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Bitcoin: behavior, profile, and trends of scientific production in Brazil

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Authors' Notes

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Abstract

Study Objective: Investigate the profile and trend of scientific production as well as the structure and formation of social networks on the topic of *bitcoin* within Brazil's academic literature.

Methodology/Approach: To achieve this, bibliometric and sociometric techniques were applied to 83 studies identified on the subject.

Originality/Relevance: Its uniqueness lies in being the most comprehensive review article to date on academic research regarding the topic of bitcoin in Brazilian academic literature, as viewed through journals indexed in the SPELL database.

Main Findings: There is a growing trend of the *bitcoin* topic within brazilian academia. The most frequently used keywords were: *blockchain*, cryptocurrency, *bitcoin*, technology, model, innovation, digital, market, accounting, and chain; while those with the highest *degree* were: *blockchain*, *bitcoin*, cryptocurrencies, cryptocurrency, innovation, *smart contract*, accounting, technology, and supply chain management.

Theoretical/Methodological Contributions: This study addresses the subject of *bitcoin* using sociobibliometric techniques, contributing to a more realistic and contemporary perspective on the mentioned topic, and subsequently aiding its growth within Brazilian academia.

Social Contributions/Management Implications: The relevance of the *bitcoin* topic in academia provides a contribution to society as a whole. This research will enhance understanding and comprehension not only for individuals, readers, and the academic community, but also for managers and decision-makers in organizations who wish to improve, delve deeper, and consequently invest in this cryptocurrency.

Keywords: bitcoin, SPELL, brazilian journals, scientific production, structure and formation of social networks

Bitcoin: comportamento, perfil e tendência da produção científica no Brasil

Resumo

Objetivo do estudo: Investigar o perfil e a tendência da produção científica e de sua estrutura e formação das redes sociais sobre o tema *bitcoin* na literatura acadêmica do Brasil.

Metodologia/Abordagem: Para tanto, utilizou-se das técnicas da bibliometria e da sociometria em 83 estudos identificados sobre o referido assunto.

Originalidade/Relevância: Se encontra em seu ineditismo, pois, até o presente tempo, este é o artigo de revisão mais completo sobre a pesquisa acadêmica a respeito do tema bitcoin na literatura acadêmica brasileira à luz dos periódicos indexados na base de dados SPELL.

Principais resultados: Tendência de crescimento do tema *bitcoin* na academia brasileira. As palavras-chave mais usadas foram: *blockchain*, criptomoeda, *bitcoin*, tecnologia, modelo, inovação, digital, mercado, contabilidade e cadeia; e as com maior *degree* foram: *blockchain*, *bitcoin*, criptomoedas, criptomoeda, inovação, *smart contract*, contabilidade, tecnologia e gestão da cadeia de abastecimento.

Contribuições teóricas/Metodológicas: Este estudo aborda o assunto *bitcoin*, mediante as técnicas sociobibliométricas, contribuindo para uma visão mais real e contemporânea sobre o citado tema, colaborando, posteriormente, para seu crescimento na academia do Brasil.

Contribuições sociais / Para a gestão: O fato do tema *bitcoin* ser atual na academia, enseja uma contribuição para a sociedade como um todo, visto que esta pesquisa contribuirá para fomentar melhor o entendimento e compreensão, não somente para as pessoas, leitores e a comunidade acadêmica, mas, também, para os gestores e tomadores de decisões de organizações que desejam se aperfeiçoar, se aprofundar, e, por consequência, investir nesta criptomoeda.

Palavras-chave: bitcoin, SPELL, periódicos brasileiros, produção científica, estrutura e formação das redes sociais

Bitcoin: comportamiento, perfil y tendencia de la producción científica en Brasil

Resumen

Objetivo del estudio: Investigar el perfil y tendencia de la producción científica y su estructura y formación de redes sociales sobre el tema bitcoin en la literatura académica en Brasil.

Metodología/Enfoque: Para ello se utilizaron técnicas bibliométricas y sociométricas en 83 estudios identificados sobre el tema.

Originalidad/Relevancia: Es único porque, hasta la fecha, es el artículo de revisión más completo sobre investigaciones académicas sobre el tema bitcoin en la literatura académica brasileña a la luz de las revistas indexadas en la base de datos SPELL.

Principales resultados: Tendencia de crecimiento del tema bitcoin en la academia brasileña. Las palabras clave más utilizadas fueron: blockchain, criptomoneda, bitcoin, tecnología, modelo, innovación, digital, mercado, contabilidad y cadena; y los de mayor titulación fueron: blockchain, bitcoin, criptomonedas, criptomoneda, innovación, contratos inteligentes, contabilidad, tecnología y gestión de la cadena de suministro.

Contribuciones Teóricas/Metodológicas: Este estudio aborda el tema de bitcoin, utilizando técnicas sociobibliométricas, contribuyendo a una visión más real y contemporánea del tema antes mencionado, contribuyendo posteriormente a su crecimiento en la academia en Brasil.

Aportes sociales / Para la gestión: El hecho de que el tema bitcoin esté de actualidad en la academia brinda un aporte a la sociedad en su conjunto, ya que esta investigación contribuirá a una mejor comprensión y comprensión, no solo de las personas, lectores y comunidad académica, sino también de directivos y tomadores de decisiones de organizaciones que deseen mejorar, profundizar y, en consecuencia, invertir en esta criptomoneda.

Palabras clave: bitcoin, SPELL, publicaciones periódicas brasileñas, producción científica, estructura y formación de redes sociales

1 Introduction

As one of the disruptive technologies of the fourth industrial revolution, *blockchain* has definitively changed the way people live and work (Luo, Hu & Bai 2021). Given this, it is understood as a decentralized and distributed database technology that operates in a trustless manner (Guo, Huang, Guo, Guo, Li, Liu, Ezzeddine & Nkeli, 2021). Thus, *bitcoin* emerges as a relatively young and rapidly growing

research topic, which is based on *blockchain* technology. As a result, the terms *bitcoin* and *blockchain* are intrinsic, as the analysis of *blockchain* technology gained popularity following the introduction of bitcoin in 2008 by Satoshi Nakamoto (pseudonym) (Merediz-Solà & Bariviera, 2019; Moura, Brauner & Muniz, 2020; Bruzgė & Šapkauskienė, 2021; Eça, Costa & Oliveira, 2023), through the publication of the *White Paper* titled "*bitcoin*: a *peer-to-peer electronic cash system*," which began the discussion on the possibility of establishing a new digital currency that is uncontrolled and not issued by a financial institution, thereby creating a decentralized network (Bitcoin, 2008; Ribeiro, 2019; Aysan, Demirtaş & Saraç, 2021).

It is emphasized that the nodes of the *bitcoin* network incorporate mutually agreed validations in the *blockchain*; thus, *bitcoin* is a cryptocurrency that adopts *blockchain* technology, which offers transparency and decentralization, eliminating third-party involvement in financial transactions (Firdaus, Razak, Feizollah, Hashem, Hazim & Anuar, 2019; Rocha, Oliveira & Talamini, 2021). Such a panorama demonstrates and materializes the progress of new technologies, highlighting cryptocurrencies in the economic field, especially concerning *bitcoin* (García-Corral, Cordero-García, Pablo-Valenciano & Uribe-Toril, 2022). This advancement is due to its transparency, portability, and divisibility. Then, the cryptocurrency market gained enormous support from investors and traders worldwide (Pattnaik, Hassan, Dsouza, Tiwari & Devji, 2023).

