting the need, on the part of federal and state governments and the national scientific community, to have instruments for defining guidelines, allocation of investment and resources, formulation of programs and evaluation of activities related to scientific and technological development in the country^[1]. The process of developing a scientific field includes, among other factors, the development of its literature. Among the various types of scientific documents, journals are extensively studied, along with other types of documents such as theses and dissertations^[2].

Many national and international governmental agencies that promote scientific and technological research elaborate and use scientific production indicators for the formulation, execution and monitoring of public policies of science and technology. Another factor that contributes to the increasing attention given to scientific production indicators is the greater availability of methodologies and electronic resources for their preparation, with indicators that are often pre-elaborated, accessible with relative ease^[3]. In the context of these indicators for evaluation of the processes, activities and results of scientific production are

the bibliometric metrics for citations and downloads. These two metrics seem to have correlation, when it is asked if the scientific production with more downloads corresponds to the most cited scientific production. As an alternative to try to answer this question, the aim of this study was to present a bibliometric analysis of the citation and download relationships of theses and dissertations from postgraduate programs in Information Science registered in the BDTD of the IBICT, covering the period from 1979 to 2019.

After conducting research on the BRAPCI and Google Scholar platforms, no specific research was found on the relationship between citation and download data of theses and dissertations produced in Postgraduate Programs in Information Science and registered in the Brazilian Digital Library of Theses and Dissertations of IBICT. However, in different contexts, similar works have been published, including an article based on the relationship between downloads and citations in journal and article levels and the influence of language ^[4]. Studies with this focus are mainly motivated by the desire to gain more insights into the scientific community in the Information Science field of Brazil, providing information to support decision-making for institutions and experts.

2. Citations and downloads in the context of Information Science

Curiosity drives the investigation of the unknown, leading individuals to continuously seek understanding of themselves and the reality surrounding them. In this sense, religion and belief have been paths utilized by humanity for centuries in the search for answers to their questions and concerns. However, cultural tradition has not always been sufficient, as arguments are often based on subjective interpretations. The need for more objective explanations about nature and its phenomena gave rise to more reliable methods capable of justifying knowledge about everyday facts ^[5]. Knowledge is no longer solely based on speculation or mere exercise of thought. It is equally grounded in observation, experimentation, and measurement, the foundations of the scientific method in its experimental form. Therefore, it could be said that the scientific method emerges from the encounter between speculation and empiricism ^[6].

Scientific communication aims to publish the scientific knowledge generated and the relationships resulting from its production and dissemination. Communication is situated in the very core of science and is as vital for it as research itself ^[7]. The chronology of studies in science communication emerged in the USA in the 1940s as a result of the significant (and sometimes disorganized) growth of scientific literature and was based on the works of Price.

Bibliometric studies emerged when the possibility of measuring science became concrete, and during this period, many works were produced. According to Targino (2000) ^[8], notable authors in this field include Garvey (1979), Merton (1973), Price (1976), Griffith (1989), and Menzel (1966). These metric perspectives encompassed various stages, from the initial steps to their implementation in articles published in journals, as well as in communications at events or messages and files in scientific social networks.

The peer-review evaluation is a key element that strengthens the scientific communication system. It is the factor that recognizes and affirms scientific knowledge and its producers. Barba (2003) defines that a group of scientific agents constitutes a scientific system, which employs bibliometric indicators as a means of comparison ^[9]. Bibliometric indicators can be used to study specific systems or groups of systems. These data can be obtained to classify scientific production based on various criteria, such as thematic (areas of activity), institutional (professionalization of those practicing science), geographic (workplace of researchers), and temporal researchers. ^[9]

Maricato and Martins (2017) state that the interest in measuring, monitoring and evaluating scientific and technological activities through indicators generated from products, especially publications, emerged in the 20th century, with the prominence of researchers such as Lotka, Zifp, Bradford, Nalimov, Solla Price, Eugene Galfield. These researchers provided the initial contributions to the development of the bibliometric and scientometric areas ^[10]. In the 1960s, these fields experienced significant growth due to their methods

and the interest in using their techniques ^[10].

