REUNIR:
Magazine of Administration, Accounting Sciences and Sustainability

www.reunir.revistas.ufcg.edu.br

ORIGINAL ARTICLE: Submitted in: 10.04.2022. Validated on: 03.13.2023. Apt for publication in: 07.01.2023. Responsible Organization: UFCG.

Network governance and public policies on sustainability: a bibliometric study

Governança de redes e políticas públicas de sustentabilidade: um estudo bibliométrico

Gobernanza en red y políticas públicas de sostenibilidad: un estudio bibliométrico

Gabriela Araújo Romão
Administration Graduation Program (PPGADM/UFG)
Universidade Federal de Goiás – UFG
Rua 3, nº 256, Qd. H, lote 28, Setor Leste Universitário,
Goiania/GO, 74615-070.
biromao@gmail.com
https://orcid.org/0000-0001-8098-0771

Estela Najberg
Administration Graduation Program (PPGADM/UFG)
Universidade Federal de Goiás – UFG
Campus Samambaia – FACE, Setor Nova Veneza,
Goiania/GO, 74001-970.
estelanajberg@gmail.com
https://orcid.org/0000-0002-2852-4442

KEY WORDS
Network governance.
Public policies on sustainability.
Bibliometric.

Abstract: Public policies on sustainability are characterized by intersectoriality and the engagement of multiple actors working together toward common goals. Network governance addresses the interconnection of actors through various networks in order to achieve stipulated goals; in this sense, it is worth investigating the possibility of reviewing public policies on sustainability based on network governance. It is in this context that this article seeks to understand the scenario of scientific production on network governance with emphasis on public policies on sustainability. The Scopus database was used as a research source. Exploratory, descriptive research with a quantitative approach was adopted, with a systematic search and bibliometric analysis. The categories of analysis were divided into descriptive and of networks. For the former, results found concern historical, geographic and academic variables. The latter investigated the networks of co-authorship, co-citation and co-occurrence of keywords. Research in the field of network governance is in full progress, with a gradual increase in annual publications. Most studies focus on the European continent, North America and Australia. There is strong integration between the field of network governance and the areas of public administration and public policies, in addition to studies linked to sustainability policies, especially those related to climate change and sustainable development. However, there are several gaps to be filled and research opportunities to be seized in the area of network governance with an emphasis on sustainability policies, especially linked to the Brazilian context.

PALAVRAS-CHAVE
Governança de redes.
Políticas públicas de sustentabilidade.
Bibliometria.

Resumo: *As políticas públicas de sustentabilidade são caracterizadas pela intersetorialidade e o envolvimento de múltiplos atores que trabalham juntos em prol de objetivos em comum. A governança de redes aborda a interconexão de atores por meio de várias redes objetivando alcançar metas estipuladas; nesse sentido, cabe investigar a possibilidade de analisar políticas públicas de sustentabilidade a partir da governança de redes. E é nesse contexto que o presente artigo busca compreender o cenário das produções científicas relacionadas à governança de redes com ênfase nas políticas públicas de sustentabilidade. Para isso, foi utilizada como fonte de pesquisa a base de dados Scopus. Foi adotada a pesquisa exploratória, descritiva, de abordagem quantitativa, com busca sistemática e análise bibliométrica. As categorias de análise foram divididas em descritiva e de redes. No que tange à primeira categoria, os resultados encontrados vinculam-se às variáveis histórica, geográfica e acadêmica. Em relação à segunda, foram investigadas as redes de coautoria, cocitação e coocorrência de palavras-chave. Conclui-se que as pesquisas no campo de governança de redes estão em plena evolução, com aumento gradativo de publicações anuais. A maioria dos estudos concentra-se no continente europeu, América do Norte e Austrália. Verifica-se forte integração entre o campo de governança de redes com as áreas de administração pública e políticas públicas, além de estudos vinculados às políticas de sustentabilidade, principalmente aquelas relacionadas às mudanças climáticas e ao desenvolvimento sustentável. Constatam-se, no entanto, diversas lacunas e oportunidades de pesquisa na área de governança de redes com ênfase em políticas de sustentabilidade a serem preenchidas, sobretudo atreladas ao contexto nacional.*

PALABRAS CLAVE
Gobernanza de la red.
Políticas públicas de sostenibilidad.
Bibliometria.

Resumen: *La políticas públicas de sostenibilidad se caracterizan por la intersectorialidad y el involucramiento de múltiples actores que trabajan juntos hacia objetivos comunes. La gobernanza en red aborda la interconexión de actores a través de varias redes para lograr los objetivos estipulados; en este sentido, vale la pena investigar la posibilidad de analizar políticas públicas de sostenibilidad basadas en la gobernanza en red. Y es en ese contexto que este artículo busca comprender el escenario de las producciones científicas relacionadas con la gobernanza en red con énfasis en las políticas públicas de sostenibilidad. Para ello se utilizó como fuente de investigación la base de datos Scopus. Se adoptó una investigación exploratoria, descriptiva, con abordaje cuantitativo, con búsqueda sistemática y análisis bibliométrico. Las categorías de análisis se dividieron en descriptivo y redes. Respecto a la primera categoría los resultados encontrados están vinculados a variables históricas, geográficas y académicas. En cuanto a la segunda, se investigaron las redes de coautoría, cocitación y coocurrencia de palabras clave. Se concluye que la investigación en el campo de la gobernanza de redes se encuentra en plena evolución, con un aumento paulatino de publicaciones anuales. La mayoría de los estudios se centran en el continente europeo, América del Norte y Australia. Existe una fuerte integración entre el campo de la gobernanza en red con las áreas de administración pública y políticas públicas, además de los estudios vinculados a las políticas de sostenibilidad, especialmente las relacionadas con el cambio climático y el desarrollo sostenible. Existen, sin embargo, varios vacíos y oportunidades de investigación en el área de gobernanza de redes con énfasis en políticas de sostenibilidad por llenar, especialmente vinculadas al contexto nacional.*

Introduction

Globalization unleashed deep social, economic and environmental changes in the last five decades. In the corporate world, productive and administrative techniques have been modified as a result of enhanced integration, flexibility and interdependence between different global markets. Similarly, the environmental issue has been incorporated into the international debates mainly due to the dangers linked to nuclear pollution and environmental disasters of global proportions. In Brazil, policies on sustainability were inserted into public agendas in a latent way, especially since the 2000s, with the formulation and implementation of several public policies such as sanitation policy, solid waste, water security, among others. In this context, the concept of sustainability is not limited to the environmental sphere, as it also covers the economic and social spheres, seeking a sustainable balance between these three pillars of development.