That said, it is evident that this topic is a developing social phenomenon, attracting significant research attention and contributing to the formation of a new area of study in the past decade (Guo & Donev, 2020), especially considering that *bitcoin* was the first decentralized cryptocurrency, thus being a pioneer in cryptocurrency markets, both in terms of market capitalization and in the interest of scientific research (Aysan, Demirtaş & Saraç, 2021). In summary, it is observed that there is a strong interaction between the topics of *bitcoin*, *blockchain*, and cryptocurrencies, the cryptocurrency represents a shift in the *design* of the financial system infrastructure, and *bitcoin* is the cryptocurrency that attracts the most attention in this regard, consequently, it is the most used in capitalization markets, utilizing technology with peer-to-peer money transactions (*peer-to-peer* = P2P), which are stored in a data block structure

called *blockchain* (Merediz-Solà & Bariviera, 2019; Ramona, Cristina & Raluca, 2019; Alsmadi, Alrawashdeh, Al-Dweik & Al-Assaf, 2022; Senna & Souza, 2023).

Given the above, it is evident that the topic of *bitcoin* has been gaining increasing attention and space in companies and global scientific literature due to its disruptive potential and interdisciplinary nature, this has led to the publication of studies on *bitcoin* in various fields of knowledge, such as computer science, business, management, economics, finance, law, sociology, among others (Wang & Hausken, 2024). Therefore, it is understood and asserted that in the favorable field of *bitcoin* research, a state-of-the-art understanding of knowledge over time is necessary (Rejeb, Rejeb, Alnabulsi & Zailani, 2023) which is currently lacking in Brazilian academia.

Thus, the research question of this study emerged: What is the behavior, profile, and trend of scientific production, and its structure and formation of social networks on the topic of *bitcoin* in the academic literature of Brazil? To, help address this issue, the objective was to investigate the profile and trend of scientific production, and its structure and formation of social networks on the topic of *bitcoin* in the academic literature of Brazil. In this regard, it is emphasized that this research will not only improve the understanding of the *bitcoin* topic in the Brazilian academic context but also help trace its evolution, underpinning, stimulating, and guiding new academic investigations on the subject. Additionally, it is noted that scientific journals were used to search for studies on the *bitcoin* topic, and their selection was due to their importance and relevance for the dissemination and socialization of research results and contributions, therefore, they are considered the main means of scientific communication in academia (Rodrigues & Fachin, 2010).

It is found that review research published in journals in the scientific literature explored, mapped, investigated, and analyzed the topic of *bitcoin* from different perspectives, using various databases, especially international ones, such as *Web of Science* (WoS), *Scopus* e *Ebsco* (Merediz-Solà & Bariviera, 2019; Ramona, Cristina & Raluca, 2019; Ribeiro, 2019; Ribeiro, 2020; Aysan, Demirtaş & Saraç, 2021; Puspita & Devi, 2023; Rejeb *et al*., 2023; Wang & Hausken, 2024). However, none of these studies focused on investigating the scientific research on the topic of *bitcoin* within the Brazilian academic

landscape. Therefore, the relevance of this current research lies in its originality, as up to the present moment, and as far as is known, this is the most comprehensive longitudinal study on scientific research regarding the topic of *bitcoin* within the Brazilian academic context, through the lens of journals indexed in the data platform *Scientific Periodicals Electronic Library* (SPELL).

It is emphasized that, to address the research question and achieve the research objective respectively, bibliometrics was used, which is an excellent technique for investigating the growth tendency of a specific academic topic, such as *bitcoin* (Bruzgė & Šapkauskienė, 2021; Luo, Hu & Bai, 2021), through the mapping of academic information from well-established databases in scientific research (Nasir, Shaukat, Khan, Hameed, Alam & Luo, 2021). It is reiterated that bibliometric research is validated as a technique upon verifying that published studies have used it to investigate recent topics in academia, such as *blockchain* technology*, big data, the internet* of things, among others (Sultan, Routroy & Thakur, 2023).

And Social Network Analysis (SNA), which is fundamentally based on sociometry and graph theory (Garcia & Menezes, 2022), allows for the investigation of the structure and formation of network relationships as a whole, subgroups of actors, and individual actors within a specific collaboration network (Bordin, Gonçalves & Todesco, 2014; Favaretto & Francisco, 2017). Therefore, it is emphasized that research employing methodologies using bibliometrics and SNA or sociometry (Ribeiro, 2023a), in the organization of the concept of sociobibliometric maps, indicate the complementarity of these two techniques (Machado Junior, Souza & Parisotto, 2014). It is noted here that sociometry means the measurement of the social (Oliveira, Souza & Castro, 2014), justifying its use in this study.

The choice of SPELL is justified because it is a scientific database that indexes open-access Brazilian journals in the fields of Administration, Accounting, and Tourism. It is owned by the National Association of Graduate Programs and Research in Administration (ANPAD), which is the association of *stricto sensu* graduate programs in these fields of knowledge and was responsible for the dissemination of SPELL throughout Brazil. SPELL currently hosts more than 55,000 documents, 41 million accesses, and

14 million *downloads*. It is further noted that SPELL was created by the Brazilian scientific community to fill the gap observed in databases and indexers focused on national journals (Rossoni & Rosa, 2024).

Thus, based on inclusive logic, SPELL was launched in mid-2012 to incorporate the majority of journals in the aforementioned areas, providing free access to all published articles on a single data platform. This allows scholars to search and research studies based on topics and terms. In this way, all journals, regardless of their classification, have the same visibility in the SPELL database, being evaluated based on the perceived quality of their publications, rather than the journal classification imposed by the *Qualis* system of the Coordination for the Improvement of Higher Education Personnel (CAPES) (Rossoni & Rosa, 2024).

This research contributes in the following aspects: (i) to the academic literature of Brazil by conducting a contemporary sociobibliometric investigation of publications within the research panorama on the topic of *bitcoin* from the perspective of journals indexed in SPELL; (ii) to help researchers better understand the evolution and *status quo* of research on *bitcoin*, providing *insights* for future studies; (iii) to serve as a basis for future research collaborations and knowledge exchange in the field of *bitcoin* among researchers and their corresponding Higher Education Institutions (HEIs); (iv) to investigate the co-occurrence of keywords in *bitcoin* research, facilitating the identification of themes and potential pathways for future research; and (v) to provide a comprehensive overview of the Brazilian academic landscape on *bitcoin* research, generating insights into the evolution, trend patterns, and future efforts of academic work related to *bitcoin*.

2 Bitcoin

The development of the *internet* and technology in the world is evolving rapidly and exponentially in various fields, especially in the financial sector. That said, it is emphasized that the enhancement of technology in the financial sector has the basic objective of making the use of financial products easier, facilitating transactions for people. Therefore, technology in the financial domain is also beneficial because of its flexible nature, as there are few regulations, mitigating the rigidity found in other conventional businesses. Thus, the progress of new technologies is also present in the financial area,

affecting existing financial operations, which aim to facilitate their use by the public (Puspita & Devi, 2023).

In light of the above, *blockchain* is highlighted as a technology for storing information in transactional blocks that form chains, providing great credibility and security, and is widely used in cryptocurrency transactions (Senna & Ribeiro, 2023). *Blockchain* technology was popularized worldwide through *bitcoin*, being used as a cryptographic mechanism to disseminate financial transactions of digital currencies, such as *bitcoin* and other cryptocurrencies (Momo & Behr, 2019; Moura, Brauner & Muniz, 2020).

Consequently, *blockchain* technology has gained substantial recognition for its ability to induce transformation and innovation in existing environmental models and business structures. As a result, the application of this technology to the domain of management and its processes has attracted increasing interest from companies and academia (Tandon, Kaur, Mäntymäki & Dhir, 2021). It is reinforced that, from a technological standpoint, *blockchain* is an innovative paradigm, and cryptocurrencies are one of the most important areas where *blockchain* technology is used, *bitcoin* is the dominant actor, both in market capitalization and in academic literature interest (Aysan, Demirtaş & Saraç, 2021).