There have been attempts to measure the scientific impact based on download and citation data and correlate them in various fields, given that most publications are now available in digital format. It is important for science to assess the value of information, whether by quantifiable means or by means of perception. Evaluating bibliometrics through downloads requires different standards than citation metrics. While Darmoni *et al.* (2000) ^[11] and Bollen *et al.* (2009) ^[12] report that downloads do not largely correspond to the impact factor, Schloegl and Gorraiz (2011) ^[13] calculate a strong correlation between citation and download frequency, when absolute values are used, and a moderate to strong correlation between the number of downloads and citation.

The activities of producing quantitative indicators in science, technology and innovation have been strengthening in the country over the last decade, with the recognition of the need by the Federal and State governments, and the national scientific community, to have tools for defining guidelines, allocating investments and resources, formulating programs, and evaluating activities related to scientific and technological development in the country ^[14].

Moreira, Vilan Filho, and Mueller (2015) ^[15] state the importance of studying the field of Information Science, considering its contribution to facilitating processes of searching, using, mediating, and sharing scientific information for the construction of citizenship, following multidisciplinary principles for knowledge building. Presenting the dynamics of scientific production of research groups in a specific field of knowledge may help in understanding how this field has evolved, or even justify the number of existing postgraduate programs. Researchers and experts have shown a growing interest in quantitative data that assists in understanding the dynamics of science and technology ^[16].

3. Methodology

This study adopts a quantitative methodological approach with the bibliometric technique, as it aimed to measure indices of scientific knowledge production and dissemination. Bibliometrics is a quantitative and statistical technique for measuring the indices of scientific knowledge production and dissemination (Fonseca, 1986). The analysis procedure was conducted through descriptive statistics. The primary data source used was the BDTD database (Brazilian Digital Library of Theses and Dissertations), covering the period from 1979 to 2019 (all the theses and dissertations registered in the database), as well as research conducted on the platforms BDTD, BRAPCI, Lattes, Publish or Perish, and Google Scholar. The research universe encompasses all doctoral theses and master's dissertations from the Postgraduate Program in Information Science present in the BDTD database of the Brazilian Institute of Information in Science and Technology (IBICT).

The methodological procedures used and their stages include a data collection of theses and dissertations from the BDTD platform, through advanced search, using the search arguments: "Information Science," "All fields," "All terms," and "limit search to Document Type" and "thesis/dissertation" and "Postgraduate Program in Information Science." These filters were defined to obtain data on the theses and dissertations between 1979 and 2019, the period that encompasses the time frame of the research.

For the data collection regarding downloads, the same BDTD platform was used, accessing the chosen option "thesis/dissertation," selecting the "download full text" function, and then choosing the "view statistics" option. This allowed access to information about the number of times the theses and dissertations defined within the research scope were downloaded, based on the search arguments defined for the study.

In order to obtain the data collection on citation, searches were conducted using different platforms. In BRAPCI, the title of the thesis/dissertation was entered in the "search" field, and then the time frame was defined (1979–2019). In the Lattes platform, in the "search curriculum" field, the search mode "subject" was selected to include the titles of the theses/dissertations. Using the software Publish or Perish, it was

possible to access other platforms such as CrossRef, Google Scholar, Google Profile, Microsoft Academic, Scopus, and Web of Science. Thus, the retrieved titles of the theses and dissertations and their citations were included for conducting the searches.

After collecting the reference data for the research, a comparison was made between the frequency and the number of citations and downloads of the theses and dissertations over the proposed period (1979–2019). The MS Excel software was used for data tabulation and descriptive statistical analysis.

4. Analysis of citations and downloads of theses and dissertations in Information Science

Considering the theses as a subgroup of this research, the entire research period and the total quantity of theses, the set counted 91,672 downloads. Likewise, considering the entire research period and the total quantity of theses, the set counted with 433 citations.

Regarding the theses, the total number of documents registered in the BDTD database is 135. Out of this total, 57 theses have been cited at least once, while 78 have not accumulated any citations. The theses that have been downloaded at least once amount to a total of 126, and those that have not been downloaded sum up to 9. **Table 1** shows the relationship between the number of theses retrieved in the BDTD and the number of citations and downloads.