Since the 1990s, the introduction of new forms of management adaptable to decentralization and cooperation, effective changes in the design of public policies, as well as innovative forms of partnerships between business organizations and State entities led to effective transformation in the role played by the State (Fleury & Ouverney, 2007). Governance thus emerged as a new way of governing the promotion of various public services since the Traditional Public Administration model has proved insufficient to solve increasingly complex adversities (Klijn & Koppenjan, 2016).

Governance can be conceptualized in different ways and is linked to the area of knowledge under study. However it is generally understood as a system that coordinates social groups, institutions and actors aimed at achieving particular goals, collectively defining and discussing in fragmented and uncertain environments (Le Galès, 2011). It can also be understood from four dominant meanings: a) governance as 'corporate governance'; b) governance as New Public Management; c) governance as multi-level governance or intergovernmental relations, and; d) governance as network governance, referring to something that occurs within networks of public and non-public actors and their interactions, besides focusing on complex interactions between actors (individuals, groups, organizations and groups of organizations) (Klijn & Koppenjan, 2016). The latter meaning of governance is the focus of this paper.

In the discussion about network governance, one should point out that the term 'network' has different meanings directly dependent on the area under analysis; however, for the purposes of this research the concept of public policy is explained and could be understood as "the integrated, stable and lasting relationships between governmental and non-governmental actors, which provide an environment in which the interests of the State are defined and a policy paradigm prevails" (Menahem, 1998, p. 285). Despite the robust literature about the relevance of public policy networks, few studies approach the governance of these networks. Calmon and Costa (2013), mention that such a scarcity could be explained by the secular dominance of research based on the monopoly of power and traditional hierarchical structures in public administration.

Public policies on sustainability, in particular, are characterized by intersectoriality and involve several actors in different areas of activity. These aspects are similar to the principles claimed by the theory of network governance, a perspective that led

to the following question: What is the scenario of scientific productions on network governance with emphasis on public policies on sustainability? In order to answer this question, the context of scientific production in the Scopus database was investigated. This choice was justified by the multidisciplinarity and functionalities in the production of bibliometric reports. The objective of this research is thus to understand the scenario of scientific productions related to network governance with an emphasis on public policies on sustainability.

This article consists of six chapters, the first of which is this introduction. The second one presents the main aspects of network governance and public policies on sustainability. Next, the methodological procedures are presented and, then, the analysis and discussion of the results. Finally, the final considerations and references are presented.

Network governance and policies on sustainability

The term 'governance' is polysemic and encompasses several fields of knowledge. Roth, Wegner, Antunes and Padula (2012) understand governance as the definition of methods for decision-making, rules, limits of autonomy, responsibilities and action of participants. Governance also refers to all governmental processes practiced by a government, market or network, whether over a tribe, family, conventional or informal organization and regardless if through norms, laws, power or language (Bevir, 2012). The author also points out that the organizational structure of governance takes three forms: hierarchy, markets and networks. Hierarchy brings the traditional format of bureaucratic coordination, in which the governance structure is given by authority, and conflicts are solved through rules and command, while culture comes from subordination. In the markets-oriented structure, governance is based on prices, conflicts are solved through bargaining, and culture is represented by competition. The structure of networks, in turn, addresses governance through relationships of trust, ways of resolving conflicts through diplomacy and culture is based on reciprocity. Governance concerns an important mechanism for networks to take root, be formed and consolidated.

Networks can be conceptualized in different ways; however, according to Wachhaus and Harrisburg (2009) it is a new way of arranging collective action, i.e., they derive from a situation of interdependence between actors in which the joint exchange of resources and information facilitates fulfilling collective objectives. Thus, the governance of networks gives effect to the commitment of actors toward generating the results for which the network was built, through a system designed to develop relational and social capital that are crucial for the network improvement and consolidation (Alvarez et al., 2010; Bernstein, 2015; Storey et al., 2018; Tang et al., 2017; Willem & Gemmel, 2013).

Specific approaches may be employed to analyze governance, including the public policy network approach that is characterized by the analysis centered on the process and structure in which public policies are constituted, i.e., in their formulation and delivery that occur in a political atmosphere that faces more and more institutional changes (Fleury, 2005; Procopiuck & Frey, 2009). Thus, the governance of public policy networks can support and assist in the understanding of different government programs, including public policies on sustainability.

In recent decades, society has experienced several transformations in different sectors of analysis. In this context of changes public policies have been studied by several authors, who have defined it in different ways. According to Souza (2006), the best-known concept remains that of Laswell (1958), who defines public policy as the answer to the following questions: who gets what? Why? And what difference does it make? The author also mentions that the essence of public policy is intertwined with the State, which is responsible for deciding on the usability of resources for the benefit of citizens. Similarly, Boneti (2012) understands public policy as the consequence of the dynamics of the game of forces that occur based on power relations between political, economic groups, social classes and other civil society organizations. Such relations establish several actions attributed to the state institution, which directs investments aiming at modifying social reality. Finally, a way of understanding public policies is through examples that, in the case of this work, is explaining the sustainability policies.