Since the creation of the digital cryptocurrency *bitcoin* in 2008, *blockchain* technology has positioned itself as a focal point of interest among a wide range of researchers and practitioners (Vianna, Silva & Peinado, 2020) being used primarily to assist in the functioning of financial institutions, such as data sharing, self-service, and facilitating communication between organizations or between an organization and its users. This allows for cost reductions in staffing and office materials, increased agility and modernization of services, and reduced bureaucracy, as has been observed in practice up to the present moment (Lopes, Castro & Russo, 2024).

It can be understood that *blockchain* is a ledger, thus linking it with Accounting. It is decentralized and stores all transactions made in a *peer-to-peer* network in a secure, verifiable, and transparent manner (Dornelles, Souza & Pain, 2023). Thus, the main advantage of *blockchain* over existing technologies is that it allows two or more interested parties to conduct transactions over the

internet (Garg, Shamshad, Gauhar, Tabash, Hamouri & Daniel, 2023), without the interference of any intermediary, as the omission of third parties can reduce processing costs while simultaneously improving the security and efficiency of financial transactions (Dabbagh, Sookhak & Safa, 2019).

In this context, *blockchain* technology has much to offer, but governments are cautious and uncertain about introducing it. This is because there is uncertainty about whether the technology is sufficiently developed to support critical issues in the social system or what unique issues might arise from this technology. Additionally, it is necessary to create an information management infrastructure, with clearly defined procedures so that information can be connected between different agencies and levels of the State (Lopes, Castro & Russo, 2024).

Thus, investments in cryptocurrencies have grown since the advent of *bitcoin*. Cryptographic currency (cryptocurrency) is a currency based on cryptography or digital currency. The birth of *bitcoin* was one of the main and preeminent foundations in establishing the reputation of cryptographic currency. Therefore, investing in cryptocurrencies can offer more security and substantial profits for investors, as in the cryptographic system, cryptocurrency is difficult to *hack.* Nonetheless, investing in cryptocurrencies can be disadvantageous, as it is a currency founded and guided by an insecure, volatile, and highly risky investment framework. Therefore, of these cryptocurrencies, the most popular is *bitcoin*, and its popularity and strength continue to increase (Oliveira, Carvalho & Sartorelli, 2020; Encinosa, 2021; Rahardja, Aini, Harahap & Raihan, 2021).

Bitcoin transactions are facilitated through the P2P network, resulting in lower transaction fees, faster processing times, and a certain level of anonymity for users. Consequently, the advent of *bitcoin* has had a substantial impact on the *FinTech* industry (responsible for automating financial services through technology), inspiring the creation of various P2P payment platforms. In summary, *bitcoin* functions as digital money, facilitating P2P transactions without the need for a central authority, such as a bank or government. This characteristic of *bitcoin* offers a degree of autonomy and freedom in personal financial management, which is not feasible with traditional currencies (Campos-Teixeira & Tello-Gamarra, 2022; Rejeb *et al*., 2023).

Additionally, the unique characteristics of *bitcoin* can be summarized as: (i) decentralized; (ii) does not require financial institutions or government; (iii) free from ties to monetary authorities; (iv) has no nationality; (v) no capitalization limit; (vi) user accounts cannot be blocked; (vii) acts as a currency, even though it is virtual; (viii) transactions and the storage of all types of data are recorded and secure; and (ix) the popularity of *bitcoin* is due to its anonymity, efficiency, and confidentiality (Castañeda-Ayarza, Neves & Teixeira, 2019; Rahardja *et al*., 2021). For this reason, *bitcoin* is considered a new class of investment asset, as its finite supply, coupled with increasing demand, induces considerable increases in its value, earning it the nickname "digital gold." Some investors perceive *bitcoin* as a hedge against inflation, similar to the historical use of gold.

It should be added that, eventually, the most significant social benefit of the cryptocurrency *bitcoin* is the protection of its users against inflation. Inflation refers to the increase in prices of goods and services, leading to consequences such as the decline in the purchasing power of the population, as the circulating currency depreciates in value. Therefore, in the case of the cryptocurrency *bitcoin*, being a currency that is independent and has no central authority to control its monetary base, the risk of inflation is mitigated or nonexistent (Boff & Ferreira, 2016).

Given the growing importance of *bitcoin*, academic research on the subject is increasing and resulting in the publication of a multitude of review articles that examine various nuances of *bitcoin* (Rejeb *et al*., 2023). Thus, below in Table 1, are some of these studies, which emphasize the respective objectives and main results of each.

Table 1

Review studies on the topic of bitcoin

Authors	Objective	Main Results
Merediz-Solà e Bariviera (2019)	They studied the scientific production on bitcoin.	The number of articles published on the topic of bitcoin has increased. The most related keywords were: cryptocurrencies, fintech, and peer-to-peer.
Ramona, Cristina e Raluca (2019)	They evaluated the literature on bitcoin based on the structures and formations of social networks.	There is a concentration of interest in the topics: bitcoin, cryptocurrencies, and blockchain. Research on bitcoin as an economic concept accounts for 33.5% of the total contributions in the area.
Ribeiro (2019)	Investigated the profile and behavior of international scientific production on the topic of bitcoin.	Evolution of the topic since 2013. The words that appeared most frequently in the titles of published studies were: bitcoin, blockchain, technology, cryptocurrency, and currency.
Ribeiro (2020)	Investigated the profile and collaboration characteristics of international scientific production on the topic of bitcoin in the light of social network analysis.	The United States and the United Kingdom were the most productive countries. In the context of social networks, it was found that publications on bitcoin began to rise from 2012.
Aysan, Demirtaş e Saraç (2021)	Conducted a comprehensive bibliometric study of the literature related to bitcoin.	The number of publications is growing. The scientific literature related to bitcoin largely encompasses research connected to Computer Science.
Puspita e Devi (2023)	Determined the development map and trend of the bitcoin topic published by well-known journals in the fields of economics and finance.	The leading topics and emerging subjects were: *blockchain*, money, digital, cryptocurrencies, finance, and risk. The cross-cutting themes were: *bitcoin*, volatility, and markets.
Rejeb *et al*. (2023)	Explored academic articles related to bitcoin.	The key topics were: *internet* of things, market efficiency, digital currency, and privacy. Thus, these can be considered the pillars of research on the topic of *bitcoin.*
Wang e Hausken (2024)	Investigated the status and evolution of research on bitcoin through bibliometrics.	The four prominent emerging areas for future research on *bitcoin* were: decentralized finance, non-fungible *tokens*, clean energy, and monetary policy.

Source: Prepared by the author (2024)

Observing Table 1, it brings to light important information about the topic of *bitcoin* in the international academic sphere, in the context of different databases, particularly *WoS, Scopus and Ebsco*. The insights presented in Table 1 confirm the growth of the *bitcoin* topic in the global academic realm, highlighting foundational themes such as *blockchain* technology, cryptocurrencies, and P2P. Thus, the importance of bibliometric studies to prospect trends and visualize behaviors is understandable, helping readers, researchers, teachers, students, and those interested in the topic of *bitcoin* to understand and comprehend the nuances that surround and underpin this term (Bruzgė & Šapkauskienė, 2021; Luo, Hu & Bai, 2021). However, none of these studies focused on the academic production in Brazil, a fact that is emphasized in this research by examining the scientific texts on *bitcoin* in the brazilian academic context from the perspective of SPELL, which is among the databases most used by Brazilian researchers in studies with a longitudinal emphasis, that is, in review articles (Ribeiro, 2023b).