Table 1. Relationship between theses, citations and downloads

Parameter	Qty	%
Cited theses	57	42%
Uncited theses	78	58%
Downloaded Theses	126	93%
Undownloaded thesis	9	7%
Total of registered theses	135	100%

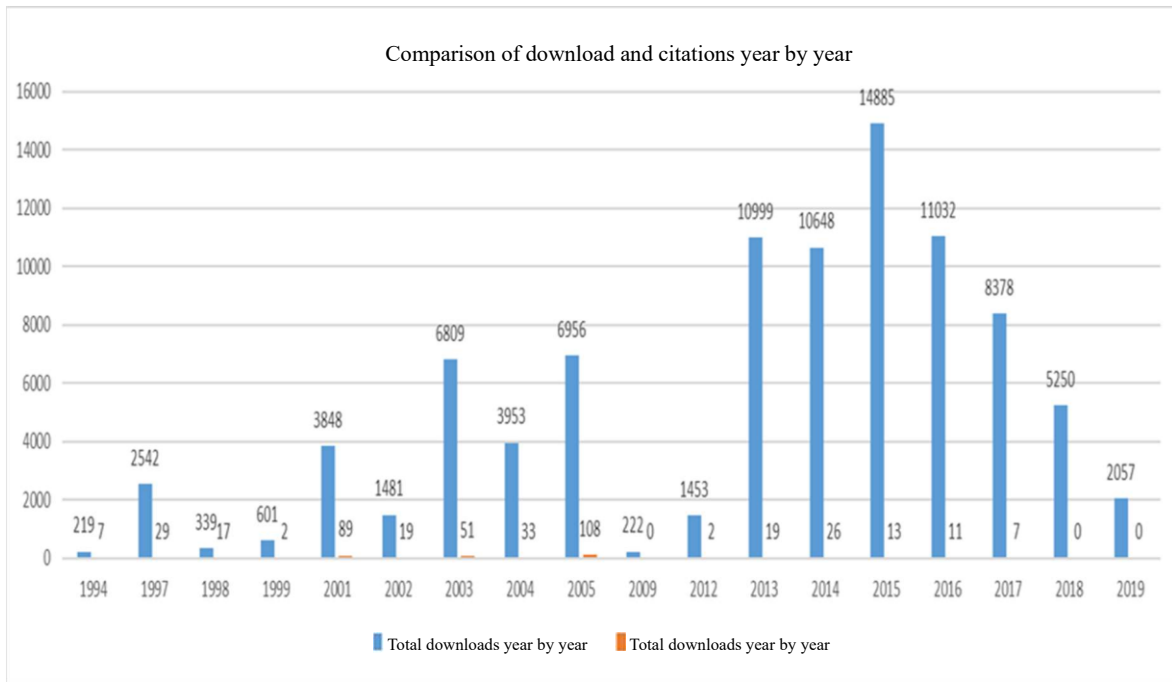
Percentage-wise, the theses cited at least once represent 42% of the total theses contained in the database, while 58% do not receive a single citation. The theses with downloads, percentage-wise, correspond to 93% of the total included in the BDTD, while only 7% of them have not been downloaded, considering the date of the research (2021).

As illustrated in **Graph 1**, the year 2005 accumulated the highest number of citations, 108 in total, representing 25% of the total citations in the studied subset (theses). On the other hand, the year 2015 recorded the highest number of downloads, with 14,885 downloads, approximately 16% of the total theses with downloads. In this scenario, the number of theses with downloads surpasses the number of theses with citations.