Sustainability concerns the quality of a process related to the inseparable integration (human and environmental), and evaluates its characteristics and properties, encompassing social, economic and environmental aspects. This evaluation takes place at a given moment, i.e., its quality at that moment, although the system is complex and dynamic. The assessment is based on indicators and/or indices, and results in quantitative information. This information enables the establishment of goals and objectives that should be achieved through long-term strategies (Feil & Schreiber, 2017). According to the authors, sustainable development can be understood as a long-term strategy to improve the well-being of society. This strategy should address economic, social and environmental aspects, especially the limitations of the latter due to access to natural resources in a perpetual and continuous manner, i.e., sustainable development is the passport to sustainability.

The environmental theme started being incorporated into international debates from the 1950s on, with the prominence of nuclear pollution. According to Machado (2005), the occurrence of radioactive rain thousands of kilometers away from the sites where the tests were performed demonstrated the importance of discussing the dangers on a global scale linked to these practices. In addition, several environmental disasters preceded the risks caused by nuclear pollution, for example, the explosion of a ship loaded with ammonium nitrate in Texas, United States, in 1947, causing the death of more than 500 individuals, in addition to 3,000 injured (Barsano & Barbosa, 2019).

Several international meetings were held as of the 1970s, notably the creation of the World Commission on Environment and Development (WCED). The commission prepared a report (Our common future) aimed at establishing a global agenda for change, and defined the concept of sustainable development, which aims to meet the needs of the present without compromising the ability of future generations to meet their own needs. Another event worth mentioning is the Rio-92, whose most important results were the outlining of the Convention on Biodiversity and Climate Change - which gave rise to the Kyoto Protocol - Agenda 21 and the Rio Declaration (Nascimento, 2012). The event also defined a set of indicators to measure the progress of sustainable development regarding the Sustainable Development Goals (SDGs) that started being debated in 2015 (Silva, 2021). The SDGs encompass 17 goals, including: life in water, action against global

climate change, clean water and sanitation, zero hunger and sustainable agriculture, health and well-being, and poverty eradication, among others. To that, the 193 Member States of the United Nations (UN) are expected to meet these goals by the year 2030 (Brasil, 2021).

As of the environmental conventions initiated in the 1970s, several countries began to formulate and implement environmental public policies in order to protect and preserve the environment. In this sense, Europe was a pioneer, as evidenced by the outlining and approval by the European Council of the First Community Action Program on the Environment, implemented between 1973 and 1977 with the aim of increasing the quality of life of the continent's citizens. Between 1983 and 1987, the program underwent its third update and started encompassing principles linked to the integration of environmental policies (Oliveira, 2003). Still according to the author, the fifth program was presented after Rio-92, aiming at the implementation by the whole community of actions to reduce pollution in sectors such as energy industry, agriculture, transportation, etc. The European countries entered other treaties in the following decades, which culminated in policies aimed at environmental protection and preservation, in addition to the strengthening of community institutions toward establishing a legal system aimed at ensuring the centralization of decisions for the benefit of the environment (Diz & Orantes, 2012).

In Brazil, public policies on sustainability have undergone several changes over time. However, the 1980s are a highlight, with the enactment of the National Environmental Policy in 1981 that established the principles, instruments and guidelines for the federative entities that operate in environmental policy. Another highlight in that decade was the promulgation of the 1988 Constitution, considered to be the "Green Constitution" for exposing, in an innovative way, the constitutionalization of the right of all to the balanced environment (Brasil, 1981; Brasil, 1988). However, it is since the 2000s that public policies on sustainability have been highlighted in the country with the enactment, for example, of policies on basic sanitation, solid waste and more intrinsic policies such as public policies developed for the semi-arid region (directly linked to water and climate issues), which are characterized by their transversality, added with the horizontalization and coordinative verticalization with the participation of the three federative entities, public-private partnerships, in addition to popular action in the implementation process.

Methodological elements of the research

This study is exploratory and descriptive in nature, as it aimed to investigate the context of scientific productions in the field of network governance research with an emphasis on public policies on sustainability (Saunders et al., 2009), in addition to describing the characteristics of the data collected (Collis & Hussey, 2005). A quantitative approach was adopted, in addition to a bibliographic survey based on bibliometric analysis. According to McBurney and Novak (2002), bibliometrics can be understood as a set of statistical methods to ascertain the progress of science by evaluating the publication performance of institutions and authors, in addition to mapping the dynamics and structures of research fields through data extracted from different documents. Bufrem and Prates (2005) state that the bibliometric study deals with the statistical analysis of the characteristics of publications, i.e., predict and

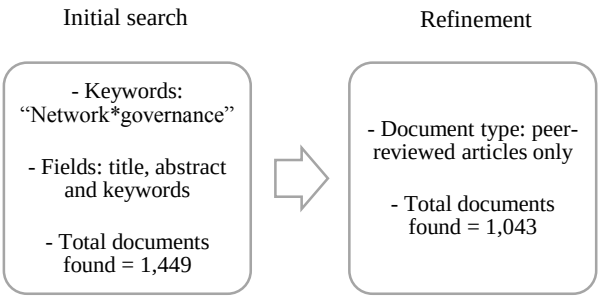
describe the scientific dissemination in a given area of knowledge, verifying behaviors evidenced by the three laws of bibliometrics that, according to Glänzel (2003), can be presented as:

- Lotka's Law or Inverse Square Law (1926): explains that a limited number of researchers produce a high number of articles in a given field of knowledge, on the other hand, a large volume of researchers produces little, i.e., the number of authors who publish *n* articles is equal to 1/n2 of the authors who publish only one article. This law allows measuring the researchers' productivity (Machado Junior et al., 2016).
- Bradford's Law or Law of Dispersion (1934): exposes the degree of importance of journals that operate in specific fields of knowledge. According to this principle, the first articles published on a given topic are submitted to a limited number of journals. Therefore, the acceptance of these works encourages other researchers to submit their articles to these scientific journals (Machado Junior et al., 2016). Therefore, Bradford's Law intends to measure the productivity of journals.
- Zift's Law or Law of Minimum Effort (1949): measures the frequency in which some words appear in different texts, generating a structured list of terms in a specific subject or field of study.

