

## Bibliometric Analysis of Articles on Web3\*

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### ABSTRACT

In this study, it is aimed to analyze the articles on Web3 and present the general situation about Web3 to researchers. Within the scope of this purpose, the trends of the studies published on Web3 according to years, the trends of the journals in which they were published, the institutions and countries that contributed the most, the keywords used in the studies, the topics and themes based on the studies, and the distribution of research areas were revealed. The research is based on bibliometric analysis. A total of 280 articles published in WoS and SCOPUS databases were analyzed. WoSViewer and Bibliometrix programs were used in data analysis. The findings were analyzed and interpreted separately in WoS and SCOPUS. As a result of the research, there was a significant increase in studies on Web3 in 2022, and the journals with the highest number of publications in WoS and SCOPUS differ. The countries that contributed the most to Web3 were China, The USA, India, England, Germany. The most cited countries are China, the USA, India, England, Iran and Canada. In general, it can be said that countries and institutions have conducted studies on Web3 by addressing many issues related to Web3. Within the scope of the results, Web3 studies address many different disciplines with many topics. However, there is a need to deepen the studies. The policies, practices and even the laws created by countries on Web3 are important for studies on Web3. Blockchain is one of the most studied topics, but it is understood that there are some hesitations about blockchain security. For this reason, Web3 studies can be conducted to increase blockchain security.

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#### Keywords:<sup>5</sup>

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### INTRODUCTION

The Internet has undergone several significant transformations since its emergence. Starting from the static web pages of Web 1.0 to the interactive and social media-driven Web 2.0, the evolution of the internet has created new opportunities and challenges for individuals and organizations. With Web 1.0, which emerged in the early 1990s, the internet was used as a medium for accessing and sharing information through basic HTML websites. These websites were read-only and had little interactivity. In the mid-2000s, the internet evolved into Web 2.0 and users began to interact and create content on platforms such as social media and forums. (O'Reilly, 2007). With Web 2.0, users began to interact on platforms such as social media and forums. Web 2.0 has contributed to the rise of platforms such as Facebook, Twitter and YouTube (Kaplan & Haenlein, 2010) and has raised concerns about centralization of data and control, privacy, data ownership and monopolistic practices (Fuchs, 2010). Web 3.0, also known as the semantic web, is a vision of the internet in which data is structured, interconnected and easily understandable by both humans and machines (Berners-Lee, Hendler & Lassila, 2001).

Unlike the semantic web, early conversations of Web3 were based on the semantic web. Berners-Lee et al (2001) describe the first challenge of creating a system that allows information sharing without centralized management or mandatory partnerships that make sharing inherently difficult. Web3 or the "Decentralized web", also attempts to address centralization and data control issues using blockchain technology and cryptographic techniques (Swan, 2015). A new iteration of the World Wide Web, Web3 incorporates principles such as decentralisation, blockchain technology and token-based economy (Kovacova et al., 2022). Web3 is a blockchain-based online ecosystem that includes peer-to-peer transactions and coordination tools (Ellie Rennie et al., 2022). Web3 is a vision of the internet based on decentralised and distributed technologies such as blockchain and aims to provide increased security, transparency and user control (Swan, 2015). Public blockchains (Bitcoin, Ethereum, etc.) serve as the primary channel for all transactions and interactions that take place in Web3 applications (Sheridan et al., 2022). They are decentralised and immutable public ledgers (Yazdinejad et al., 2022). While cryptocurrencies have popularised them, their use cases are expanding to cover

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all kinds of data (Sheridan et al., 2022). The core technologies of Web3 include blockchain, smart contracts, decentralized applications (dApps), decentralized autonomous organizations (DAOs), and non-fungible tokens (NFTs) (Tapscott and Tapscott, 2016). These technologies enable the emergence of various applications such as decentralized finance (DeFi), digital identity management, data sharing and digital asset ownership (Zohar, 2015). Non-Fungible Tokens (NFTs) are unique digital assets that represent ownership of a specific item or content, such as art, music, or virtual real estate (Catlow et al., 2021). Smart contracts are self-executing contracts in which the terms of the agreement between the buyer and seller are written directly in code (Szabo, 1997). Once predefined conditions are met, contracts are automatically executed and enforced, reducing the potential for intermediaries and disputes (Buterin, 2013). Smart contracts have a wide range of applications, from simple asset transfers to complex, multi-party transactions and decentralized applications (Merkle, 2017). Decentralized Applications (dApps) are applications that run on decentralized networks such as blockchain or distributed ledger technologies rather than on central servers (Greve, 2016). dApps are often built on top of smart contracts and provide the possibility to take advantage of automated and trustless execution (Merkle, 2017). Decentralized Autonomous Organizations (DAOs) are organizations that operate through rules coded as computer programs on a blockchain and are collectively governed by token holders (Buterin, 2014). DAOs enable decentralized decision-making and governance and have the potential to create more transparent, democratic and efficient organizations (Tapscott and Tapscott, 2016).