3 Methodological procedures

The objective of this study was to investigate the profile and trend of scientific production, as well as the structure and formation of social networks on the topic of *bitcoin* in brazilian academic literature. Thus, the research had a quantitative approach, utilizing sociobibliometrics for its descriptive purposes (Cardoso, Bernardino & Pessoa Araújo, 2018). It is reiterated that discussing the scientific production on a particular topic can better assist in its understanding and comprehension, aiming to diagnose possible gaps (Vendramin, Lima, Santos, Guasso & Fernandes, 2020). Regarding the bibliometric procedures (Andrade Júnior & Ceranto, 2013), and sociometry, also known as SNA (Pessoa Araújo, Mendes, Gomes, Coelho, Vinícius & Brito, 2017), are used in quantitative research, being crucial for improving the results and development in the discussion and content investigated, thus providing a differential for review studies (Ferreira & Silva, 2019).

Bibliometrics is one of the most widely used quantitative methods in literature analysis, based on three basic laws: *Lotka's* Law or the Inverse Square Law, which is the oldest and emphasizes the productivity of researchers through their published studies. *Bradford's* Law or the Law of Scattering, which involves the classification of scientific articles in different journals, thus establishing cores of a stipulated subject in a group of academic journals; and *Zipf's* Law or the Law of Least Effort, which

focuses on the frequency of occurrence of words in certain texts, producing an ordered list of a defined theme. Additionally, *Price's* Law or the Law of Elitism allows for identifying the elite of researchers in a particular subject or field of knowledge (Mondo & Fiates, 2014; Machado Junior, Souza, Parisotto & Palmisano, 2016; Garg *et al*., 2023; Hayashi, 2023).

The use of bibliometrics and SNA facilitates the combination of elements for understanding and evaluating the mode of communication, exchange of information, and knowledge of the topic under investigation. Thus, with the support of SNA, scholars gain an overview of the structure and formation of knowledge, as well as research groups, and consequently, the collaboration in scientific production on the subject matter under investigation (Moraes & Kafure, 2020). Thus, SNA is composed of elements that guide its scope and focus, which are: nodes (actor), ties (connections between pairs of actors), structural holes (weak ties), density (measures the number of connections in a network), and centrality (location of the actor in relation to the entire network) (Capobiango, Silveira, Zerbato & Mendes, 2011; Rossoni & Machado-da-Silva, 2013; Silva, 2014; Ribeiro, 2023a).

Among these network elements, density is highlighted, which measures the number of connections between actors in a collaboration network. The denser the network, the closer it will be to 1.0, resulting in more uniform communications between actors. Thus, a social network with low density will have a calculation lower than 0.2, indicating it is a distant network with low internal harmony. Centrality is another widely used property, which assesses the relevance and prominence of an actor in a social network (Santos & Farias Filho, 2016; Ribeiro & Corrêa, 2022; Urbizagástegui-Alvarado, 2022).

Of these, (*degree)* centrality is emphasized, which measures the number of partners an actor has with other(s) actor(s); and (*betweenness)* centrality, which assesses the "power" an actor has in controlling and facilitating the flow of information, and consequently, knowledge in a social network (Cruz, Espejo, Costa & Almeida, 2011; Welter, Souza, Trajano & Behr, 2021). Thus, this study calculated and utilized *degree* and *betweenness* centrality to identify the impact of nodes (actors) in the network in different nuances: (i) showing how different actors can be connected to a specific actor *(degree)*; and (ii) showing

how a specific actor controls the flow of information with other actors *(betweenness)* (Pyun & Rha, 2021).

3.1 Data Collection and Analysis Procedures

SPELL was the established database for searching studies on the topic of *bitcoin* in Brazilian academia. The choice of SPELL is due to its status as a reference in the field of Administration in Brazil, and because its impact indicators are used in the classification of *Qualis*/CAPES journals in the fields of Administration, Accounting, and Tourism (Fraga, Colomby, Gemelli & Prestes, 2022). In consideration of this, it is highlighted that the 2017-2020 Quadrennial Evaluation Report, published by CAPES, which verifies the definitions of evaluation standards, inferred the impact index of SPELL as a consistent and approved measure. Thus, in recent years, SPELL has made an undeniable contribution to the publication of scientific production in Brazil (Rafael, 2023).

The search for studies on the topic of bitcoin in the SPELL data platform was primarily conducted using the following preferred keywords: “*bitcoin*”, “*bitcoins*”, “*blockchain*”, “*blockchains*”, “*cryptocurrency*”, “*cryptocurrencies*”, “*digital currency*”, “*digital currencies*”, “*virtual currency*”, “*virtual currencies*”, "cryptocurrency" and "cryptocurrencies." The use of these keywords is explained by their relevance to the scope and focus of this study, and because they have already been used in similar research (Merediz-Solà & Bariviera, 2019; Ramona, Cristina & Raluca, 2019; Ribeiro, 2019; Ribeiro, 2020; Aysan, Demirtaş & Saraç, 2021; Puspita & Devi, 2023; Rejeb *et al*., 2023; Wang & Hausken, 2024), legitimizing their use in this academic work.

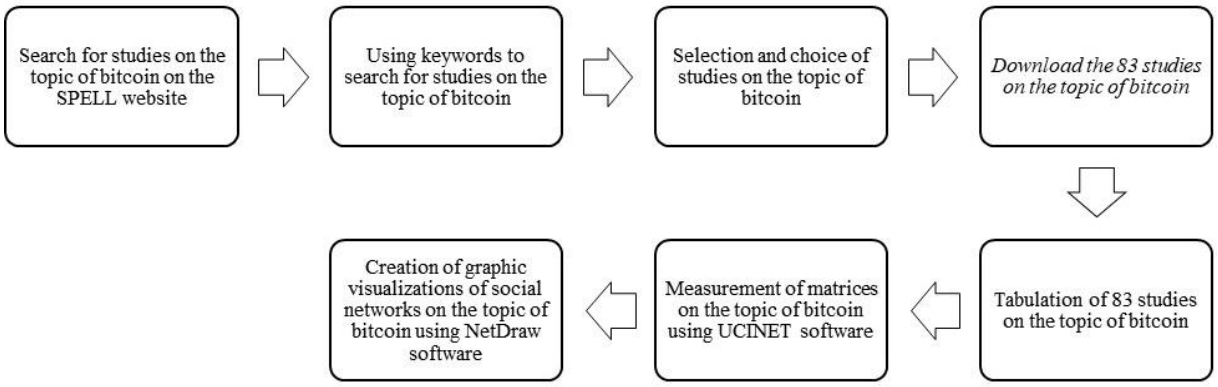
It is highlighted that each of these keywords was employed non-simultaneously in the *"drop down boxes"* search filter of SPELL, in the fields: Document Title, Abstract, and Keyword. Thus, all studies on the topic under analysis were found and added to this research. It is emphasized that, to ensure the article on the *bitcoin* topic was indeed in harmony with the focus of this research, the respective abstracts of the selected studies were read to ensure that the chosen scientific text was aligned with the essence and purpose of this research.

Therefore, the sample for this research identified 83 articles relevant to the objective of this scientific work over a period of eight years, from 2016 to 2023. It is noted that the first article found on the term *bitcoin* in the SPELL database appeared in 2016, and the search was conducted up to 2023, as the year 2024 is currently ongoing. Subsequently, on February 16, 2024, the tabulation of the studies began, and simultaneously, the creation of the bibliometric indicators for this research was conducted, which included: periods, journals, authors, HEIs, and keywords. This process was completed on February 18, 2024.