In addition, technological advances gave rise to new techniques that complement the three original laws, including the mapping of networks of co-citation, co-authorship and keyword co-occurrence (Bufrem & Prates, 2005). According to Van Eck and Waltman (2014), co-citation is about measuring relationships between two articles based on the number of publications in which they are cited concurrently; co-authorship presents how researchers connect according to the number of publications they produce in partnership and, finally, co-occurrence demonstrates the frequency with which two keywords are used simultaneously, presenting research themes.

The systematic search process initially occurred in the choice of the Scopus database. This decision is justified by the functionalities of this database in producing bibliometric reports, in addition to being an indexer of works from different fields of study. Then, the keyword was chosen, which in this case was "network governance". Figure 1 shows the search script:

Figure 1
Survey script



Source: Own elaboration (2022).

Database was searched on April 21, 2022, and the only refinement applied was the type of document, selecting only peer-reviewed articles. It is worth mentioning that in a first search the keyword "bibliometric*" was added to the search string, i.e., TITLE-ABS-KEY ("network*governance AND "bibliometric*), but no document was found. Due to the number of keywords that head the theme of public policies on sustainability, it was decided not to include the topic in the research script, but to discuss it based on an analysis developed in each variable presented in the next chapter of this work.

For the descriptive data analysis the

reports produced by Scopus were used and data was processed using the Excel software. The Mendeley reference manager software was also used to deepen the articles review. For the analysis of bibliometric networks, the text mining software VOSviewer 1.6.18 was used.

Presentation and discussion of results

To understand the scenario of scientific productions related to network governance with emphasis on public policies on sustainability, the research categories were divided into:

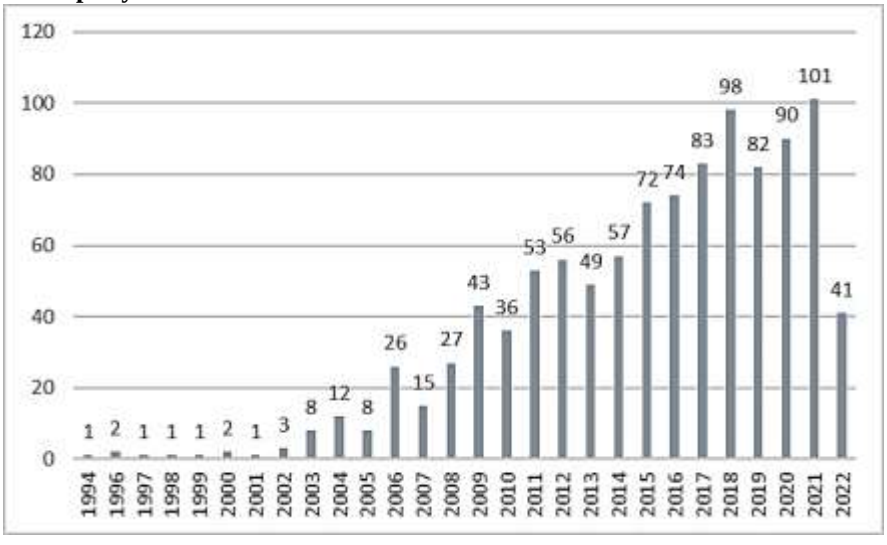
1) Descriptive analysis: historical, geographical and academic overviews.

2) Bibliometric network analysis: co-authorship, co-citation and co-occurrence of keywords.

Descriptive Analysis:
Historical Overview

To understand the evolution of production in the field of network governance, the first variable analyzed refers to the volume of publications per year, with reference to data obtained from the Scopus database. The information presented in Figure 2 suggests that the literature on network governance begins to emerge in 1994, but until 2002 there is a limited number of publications, ranging from 1 to 3. Between 2003 and 2005 there was a considerable increase compared to previous years, with 8, 12 and 8 publications respectively; it is from 2008 on, with 27 papers, that the volume of publications becomes more consistent, despite some decreases in specific periods. It can be seen, for example, that between 2011 and 2018, the number of publications jumped from 53 to 98, despite the decrease in studies published in 2019 and 2020, with 82 and 90, respectively. The year of 2021 was when most articles in the field were published, with 101 papers. The average number of publications from 1994 to 2022 was 37.25 articles per year.

Figure 2
Number of publications per year



Source: Own elaboration based on the Scopus.

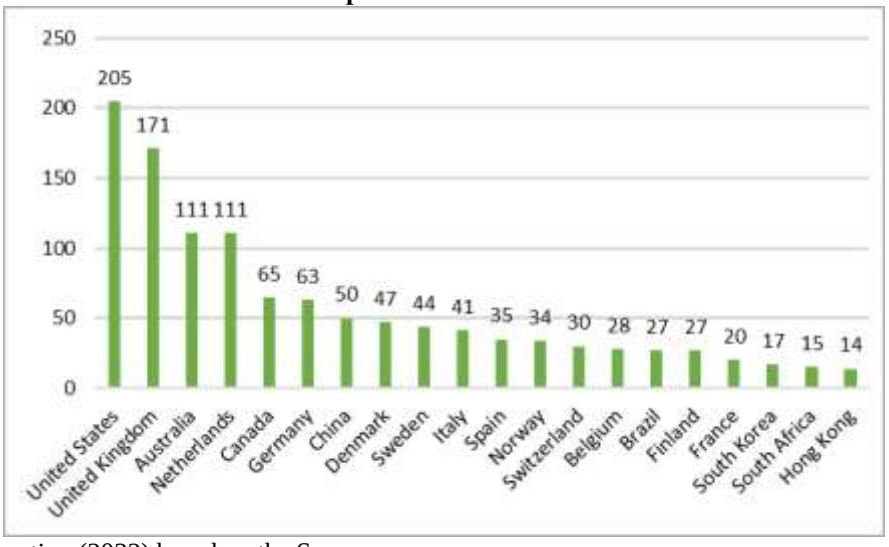
The data presented in Figure 2 also show that interest in the field of knowledge has remained over time, evidencing its relevance and importance. It is worth mentioning that the topic continues to be in evidence since only this year (until April 21), 41 articles have already been published, pointing to new investigations on the nature of network governance. With regard to the combination of network governance with an emphasis on the area of public policies on sustainability, the first article was published in 2004 (article of Australian origin, theme referring to water resources policy) and, in Brazil, only in 2017 (study on local sustainable development policies).