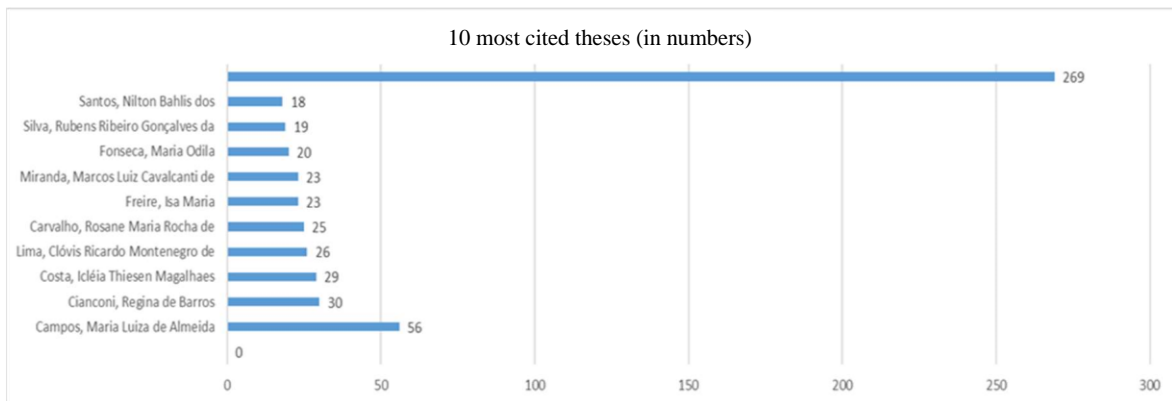
Graph 2 shows the 10 most cited theses considering the time frame of the research. These 10 theses together, add up to 269 citations, representing 62% of the overall total of citations (433).

Graph 3 presents the 10 theses with the most downloads. The 10 theses together, add up to 27,144, downloads, representing about 30% of total downloads (91,672).

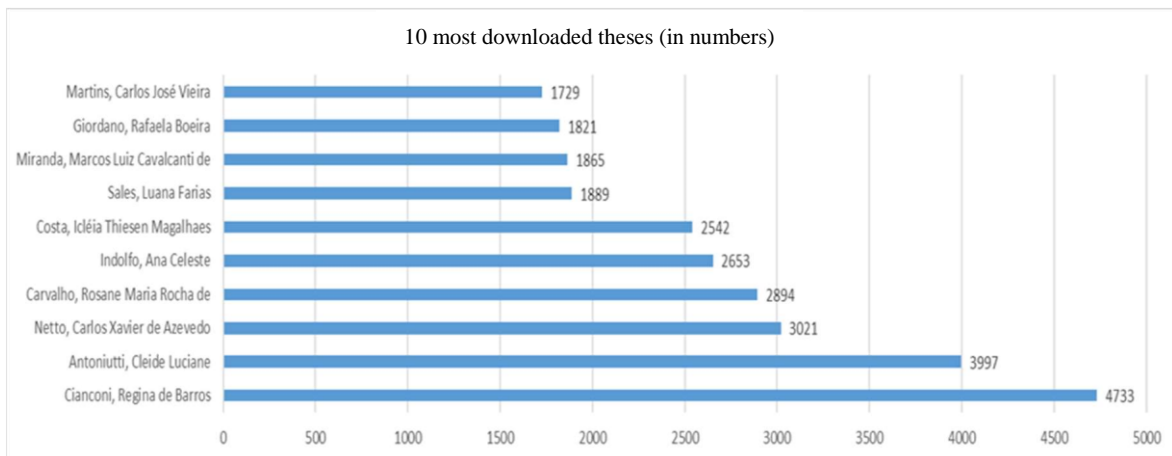
Deepening the analysis of **Graph 2** and **Graph 3**, it can be observed that four authors of the most cited theses also appear on the list of the top 10 authors with theses having the most downloads: Cianconi, Regina de Barros (2003); Costa, Icléia Thiesen Magalhaes (1997); Carvalho, Rosane Maria Rocha de (2005); and Miranda, Marcos Luiz Cavalcanti de (2005).



Graph 1. Relationship between downloads and citations of theses per year, according to BDTD



Graph 2. 10 most cited theses (in numbers)



Graph 3. 10 most downloaded theses (in numbers)

Table 2. Thesis title organized by date and metrics (download and citation)