Regarding SNA, the relationships were visualized using correspondence analysis techniques through the creation of matrices. It is emphasized that the date of the start of the creation of the matrices for this study was February 18, 2024, and their completion occurred on February 22, 2024. The matrices were organized and generated in *Microsoft Excel,* and subsequently submitted to *UCINET software*, which is confirmed to be effective for constructing social networks of bibliometric research, i.e., sociobibliometric networks. Next, the visualization of social networks was done through sociograms described by the *NetDraw software*, which is the program used for drawing and representing matrices. Thus, the scientific production, structure, and formation of actor networks were analyzed based on the findings of the social networks presented in this research (Ferreira & Silva, 2019; Gomes & Silva, 2022; Ferreira de Araújo & Silva, 2023). These social networks included: co-authorship, collaboration of HEIs, and keywords. It is also worth mentioning that the *Word Art software* was used to create the keyword cloud. For better understanding and comprehension, Figure 1 highlights the methodological path of this research.

Figure 1

Methodological Path



Source: Prepared by the author (2024)

4 Analysis and discussion of results

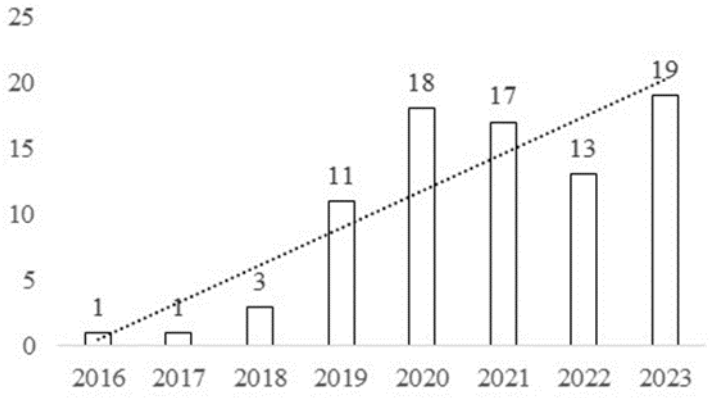
This section addressed the analysis and discussion of the 83 articles published in Brazilian academia on the topic of *bitcoin* from the perspective of academic journals indexed in SPELL.

4.1 Periods

Seeking to verify if there is any growth trend of the topic under investigation (Senna & Ribeiro, 2023) Figure 2 was created to visualize the 83 articles on the topic of *bitcoin* that were published over an eight-year period in Brazilian academia, in the context of journals indexed in the SPELL electronic library.

Figure 2

Periods



Source: Research Data (2024)

That said, observing Figure 2, a significant growth in the topic of *bitcoin* in Brazilian academia is noted, with the peak of publications occurring in the final year of this research, namely 2023. This finding is corroborated by articles that had similar objectives to this study (Merediz-Solà & Bariviera, 2019; Ribeiro, 2019; Aysan, Demirtaş & Saraç, 2021), however, focusing on international scientific production. Nonetheless, what is observed is that academic research on the topic of *bitcoin* in the brazilian scientific context is moving in the same direction as evidenced globally, and this is explained by the emergence of the *bitcoin* theme not only in academia but particularly in the global corporate landscape global (Tandon *et al*., 2021; Puspita & Devi, 2023; Wang & Hausken, 2024). Overall, the results presented in Figure 2 are motivating for teachers, scholars, researchers, and interested parties, thereby generating opportunities to add knowledge through the production and dissemination of scientific knowledge, highlighting findings and contributions on the topic of *bitcoin*, these can be disseminated and shared later through scientific communication, especially in academic journals in the field (Ribeiro, 2020).

4.2 Journals

Scientific communication, particularly through scientific journals, allows access to information and knowledge referenced and validated by academia (Rodrigues & Fachin, 2010). Thus, Figure 3 was

constructed by subdividing productivity zones, highlighting the journals that published studies on the topic of *bitcoin* in brazilian academia, and showcasing the most productive scientific journals.

Figure 2

Periods

Journal	Abbreviation	Qualis (2017-2020)	Publishing institution	Articles	Zones
Brazilian Administration Review	BAR	A2	ANPAD	5	
Revista Gestão & Tecnologia	RG&T	A4	FPL	5	
Revista Eletrônica de Gestão Organizacional	Gestão.org	A4	UFPE	4	
Journal of Information Systems and Technology Management	JISTEM	A3	USP	4	1
Revista Brasileira de Finanças	RBFin	A4	SBFin	4	
Revista de Administração Contemporânea	RAC	A2	ANPAD	4	
Revista Liceu On-line	Liceu	B3	FECAP	4	
10 journals published 2 articles			Contextus - Revista Contemporânea de Economia e Gestão, Innovation and Management Review, Marketing & Tourism Review, NAVUS - Revista de Gestão e Tecnologia, Revista Contabilidade & Finanças, Revista da CGU, Revista de Administração da UFSM, Revista de Gestão, Finanças e Contabilidade, Revista Mineira de Contabilidade e Sinergia	2	2
33 journals published 1 article			Advances in Scientific and Applied Accounting, Cadernos EBAPE.BR, Contexto - Revista do Programa de Pós-Graduação em Controladoria e Contabilidade da UFRGS, Desafio Online, Future Studies Research Journal: Trends and Strategies, International Journal of Business & Marketing, International Journal of Innovation, International Journal of Professional Business Review, InternexT - Revista Eletrônica de Negócios Internacionais da ESPM, Pensar Contábil, Perspectivas em Gestão & Conhecimento, RAUSP Management Journal, Revista Brasileira de Gestão de Negócios, Revista Brasileira de Inovação, Revista Brasileira de Pesquisa em Turismo, Revista Capital Científico – Eletrônica, Revista de Administração da Unimep, Revista de Administração de Empresas, Revista de Administração FACES Journal, Revista de Administração IMED, Revista de Administração Mackenzie, Revista de Contabilidade do Mestrado em Ciências Contábeis da UERJ, Revista de Gestão e Projetos, Revista de Gestão e Secretariado, Revista de Tecnologia Aplicada, Revista do Serviço Público, Revista ENIAC Pesquisa, Revista Gestão Organizacional, Revista Inovação, Projetos e Tecnologias, Revista Pensamento Contemporâneo em Administração, Revista Rosa dos Ventos - Turismo e Hospitalidade, Sociedade, Contabilidade e Gestão e Teoria e Prática em Administração	1	3

Source: Research Data (2024)

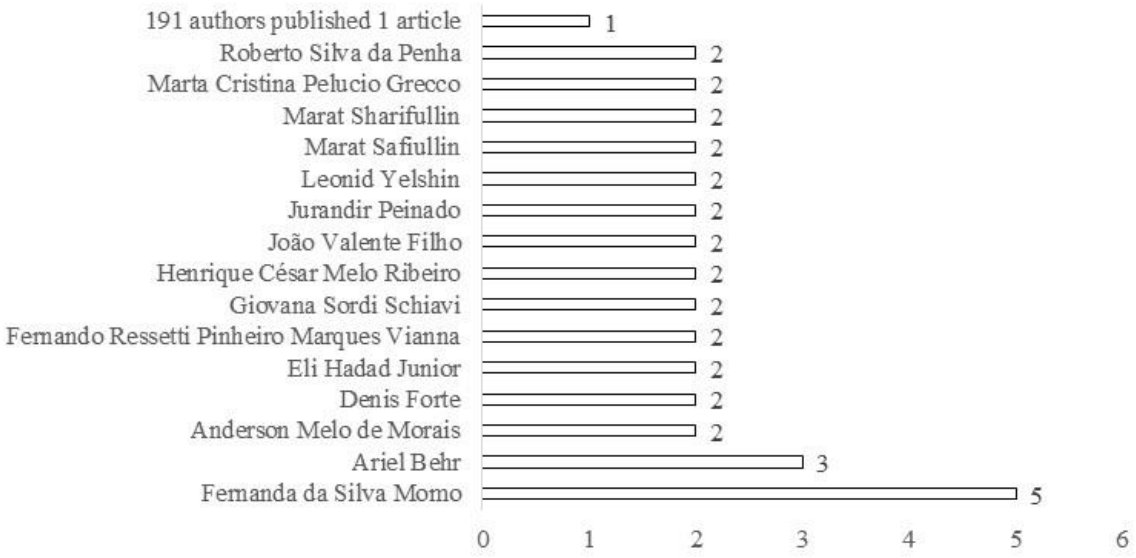
Analyzing Figure 3, a small core of journals is identified, which can be seen in zone 1, consisting of: BAR, RG&T, Gestão.org, JISTEM, RBFin, RAC e Liceu, which addressed the topic under investigation in a more comprehensive manner, accounting for more than 1/3 of the total articles identified on the analyzed topic. It is also observed that there is a vast peripheral region divided into two other zones, where in these surrounding zones, there is an increase in the number of scientific journals that gradually decrease the productivity of publishing articles on the subject under analysis. Thus, it is observed that the journals highlighted in zone 1 have a certain level of importance regarding the scientific production on the focus topic of this research, thereby establishing a core of superior quality and greater prominence for this study. However, it is important to note that the journals found in zones 2 and 3 of this research may improve their standing if researchers begin to submit their scientific texts to these journals, and if approved for publication, they will decisively influence and contribute to the growth of the topic under investigation in academia, this, in turn, would make these journals more productive and, consequently, more likely to become part of the core of the most prolific journals on the topic highlighted in this study (Machado Junior *et al*., 2016; Garg *et al*., 2023).