Geographical Overview

As regards the origin of the 1,043 publications found in the Scopus database, studies are spread over 75 countries, and 23 papers did not bring information about the country of origin. Figure 3 shows the number of publications from the 20 countries that published the most in the field of network governance.

The information presented suggests that most studies were produced in the European continent, although the United States (205 articles) and Canada (65 articles) rank, respectively, the first and the fifth in number of publications. In second place comes the United Kingdom, with 171 studies published, followed by Australia and the Netherlands with the same number of publications (111 articles). Brazil occupies the fifteenth position with 27 works published, being the only country representing Latin America. A deeper study points out that the first article of Brazilian origin seems to have been published in 2012, showing that the field of network governance is relatively new in the country; the year 2020 represents the largest number of Brazilian publications, with 6 articles.

Figure 3
Number of publications of the 20 countries that publish the most



Source: Own elaboration (2022) based on the Scopus.

When reviewing the combination of network governance and public policies on sustainability, it appears that the United States was the country that published the most articles

(35), followed by Australia, with 23 and Germany, with 15. Brazil published 5 articles on this theme, accounting for 18.5% of the total number of articles published in the country. This information shows that there is a research gap in the field and new studies may emerge based on the national context.

Academic Overview

Regarding the authorship of the 1,043 articles, 160 authors work in several institutions located in different countries. Table 1 shows the main researchers who have published in the field of network governance. A deeper consultation was also carried out on each of these authors in order to understand whether studies have been developed in the area of policies on sustainability. Of the eleven researchers cited, three have published works on the environmental theme, namely: Torfing, J., Kapucu, H., and Sørensen, E. The topics were: energy transition, innovation system and sustainability; climate change and adaptation; and energy transition, innovation system and sustainability, in that order; however, none of these studies is directly related to the works developed in the field of network governance.

Table 1 shows that the researcher who published the most was Torfing J., with 8 studies, followed by Turnbull, S., with 7 articles published. The researcher Wegner, D., with 5 studies published, is the only Brazilian representative in the ranking of the main authors in the field. This information shows that this researcher was responsible for 18.5% of the articles of Brazilian origin; however, the author's research is not linked to the environmental theme. Another relevant point of analysis is that most of the 160 researchers in the area have published only one article, which confirms Lotka's Law.

Table 1
Main authors

Author	Number of articles	Affiliation	Country
Torfing, J.	8	Roskilde Universitet	Denmark
Turnbull, S.	7	International Institute for Self-governance	Australia
Kapucu, N.	6	University of Central Florida	The United States of America
Davies, J.S.	5	De Montfort University	United Kingdom
Everingham, J.A.	5	The University of Queensland	Australia
Kenis, P.	5	Tilburg School of Economics and Management	The Netherlands
Klijn, E.H.	5	Erasmus Universiteit Rotterdam	The Netherlands
Lewis, J.M.	5	School of Social and Political Sciences	Australia
Pirson, M.	5	Fordham University	The United States of America
Sørensen, E.	5	Roskilde Universitet	Denmark
Wegner, D.	5	Unisinos University	Brazil

Source: Own elaboration (2022) based on the Scopus.

The results presented in Table 1 can also be analyzed by cross-checking the data

obtained in Table 2, i.e., which are the ten most cited papers in the
field of network governance. The article with the highest number of citations (1,779) is attributed to the authors Provan, K. G., and Kenis, P., but only the second one is listed as the main author in the field. The first author in the ranking presented in the previous table, i.e. Torfing, J., appears in fifth place as co-author, however. The researcher Sørensen, E., can be found in Table 1 and Table 2, both as one of the main authors, with 5 articles published, and as the author of two of the most cited articles.

In relation to the environmental theme, three articles deal with the area, being them: "*Multi-stakeholder partnerships for sustainable development: Rethinking legitimacy, accountability and effectiveness*" by Backstrand, K.; "*Using collaboration as a governance strategy: Lessons from six watershed management programs*", de Imperial M.T.; and "*The globalization of organic agro-food networks*" by Raynolds, L.T., evidencing the relevance of the theme in the context of networks governance.