Using Web3 technology can make all information sharing much faster and safer than it is today. The importance of the Web3 field, which offers a lot of potential and convenience in every field for our age, cannot be ignored. This valuable topic is an unexplored area whose potentials, or perhaps the risks it may bring with it, are open to exploration. While it is already the subject of much literature, it appeals to many disciplines. All of the Web3 studies in the literature are theoretical or applied studies that are specific according to the fields. However, there is no analysis study that allows us to see the whole. An overview of publications related to Web3 is important for researchers and will guide them on topics researched, collaborations and trends. In this study, it is aimed to contribute to the literature by analyzing the articles published in the last six years in any field related to Web3. For this purpose, a general perspective has been tried to be presented by revealing the trends of published Web3 studies by years, journals, institutions and countries, and the keywords, topics and themes used in studies on Web3. In this context, the research questions sought to be answered in this context are listed below.

- What are the distributions of Web3 studies according to years?
- What are the distributions of journals for Web3 studies?
- What is the general distribution of journals?
- How are the impact factors of journals?
- How is the publication frequency of journals according to years?
- Which countries and institutions contributed the most to Web3 literature?
- How is the general distribution of countries according to Web3 studies?
- What is the situation of countries according to the number of citations?
- What is the general distribution of institutions according to Web3 studies?
- What topics have institutions and countries addressed about Web3?
- What are the keywords, topics and themes used in studies on Web3?
- What is the distribution of research by keywords?
- What are the topics and trends in Web3 studies?
- What are the themes in Web3 studies?
- What is the distribution of research by subject area?

## METHOD

In this study, bibliometric analysis was utilized to examine papers published on Web3 over the last six years. Bibliometric analysis is useful for making sense of vast amounts of unstructured data, revealing the overall structure or trend for fields, and mapping analytical outputs (Pritchard; 1981; Donthu et al., 2021). The following is an explanation of the process used in this study with bibliometric analysis.

## Sample of the Study

In the Web of Science (WoS) database and SCOPUS by selecting the "topic (title, abstract, keywords)" with the keywords "Web 3, Web3, Web3.0, Web 3.0", 373 (Wos:184, SCOPUS:189) article studies in all disciplines written in English between 2018 and July 2023 were reached. However, as a result of the examinations, 93 repeated studies were found and as a result, 280 articles were included in the analysis. Reason for reviewing articles published from 2018 onwards, Web3 was characterized as semantic web in previous years. Therefore, in order to reveal the general structure of Web3 and not to limit it to the semantic web, studies have been examined since 2018.

## Data Analyses

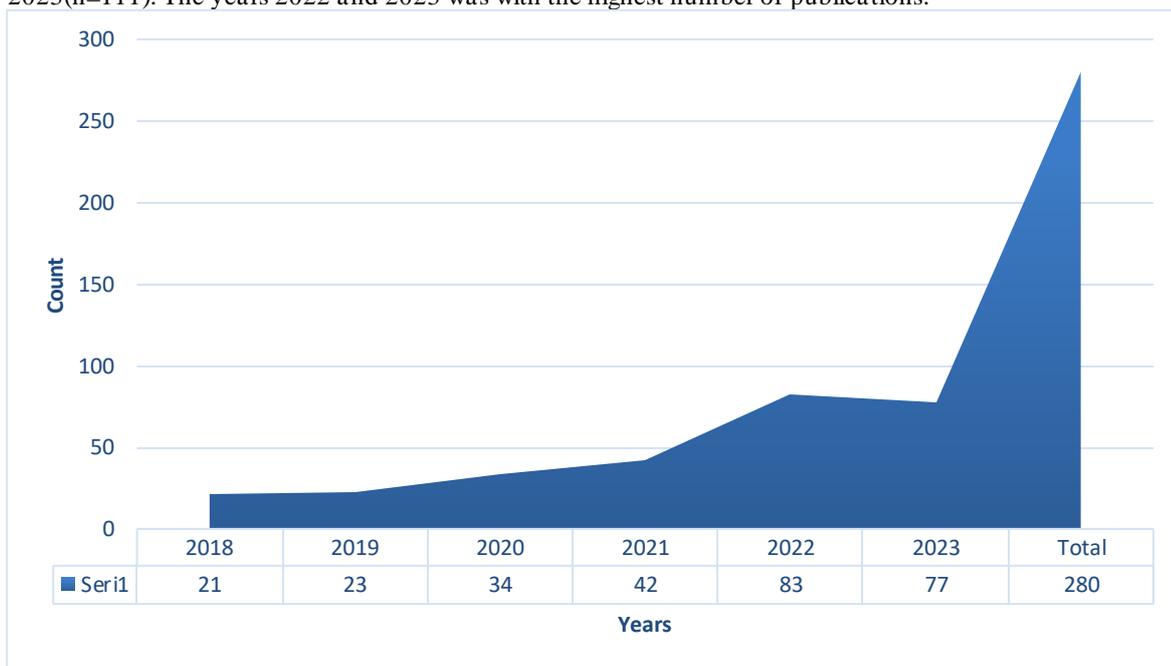
Data from the database were downloaded by year. WoSViewer and Bibliyometrix was used to evaluate the collected data. WoSviewer is used for text mining. This function of WoSviewer allows the creation of a set of document-based maps (Van Eck & Waltman, 2011). WoSviewer analyzes co-occurrences, bibliographic joins and links in documents using network, overlay or density visualization methods (Arruda et al., 2022). Bibliometrix is both a programming language and a free environment for statistical computing (Arruda et al., 2022). It provides detailed analysis using phased analysis methods. To achieve significant findings in some analyses, data was compiled in Excel.