4.3 Authors

Given this, it is beneficial to understand and, at the same time, consider the relevance of the researchers involved in the process of knowledge construction who impact and contribute to the dissemination of the scientific field of the topic under analysis (Vendramin *et al*., 2020). In light of this, Figure 4 was created, which includes the authors who published on the topic of bitcoin in Brazil, highlighting the most prolific researchers in this study, who were: Fernanda da Silva Momo e Ariel Behr.

Figure 4

Authors



Source: Research Data (2024)

It is also worth noting the following scholars: Anderson Melo de Morais, Denis Forte, Eli Hadad Junior, Fernando Ressetti Pinheiro Marques Vianna, Giovana Sordi Schiavi, Henrique César Melo Ribeiro, João Valente Filho, Jurandir Peinado, Leonid Yelshin, Marat Safiullin, Marat Sharifullin, Marta Cristina Pelucio Grecco e Roberto Silva da Penha. It is also noted that 191 academics, accounting for approximately 93% of the total authors (191 ÷ 206) published only one study each. It is observed that the number of academics who published only one article is higher than what is predicted by *Lotka's* Law, which is approximately 60% of the scholars (Dornelles, Souza & Pain, 2023). Thus, this finding confirms that co-authorship on the topic of bitcoin is widespread and uniformly distributed; however, the concentration of researchers focused on publishing studies about *bitcoin* is still small, influencing its academic production (Merediz-Solà & Bariviera, 2019), and this result is quite similar to what was found in the study by Ribeiro (2019).

On a macro level, it is also highlighted that this distribution found in this research aligns closely with *Lotka's* Law, which suggests that in many fields of knowledge, it is possible to observe the pattern of

a few authors publishing prolifically, alongside many researchers with low scientific production (Machado Junior *et al*., 2016). And finally, Price's Law, which is derived from *Lotka's* Law, suggests that, considering the 206 authors responsible for publishing 83 studies on the topic under investigation, the "elite" of the scholars can be considered the two authors who published the most, namely: Fernanda da Silva Momo e Ariel Behr, both of whom are responsible for 10% of the scientific production on the subject investigated (Pessoa Araújo *et al*., 2017). In summary, the prominence of the authors in terms of their productivity is a fundamental factor for their recognition as central researchers in co-authorship networks, contributing to the informational flow on the subject analyzed (Ribeiro, 2023b). However, being prolific does not necessarily mean being central, a fact observed in complementary studies by: Ribeiro (2019) e Ribeiro (2020) on the topic of *bitcoin* in the international scientific literature.

4.4 Co-authorship Networks

Co-authorship networks are understood as the interactions between two or more researchers within a collaboration network, who come together and share their experiences and knowledge in production, simultaneously fostering scientific collaborations and the most active research groups on a common topic (Capobiango *et al*., 2011). That said, Figure 5 was created, consisting of 456 ties and 206 nodes. It is revealed that betweenness centrality was used as a measurement in the co-authorship networks of this research. In this case, the authors who stood out in terms of *betweenness* were: Fernanda da Silva Momo, Roberto Silva da Penha, Marta Cristina Pelucio Grecco, Anderson Melo de Morais, Jurandir Peinado, Fernando Ressetti Pinheiro Marques Vianna e Giovana Sordi Schiavi. Among these researchers, all are among the most prolific and, therefore, can be considered the most relevant and strategic for the flow of information, simultaneously contributing to the creation of academic value and the generation of knowledge on the topic of *bitcoin* in Brazilian academic literature.

Figure 5

Co-authorship Networks

Source: Research Data (2024)

Further analyzing Figure 5, the existence of so-called structural holes is observed, which are *gaps* in the informational flow of knowledge on the topic under investigation. These may result from weak ties in the relationships between actors, influencing the structures of social networks and, consequently, the formation of connections between the actors in the networks (Oliveira, Souza & Castro, 2014). Thus, it is possible to highlight that the structural holes in the co-authorship networks of this research directly impacted the emergence of weak ties (Rossoni & Machado-da-Silva, 2013; Ribeiro, 2020).

This result is corroborated by observing that the density calculation of the co-authorship networks was 0.0113, corresponding to 1.13% of the total interactions among the 206 authors identified in this research, revealing it to be well below an adequate density. Therefore, the cited network has low density in terms of informational relationships between researchers, simultaneously influencing structural *gaps* and, consequently, weak ties, impacting the flow of information and knowledge on the topic under

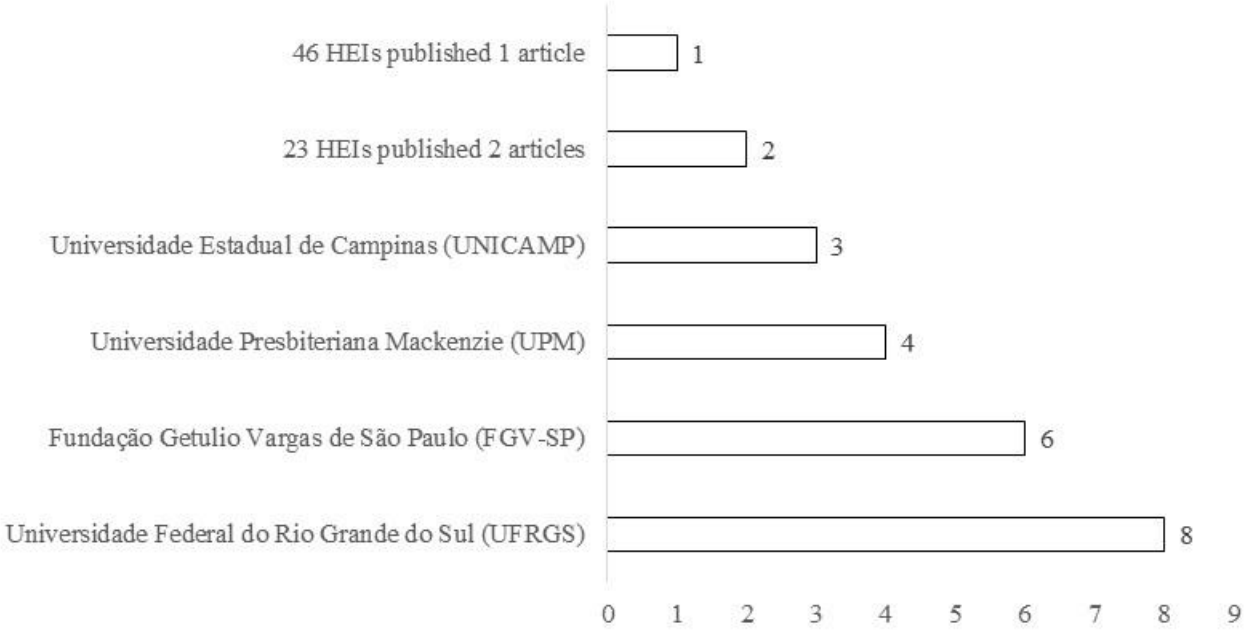
investigation, and, importantly, affecting the productivity and, thus, the prominence of their respective native HEIs in the production of academic knowledge (Santos & Farias Filho, 2016; Ribeiro, 2023a).