Table 2
Most cited works

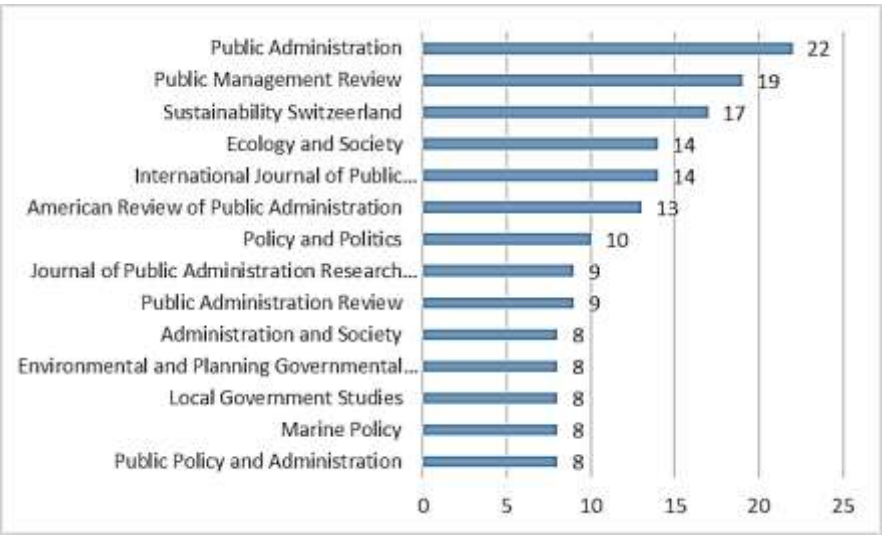
Order	Author(s)	Article title	Year	Number of citations
1	Provan, K.G., Kenis, P.	*Modes of network governance: Structure, management, and effectiveness*	2008	1779
2	Jones, C., Hesterly, W.S., Borgatti, S.P.	*A general theory of network governance: Exchange conditions and social mechanisms*	1997	1446
3	Rhodes, R.A.W.	*Understanding governance: Ten years on*	2007	735
4	Stoker, G.	*Public value management: A new narrative for networked governance?*	2006	710
5	Sørensen, E., Torfing, J.	*Making governance networks effective and democratic through metagovernance*	2009	500
6	Backstrand, K.	*Multi-stakeholder partnerships for sustainable development: Rethinking legitimacy, accountability and effectiveness*	2006	408
7	Imperial M.T.	*Using collaboration as a governance strategy: Lessons from six watershed management programs*	2005	342
8	Raynolds, L.T.	*The globalization of organic agro-food networks*	2004	321
9	Sørensen, E.	*Metagovernance: The changing role of politicians in processes of democratic governance*	2006	320
10	Ball, S.J.	*Privatising education, privatising education policy, privatising educational research: Network governance and the 'competition state'*	2009	286

Source: Own elaboration (2022) based on the Scopus.

Another variable analyzed refers to the journals that publish studies in the field of network governance. Figure 4 shows the main journals and the number of articles published in each of them. The journals "Public Administration", "Public Management Review" and "Sustainability Switzerland" stand out with 22, 19, and 17 articles published, respectively. Based on the cross-referencing of the information in Table 2 and Figure 4, the ten most cited articles were published in most of the main journals, confirming Bradford's Law. It is worth mentioning that the fourteen journals presented

are mainly targeted to the area of Public Administration and Public Policy, with emphasis on the specific field of sustainability.

Figure 4
Main journals



Source: Own elaboration (2022) based on the Scopus.

The last descriptive analysis developed in this work deals with the 20 main keywords present in the studies found in the Scopus database and that respond to Zift's Law. Data obtained in Table 3 allowed not only considering the information presented in the previous illustrations, but also understanding the interdisciplinarity of the theme, i.e., to which areas of the study the network governance is more strongly linked. The keyword "network governance" presented the highest number of occurrences (315), followed by "governance approach" (246 occurrences), "governance" (182 occurrences) and "networks" (78 occurrences). When analyzing the subsequent keywords, studies oriented to sustainability are relevant since of the 20 keywords with the highest number of occurrences, 3 of them ("climate change", "sustainability" and "sustainable development", with 38 occurrences each) deal with this specific area. Graph 2 shows that most studies are produced in Europe and the United States, presenting 69 (Europe and Europe Union) and 34 occurrences, respectively.

In Brazil, of the 5 articles found relating the environmental theme to network governance, 1 article portrays the initiative of policies on sustainable local development in Brazil; 2 articles analyze waste collection and treatment policies; 1 article addresses landscape restoration in the Brazilian Amazon taking into account climate change, and the last study deals with the recovery process of the Doce River basin. There are several possibilities for studies in this field of research such as, for example, linked to the Sustainable Development Goals (SDGs) that encompass the implementation of climate policies, renewable energies, water security, basic sanitation, among others.

Table 3
Main keywords present in the studies found in the Scopus database

Order	Keywords	Occurrences in Scopus
1	*network governance*	315
2	*governance approach*	246
3	*governance*	182
4	*networks*	78
5	*human*	54
6	*network analysis*	52
7	*article*	46
8	*decision making*	45
9	*humans*	40
10	*innovation*	39
11	*climate change*	38
12	*sustainability*	38
13	*sustainable development*	38
14	*Europe*	37
15	*stakeholder*	35
16	*democracy*	34
17	*United States*	34
18	*collaboration*	33
19	*social network*	33
20	*European Union*	32

Source: Own elaboration (2022) based on the Scopus.

Bibliometric Networks Review:

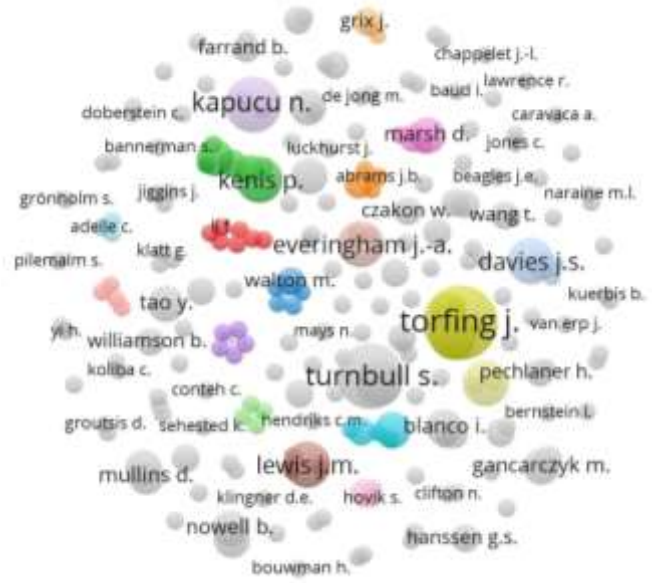
Co-authorship Bibliometric Networks Review

Based on the export of the 1,443 articles from the Scopus database to the VOSviewer software, the following commands were selected to review the co-authorship networks: articles with more than 25 authors were not considered, and the author should necessarily have published at least 2 articles even if their names were not cited. Following both commands, only 227 authors met these requirements out of a total of 2,121 authors (considering authors and co-authors), confirming Lotka's Law once again. The individual analysis of co-authorship links resulted in 127 clusters and 135 links.