Title	Author	Publi	Down	Cit
Theoretical and instrumental configurations for aerotropolis strategic information analysis: An interdisciplinary flight	Martins, Carlos José Vieira	2016	1729	0
From newspaper to science: The Brazilian digital library as a source of information for scientific research	Giordano, Rafaela Boeira	2016	1821	0
Uses of Big Data in electoral campaigns	Antoniutti, Cleide Luciane	2015	3997	0
Semantic integration of scientific publications and research data: Proposal of an extended publication model for the Nuclear Sciences Area	Sales, Luana Farias	2014	1889	13
Political-archival dimensions of document evaluation in the Federal Public Administration (2004–2012)	Indolfo, Ana Celeste	2013	2653	12
The Information Science and the holographic paradigm: the utopia of Vannevar Bush	Santos, Nilton Bahlis dos	2005	385	18
Knowledge organization and representation: theoretical and methodological foundations in information search and retrieval in virtual environments	Miranda, Marcos Luiz Cavalcanti de	2005	1865	23
The transformations of the relation museum and public: the influence of information and communication technologies in the development of a virtual public	Carvalho, Rosane Maria Rocha de	2005	2894	25
Information regulation of supplementary health care	Lima, Clóvis Ricardo Montenegro de	2005	102	26
Archivology and Information Science: (RE)definition of interdisciplinary frameworks	Fonseca, Maria Odila	2004	1122	20
Knowledge management: Vision of individuals and organizations in Brazil	Cianconi, Regina de Barros	2003	4733	30
Digitalization of public photographic collections and their institutional and social consequences: Technology and awareness in the digital universe	Silva, Rubens Ribeiro Gonçalves da	2002	1154	19
The social responsibility of Information Science and/or the look of the possible-conscience on the scientific field	Freire, Isa Maria	2001	293	23
The organization of knowledge units in hyperdocuments: The conceptual model as a communicational space for authorship	Campos, Maria Luiza de Almeida	2001	279	56
Rock art in Brazil: Issues of information transfer and representation as a path to interpretation	Netto, Carlos Xavier de Azevedo	2001	3021	2
Institutional memory: The conceptual construction in a theoretical and methodological approach	Costa, Icléia Thiesen Magalhaes	1997	2542	29

Note: Publi = Date of publication; Down = Quantity of downloads per thesis; Cit = Quantity of citations per thesis.

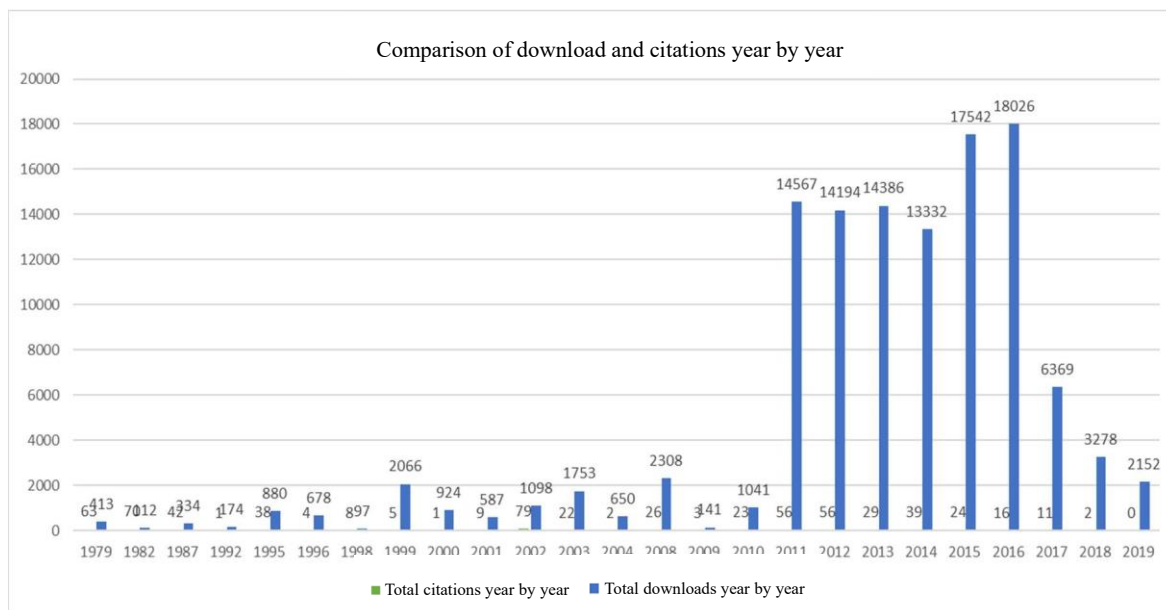
Table 2 is organized by the year of publication and presents a compilation of the ten most cited theses with the ten theses with the most downloads, considering the time frame of the study, based on data from BDTD. Categorizing the titles by thematic unit, it is possible to verify that the theses with more citations and downloads had addressed, at least, the following topics over time: Information management; Information sources; Scientific production; Archival science; Organization and representation of

information; Information and communication technology; Memory, society and information. This may indicate trends or preferences for research topics in the field, with more recent theses focusing on themes related to information management; information sources; scientific production; and information and communication technology.