4.5 HEIs

Thus, it is understood that HEIs are essential as the primary producers of scientific knowledge on academic topics (Mondo & Fiates, 2014). In this way, Figure 6 was generated, highlighting the most fruitful institutions in terms of scientific production on the topic of bitcoin in the national academic literature, which were: UFRGS, FGV (SP), UPM and UNICAMP, all located in the Southeast and South regions of Brazil. This finding was confirmed in the research by Eça, Costa e Oliveira (2023) which characterized Brazilian companies that use *"blockchain"* technology in their business models. It is reinforced that blockchain technology was popularized worldwide through *bitcoin* (Momo & Behr, 2019), and *bitcoin* itself adheres to *blockchain* technology in its processes (Firdaus *et al*., 2019).

Figure 6

HEIs



Source: Research Data (2024)

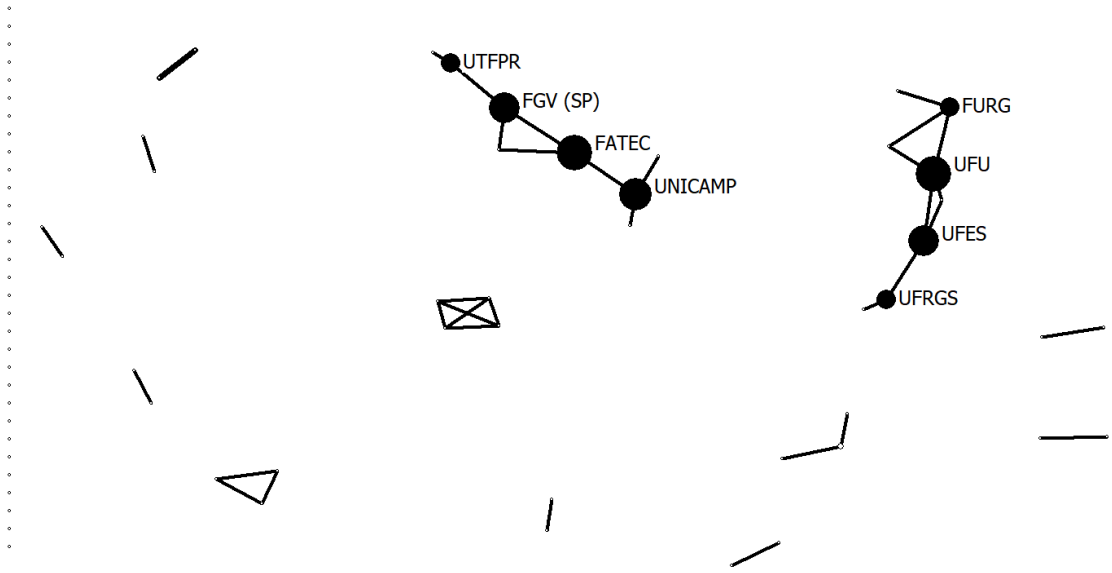
Regarding the HEIs with the highest scientific production, as visualized in Figure 6, it is observed that this result is similarly corroborated in the study by the authors Andrade Júnior and Ceranto (2013) who mapped the academic production on technology and innovation management (GTI) in the brazilian academic context. It is emphasized that the terms innovation, and particularly technology, are inherent themes to the topic of *bitcoin* (Merediz-Solà & Bariviera, 2019; Bruzgė & Šapkauskienė, 2021; Tandon *et al*., 2021; García-Corral *et al*., 2022). Overall, the prominence of the most productive HEIs in this research can be a crucial factor for these institutions to also stand out in terms of their respective centralities in the collaboration networks of HEIs (Ribeiro, 2023b).

4.6 Collaboration Networks of HEIs

That said, it is beneficial to understand the social networks of HEIs (Higher Education Institutions), as they can contribute to the advancement of the topic being investigated in academia. Additionally, identifying these social networks will help strengthen and consolidate these HEIs, promoting the convergence of *insights* through the native researchers of these institutions, research activities, and joint scientific production on the topic currently under analysis (Beuren *et al*., 2009). In light of the above, Figure 7 was created, consisting of 72 ties and 73 nodes.

Figure 7

Collaboration Networks of HEIs



Source: Research Data (2024)

It is worth noting that betweenness centrality was the measure chosen to visualize the most central HEIs, as it demonstrates the 'control' that actors have in making the informational flow on a specific topic circulate and 'move forward' in academic literature (Welter *et al*., 2021; Ribeiro, 2023a). In this way, the most central HEIs are: UFU, FATEC, UNICAMP, FGV (SP), UFES, FURG, UFRGS e UTFPR. Of these, three are among the most proficient HEIs in scientific production on the topic of *bitcoin* in Brazil, namely: UNICAMP, FGV (SP) e UFRGS, thus, it is evident that these institutions are not only the most important in terms of proliferating the subject of this study, but also the most strategic, as they are responsible for “advancing” the investigated theme and, consequently, impacting the dynamics of the flow informational flow in academia, making them considered, for this research, as “bridges” for the development, diffusion, dissemination, and socialization of this subject in Brazil (Silva, 2014; Ribeiro & Corrêa, 2022).

Continuing the analysis of Figure 7, specifically regarding its density, it is noted that it was measured at 0.0141, meaning that only 1.41% of the total interactions are effectively occurring between

the HEIs in this study. Thus, it is evident that there is low density, which directly impacts the knowledge flow on the topic under analysis in this research. This indicates the presence of structural holes in the formation and structure of the HEIs' networks, consequently leading to the manifestation of weak ties, which impacts the cohesion and fluidity of information flow on the topic focused on in this research (Cruz *et al*., 2011; Santos & Farias Filho, 2016; Ribeiro, 2023a), influencing, subsequently, the development of this subject in academia in Brazil, and, consequently, the potential impact on the refinement of the themes that underpin, guide, and branch out from it, such as *blockchain* and cryptocurrencies.

4.7 Word Cloud of Keywords

By investigating the keywords assigned by authors in their research, it is possible to identify which themes are most closely associated with the study of a particular topic (Garcia & Menezes, 2022). Thus, Figure 8 was created, allowing for the observation of various terms used to characterize articles on the topic of *bitcoin* within the brazilian academic sphere.