There is a considered amount of small clusters (of the 127, only 2 clusters have the co-authorship link of 7 authors, 4 clusters are composed of 5 authors, 6 clusters are formed by 4 authors and 11 clusters are formed by 3 authors, while the rest of the clusters have between 1 and 2 co-authorship links). This result shows that few authors are co-authors of a large number of papers. The cross-referencing of data in Tables 1 and 2 (i.e., main authors and most cited papers with the information from the co-authorship networks) allows highlighting some authors, including Torfing J., number 1 in the ranking of the authors who publish the most in the area and author of one of the most cited papers in the field of network governance. This author has co-authorship links with 4 other authors, including Sørensen, E., who also participates in both rankings. Other authors with important influence in the field of study of this research also build co-authorship links, such as Turnbull S. with Pirson M.

One of the criteria for the analysis of the country co-authorship network was the minimum number of articles published per country equal to 4. Based on that, of the 97 countries that have published in the field of network governance, only 35 met this criterion. The network presents 6 clusters with 206 links; the cluster with the largest grouping of items is formed by: Austria, Denmark, Finland, France, Italy, Netherlands, New Zealand, Spain and Sweden; the cluster with the smallest grouping of items is composed of: Brazil, Chile, Japan and United Kingdom, i.e. these countries have stronger links with each other than with different clusters.

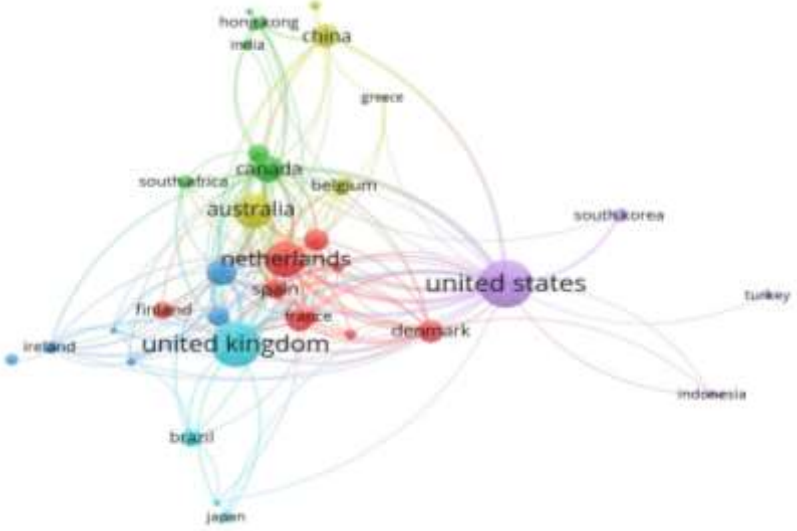
Figure 5
Map of co-authorship networks between authors



Source: own elaboration (2022) from VOSviewer.

The countries publishing the most in the area of network governance also have the highest number of co-authorship links with other nations, and this result is in line with the information presented in Figure 3, which presents the countries that publish the most in the field of study.

Figure 6
Map of co-authorship networks between countries



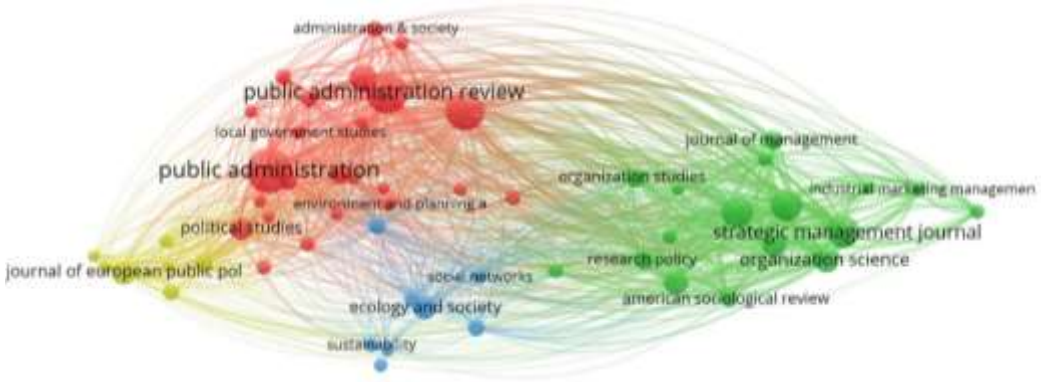
Source: Own elaboration (2022) based on the VOSviewer.

Co-authorship Bibliometric Network Review

This analysis presents the most cited journals in the field of study of network governance, and identifies the strength of link that indicates the connection between them. In this study, the minimum of 75 co-citations was defined for integration of the source into the co-citation network. Of the 26,527 sources, only 56 were co-cited at least 75 times, and the journals that did not fit this criterion were excluded. In turn, each node shown in the network refers to a journal; the size of the node shows the number of citations the journal received. The proximity of the journals shows a stronger relationship than those that are further away.