With dissertations as a subset of this research, considering the entire research period and the total amount of dissertations, there was a total of 117,594 downloads. Likewise, considering the entire research period and the total number of dissertations, the subset had 631 citations.

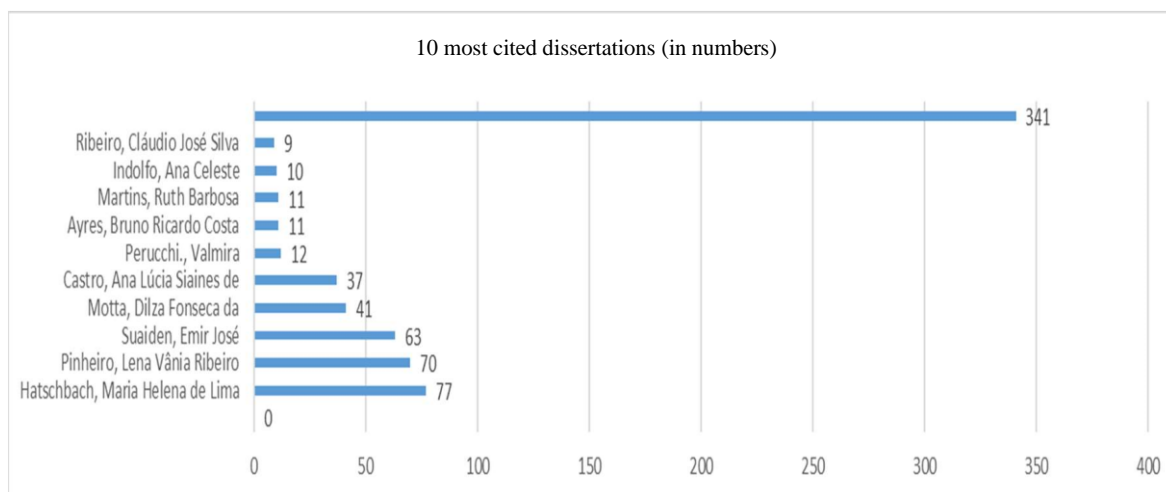
Regarding dissertations, the total number of dissertations registered in BDTD is 355. Among these, 145 dissertations were cited at least once, and 210 have not received any citations. Dissertations with at least one download totaled up to 345, while those without any downloads amount to 10. Percentage-wise, the dissertations cited at least once represent 41% of the total base, while 59% did not receive any citations. Dissertations with downloads, percentage-wise, accounted for 97% of the total dissertations in BDTD, while only 3% of them have not been downloaded, considering the research’s time frame.

The year 2002 accumulated the highest number of citations, as shown in **Graph 4**, with a total of 79 citations, representing approximately 13% of the total citations. The year 2016 recorded the highest number of downloads, with 18,026 downloads, accounting for about 15% of the total dissertations downloaded. The number of dissertations downloaded surpasses the number of dissertations cited.