Figure 8

Word Cloud of Keywords

Source: Research Data (2024)

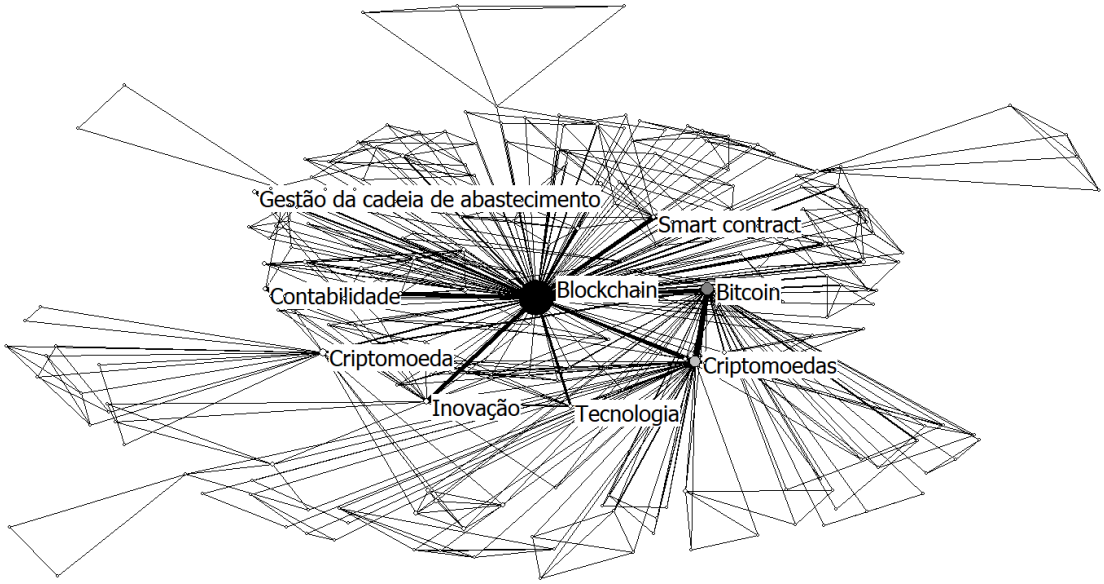
The most frequently used words were: blockchain (54 times), cryptocurrency (22), *bitcoin* (17), technology (13), model (nine), innovation (eight), digital (seven), market (seven), accounting (six), and chain (six). Therefore, according to *Zipf's* Law, these themes are the most discussed in the brazilian academic landscape regarding the subject of this research (Machado Junior *et al*., 2016), which is *bitcoin*. This result is similarly corroborated by analogous research that investigated the international academic production on the topic of *bitcoin* (Merediz-Solà & Bariviera, 2019; Ribeiro, 2019; Puspita & Devi, 2023).

4.8 Social Networks of Keywords

Subsequently, to better understand the word cloud visualized in Figure 8, the social networks of keywords were generated, as depicted in Figure 9. Through their interconnections, this allows for the identification of the core themes addressed by the scientific community regarding the topic currently under investigation (Sultan, Routroy & Thakur, 2023). It is noted that the keyword networks presented in Figure 9 were established with 1.152 ties and 221 nodes. In light of this, it is emphasized that the 83 articles investigated contained a total of 221 unique keyword occurrences. However, the following parameters were adhered to: (i) no distinction was made between uppercase and lowercase letters; and (ii) singular and plural words were kept separate díspares (Favaretto & Francisco, 2017).

Figure 9

Social Networks of Keywords



Source: Research Data (2024)

It is emphasized that degree centrality was used to analyze the social networks of keywords in the articles published on the study's topic (Pyun & Rha, 2021). It was found that the keywords with the highest centrality were: *blockchain*, *bitcoin*, cryptocurrencies, cryptocurrency, innovation*, smart contract*, accounting, technology, and supply chain management. More specifically, the keywords: *blockchain*, *bitcoin,* and cryptocurrencies were the most frequently used by researchers, aligning with studies analogous to this one (Merediz-Solà & Bariviera, 2019; Ramona, Cristina & Raluca, 2019; Ribeiro, 2019; Puspita & Devi, 2023). Furthermore, observing Figure 9, it is noticeable that there are strong ties linking the three most central Keywords, this clustering of these themes can be explained by the existing affinity between them, contributing to their growth within the academic sphere (Ramona, Cristina & Raluca, 2019; Senna & Souza, 2023).

This result indicates that these highlighted keywords have a high influence over the other keywords investigated, demonstrating that these more central keywords can be considered the most impactful themes and, consequently, the most dominant regarding the topic of this research

(Urbizagástegui-Alvarado, 2022). It can also be understood that the subjects most investigated, according to Figure 9 of this study, tend to 'exhaustion' due to the knowledge already created and disseminated by them. However, since the keywords that are the driving forces and, consequently, of greater importance, are close to the central axis of the network, they can be identified as emerging in terms of underpinning, guiding, and leading the main theme of this research. It is worth noting that empirical studies are a widely disseminated and socialized source of knowledge in the scientific community (Senna & Souza, 2023), thus, academic works that involve the themes of innovation, *smart contract*, accounting, technology, and supply chain management may present an opportunity to further develop the topic of *bitcoin*, contributing to its growth and maturation in the Brazilian academic literature.

5 Conclusion

The aim of this study was to investigate the profile and trends of scientific production, as well as the structure and formation of social networks on the topic of *bitcoin* in Brazilian academic literature. Methodologically, this research employed bibliometric techniques and Social Network Analysis (SNA) on 83 identified articles. The main results show that the topic under investigation has a tendency for growth in the Brazilian literature. The scientific journals that stood out in terms of scientific production were: BAR and RG&T. Fernanda da Silva Momo was the most prolific author and ranked among the researchers with the highest betweenness centrality. UFRGS and FGV (SP) were the most productive HEIs and ranked among the most central and relevant institutions in terms of mediating, controlling, and facilitating the informational flow on the topic of *bitcoin* within brazilian academia. The most commonly used keywords (Figure 8) by authors in their respective studies were: *blockchain*, cryptocurrency, *bitcoin*, technology, model, innovation, digital, market, accounting, and chain.

With regard to social networks, it was found that both the co-authorship networks and the collaboration networks of HEIs had low density measurements, which influenced the emergence of weak ties and, as a result, hindered greater fluidity and harmonization of the knowledge flow on the topic of Bitcoin within Brazilian academia. In this context, the keywords that stood out in terms of centrality were: *blockchain*, *bitcoin*, cryptocurrencies, cryptocurrency, innovation, *smart contract*, accounting, technology,

and supply chain management, with the first three being strongly interconnected, indicating that they are intrinsic to the topic of *bitcoin* within brazilian literature. It can also be understood that these highlighted keywords are the driving forces in researchers' studies on the topic of *bitcoin*, reaffirming their respective influence on the performance and evolution of this topic within brazilian academia.

In general, this research provides a contemporary investigation of brazilian studies on the topic of *bitcoin* from the perspective of socio-bibliometric indicators, generating data, information, and knowledge that could be important for the emergence of new *insights* and, consequently, future studies. These will be crucial in further advancing the topic of *bitcoin* and its related themes in academia, potentially impacting the Brazilian corporate environment as well, by increasing the comprehensibility of the term *bitcoin* for managers and decision-makers in companies seeking to stay updated, and simultaneously, become more informed and knowledgeable through the reading of scientific studies published in journals.

It is emphasized that this academic work contributes to the contemporary study of the topic of *bitcoin* in Brazil from the perspective of journals indexed in SPELL. Therefore, this may be the main limitation of this article, namely, the exclusive use of the SPELL repository for research. However, it is reiterated that both the research question and the study's objective were successfully addressed and achieved. However, for future research, it is suggested to expand the areas of knowledge, such as Computer Science, Business, Economics, Finance, Law, and Sociology, to search for more articles. The improvement of this scientific text could be achieved by using other national and international data platforms, such as Periódicos CAPES, *SciELO*, *EBSCO*, *Web of Science* e a *Scopus*. It is also suggested to incorporate more keywords with search terms analogous to the topic of *bitcoin*, thereby encompassing more research on the referenced subject. It is also advisable to use new methods for measuring social networks of actors, such as co-citation analysis. Another recommendation is to conduct a systematic literature review of the 83 studies investigated in this research.

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