Figure 7 shows 4 clusters based on the total strength of the link between journals. Different clusters present different groupings: the red cluster is grouped in 24 items, the green cluster has 17 items, the blue cluster has 8 items and the yellow cluster has 7 items, i.e., the journals grouped in the same cluster show the strength of the link between them, which expresses the frequency with which two or more journals appear simultaneously in a publication. This journal co-citation network also demonstrates and confirms the information presented in Figure 4 which shows that the main journals (Public Administration, Public Administration Review and etc.) are the most cited and have the highest number of links with other journals.

Figure 7
Map of co-authorship networks in journals



Source: Own elaboration (2022) based on the VOSviewer

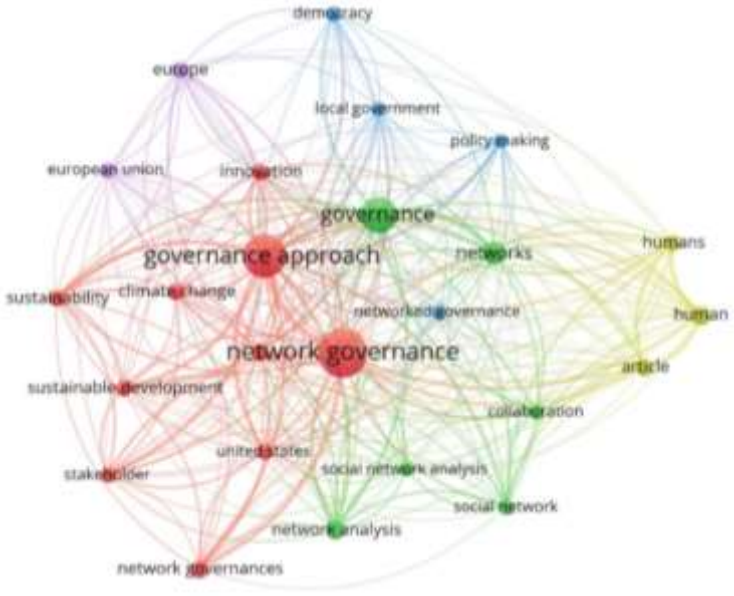
Co-occurrence Bibliometric Network Review

The search found 4,402 keywords in the 1,443 articles presented in the Scopus database. For the creation of the keyword co-occurrence network, the criterion of minimum occurrence was set at 30, i.e., only keywords that were cited at least 30 times were reviewed. This requirement reduced the number of words to 25.

Figure 8 shows the creation of 5 clusters in which the 25 items are grouped. It should be noted that the link between the occurrence of keywords is stronger when they belong to the same cluster. The cluster with the largest number of items consists of 10 keywords, namely: climate change, decision making, governance approach, innovation, network governance, stakeholder, sustainability, sustainable development, United States. This result unveils the themes with greatest connection with each other, in addition to demonstrating an important concentration of network governance research linked to the area

of sustainability, as shown in Table 3, referring to the main keywords found in the Scopus database.

Figure 8
Map of keyword co-occurrence networks



Source: Own elaboration (2022) based on the VOSviewer.

Final Considerations

The objective of this work was to understand the scenario of scientific productions related to network governance with an emphasis on public policies on sustainability. To that, bibliometric analyses were made based on the data obtained by the Scopus database. The results were presented through four categories: historical, geographic, academic and bibliometric networks of co-authorship, co-citation and co-occurrence of keywords. Regarding the historical analysis, there has been a gradual increase in publications since 1994 and, despite decreasing oscillations in specific years, such growth demonstrates the relevance of the theme and the possibility of new studies of this nature.

Regarding publications related to policies on sustainability, the first publication dates back to 2004, while in Brazil the first publication was not before 2017, indicating that this is still a recent research area, especially in Brazil. In the geographic overview, we sought to review the number of publications by country, highlighting the top 20 countries that publish the most. Results show that most studies are concentrated on the European continent, notably the United Kingdom, the Netherlands and Germany; however, the United States, Canada and Australia emerge as important centers outside Europe. It should be noted that Brazil occupies the fifteenth position, being the only representative of Latin America. With regard to articles addressing public policies on sustainability, the United States, Australia and Germany have a considerable volume of publications, evidencing that this theme stands

out in those countries. In Brazil, only 5 articles were found proving the existence of a research gap in the area.

The academic overview allowed identifying the researchers who publish the most, and also understanding that none of them published articles in the area of sustainability linked to the field of knowledge about network governance. In Brazil, the author Wegner D, affiliated with the institution Unisinos, has 5 publications in the field, accounting for 18.5% of all the Brazilian publications. Another variable analyzed refers to the 10 most cited works, highlighting 3 of them that deal with policies on sustainability. The third analysis in the academic overview discloses the most important journals, noting that the fields of study covering public administration, public policies and sustainability gather a relevant number of articles. Finally, the last variable interpreted deals with the 20 main keywords disclosed in the 1,143 articles, showing that the themes related to sustainability, sustainable development and climate change gather a considerable amount of research linked to network governance.

The analysis of the co-authorship bibliometric networks of authors confirmed a considerable number of links between them, but presented limited clusters showing that few authors are co-authors of other works. The co-authorship network by country confirmed that those who publish the most also have the highest number of co-authorship links with other nations. Regarding the analysis of the journals' co-citation network, it is confirmed that the main journals are the most cited and have relevant links with other journals. Finally, the last network reviewed addressed the co-occurrence of keywords, and demonstrated the concentration of themes on sustainability policy linked to the field of network governance.

As a research limitation, we highlight the use of only one database to analyze the panorama of scientific productions in the field of network governance, which may have limited the number of national studies. Another limiting issue corresponds to the difficulty in developing the research script using keywords linked to the theme of public policies on sustainability, which may have altered, even to a limited extent, some of the figures presented in this research.

As a contribution to future studies, it is suggested that new research be carried out based on the analysis of the governance of networks of public policies on sustainability in the Brazilian context, since there are several gaps to be filled in this field of study, as in the themes related, for example, to the Sustainable Development Goals (SDGs).

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