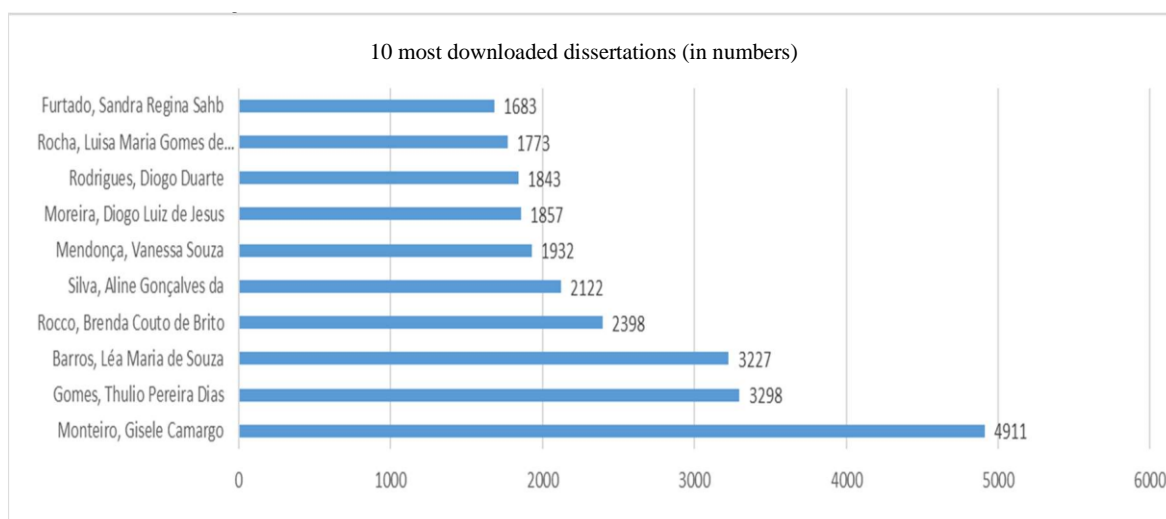


Graph 4. Download and citation ratio of dissertations per year, according to BDTD

The 10 most cited dissertations (**Graph 5**) together total 269 citations, representing 62% of the overall total of citations. On the other hand, the 10 dissertations with the most downloads sum up to 27,144, which is approximately 30% of the total downloads. None of the authors of the dissertations among the top ten most cited appear among the 10 authors with the most dissertation downloads (**Graph 6**).



Graph 5. 10 most cited dissertations (in numbers)



Graph 6. 10 most downloaded dissertations (in numbers)

The 10 most cited dissertations gathered 341 citations, representing 54% of the total citations (631). On the other hand, the 10 most downloaded dissertations gathered 25,044 downloads, representing 21% of the total downloads (117,594). **Table 2** presents a list of the 10 dissertations with the highest number of citations, organized in descending order of citations. It is possible to notice, from the analysis of the titles of the dissertations, the following thematic units of the field of Information Science: informational literacy; representation and organization; memory and society; information and communication technologies; and scientific production.

Table 3 presents the list of the top 10 dissertations with the highest number of downloads, organized in descending order of downloads. From the analysis of the titles of these dissertations, it is possible to identify at least the following thematic areas in the field of Information Science: information literacy competence; organization and representation of information; information management; open data; information literacy; memory and society.

Table 2: List of the 10 most cited dissertations, by title, citation and publication

Title	Author	Publi	Cit
Information literacy: conceptual aspects and initiatives in the digital environment for higher education students	Martins, Carlos José Vieira	2002	77
Bradford's Law: a conceptual reformulation	Giordano, Rafaela Boeira	2016	70
Brazilian public library: performance and perspectives	Antoniutti, Cleide Luciane	2015	63
The relational method as a new approach to thesaurus construction	Sales, Luana Farias	2014	41
The museum: from sacred to secret: an approach on museum information and communication	Indolfo, Ana Celeste	2013	37
Production indicators of the research groups of the Federal Institute of Education, Science and Technology of Paraíba.	Santos, Nilton Bahlis dos	2005	12
Information, Volunteering and Digital Networks	Miranda, Marcos Luiz Cavalcanti de	2005	11
The transformations of the relation museum and public: the influence of information and communication technologies in the development of a virtual public	Carvalho, Rosane Maria Rocha de	2005	11
The use of archival standards in the Brazilian State: an analysis of the Federal Executive Branch ¹⁰	Lima, Clóvis Ricardo Montenegro de	2005	10
In search of knowledge organization: the management of information in Brazilian Social Security databases using the domain analysis approach	Fonseca, Maria Odila	2004	9

Note: Publi = Date of publication; Cit = Quantity of citations per dissertation

Table 3: List of the 10 most downloaded dissertations, by title, citation and publication

Title	Author	Publi	Cit
The school library in the formation of information competencies: contributions and perspectives in libraries of Colégio Pedro II	Martins, Carlos José Vieira	2016	4911
A charge é o assunto: análise documentária de charge	Giordano, Rafaela Boeira	2015	70
Folksonomy as a collaborative classification practice for information retrieval	Antoniutti, Cleide Luciane	2011	3298
A study on digital archival document management in the Brazilian federal public administration	Sales, Luana Farias	2013	3227
The public library as a factor of social and digital inclusion: a study of the Biblioteca Parque de Manginhos	Indolfo, Ana Celeste	2012	2398
Competence in information and profile of librarians in the Health Sciences Area: investigating university hospitals	Santos, Nilton Bahlis dos	2015	2122
A Panorama of the use of open government data in Brazil: a study from the applications developed	Miranda, Marcos Luiz Cavalcanti de	2015	1932
Information Science and web design: theoretical intersections in search of better practices	Carvalho, Rosane Maria Rocha de	2016	1843
Museum, information and communication: the process of museumographic discourse construction and its strategies	Lima, Clóvis Ricardo Montenegro de	1999	1773
Quality of life of the elderly: proposal for the improvement of indicators	Fonseca, Maria Odila	2013	1683

Note: Publi = Date of publication; Down = Quantity of downloads per dissertation

5. Final considerations

The objective of this study was to present a bibliometric analysis of the relationships between citations and downloads of theses and dissertations from postgraduate programs in Information Science registered in the BDTD of IBICT, covering the period from 1979 to 2019, as an alternative to assess the correspondence between the number of downloads and the number of citations.

The study found that the number of downloads of theses and dissertations is much higher than the number of citations. However, based on the data presented, it is not possible to assert that theses and dissertations with the highest number of downloads are also the ones with the highest number of citations. Similarly, it cannot be confirmed that the most cited theses and dissertations are the most sought-after in the database. Only four authors of theses appear among the 10 most downloaded/cited theses: Cianconi, Regina de Barros (2003), Costa, Icléia Thiesen Magalhaes (1997), Carvalho, Rosane Maria Rocha de (2005), and Miranda, Marcos Luiz Cavalcanti de (2005), while among the dissertations, none of the authors are present in both lists simultaneously. Based on the results of this study, it can be concluded that, in most cases, the most downloaded works are not necessarily the most cited ones.

The theses of the Postgraduate Program in Information Science (135 registered in BDTD) were cited 433 times, and downloaded 91,672 times. The dissertations of the Postgraduate Program in Information Science (355 registered in the BDTD) were cited 631 times and the number of downloads was 117,594. Percentage-wise, the theses were cited more frequently (42%) than the dissertations (41%), while the opposite is true for the download rate. The dissertations had a higher percentage of downloads (97%) compared to the theses (93%).

The year 2005 had the most cited theses, and accumulated the highest number of thesis downloads. For dissertations, the year 2002 had the most citations, whereas the highest number of downloads occurred in 2016. The highest number of citations for both theses and dissertations are from years prior to those with the highest number of downloads. Four authors of the most cited theses also appear in the list of theses with the highest number of downloads. Based on this factual relation, it is important to evaluate in future studies whether the time of publication of theses and dissertations is a determining factor for their citation or download rates. According to this study, the citation and download rates vary from year to year, without necessarily decreasing or increasing over time.

The focus of this study was not to evaluate the preference of the scientific community for works with more citations or higher download numbers. However, this qualitative analysis is important for future studies. On the other hand, it is possible to categorize the subjects presented in the titles of the most cited theses and dissertations and those with the highest number of downloads, in order to enumerate thematic units that seem to point to preferred themes in the field of Information Science, such as information literacy, information organization and representation, information management, open data, information literacy, memory and society, archiving, information management, and scientific production, for example. Other related works can be evaluated, such as investigating whether the most cited theses and dissertations have generated scientific articles published in journals with a reference qualification. A significant portion of the Brazilian scientific production in the Information Science field consists of journal articles and postgraduate works at various levels. By studying these communication channels, we can understand aspects of the scientific community, facilitating decision-making for managers and scientists regarding administrative, funding, or research-related issues.

Disclosure statement

The author declares no conflict of interest.

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