## FINDINGS

Findings according to the research questions are presented in this section.

### What are the trends of Web3 studies according to years?

The distribution of the studies according to years was analyzed. When Figure 1 is analyzed, the years with the highest number of publications were 2018(n=29), 2019 (n=28), 2020 (n=39), 2021(n=57), 2022 (n=106) and 2023(n=111). The years 2022 and 2023 was with the highest number of publications.



**Figure 1. The general distribution of research by years**

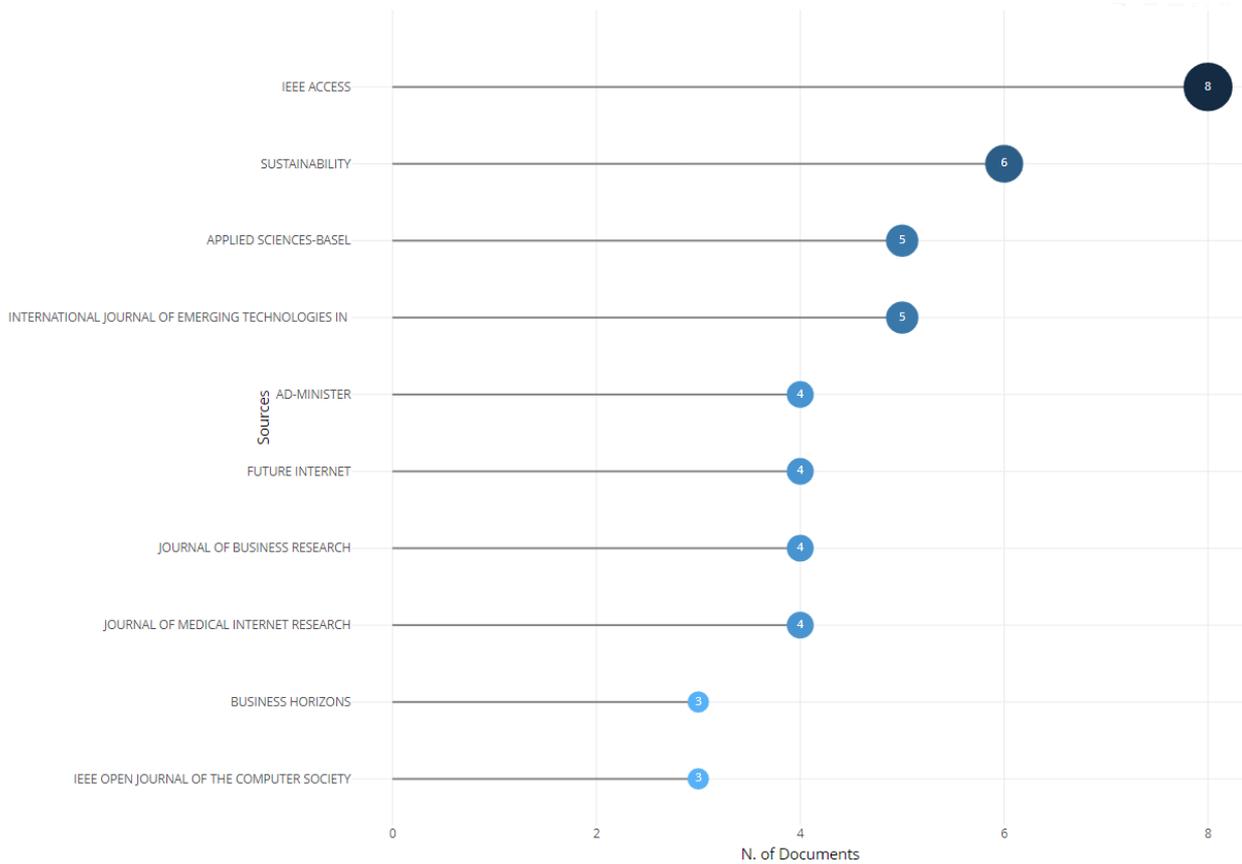
Studies on Web3 have definitely increased every year. However, this increase was very small before 2021, and the increase between 2021 and 2022 was high. Although it is half of 2023, the work is much more than previous years.

### What are the trends of journals for Web3 studies?

The journals in which Web3 studies were published in WoS and SCOPUS databases, their impact factors and the status of the journals on Web3 over time were examined.

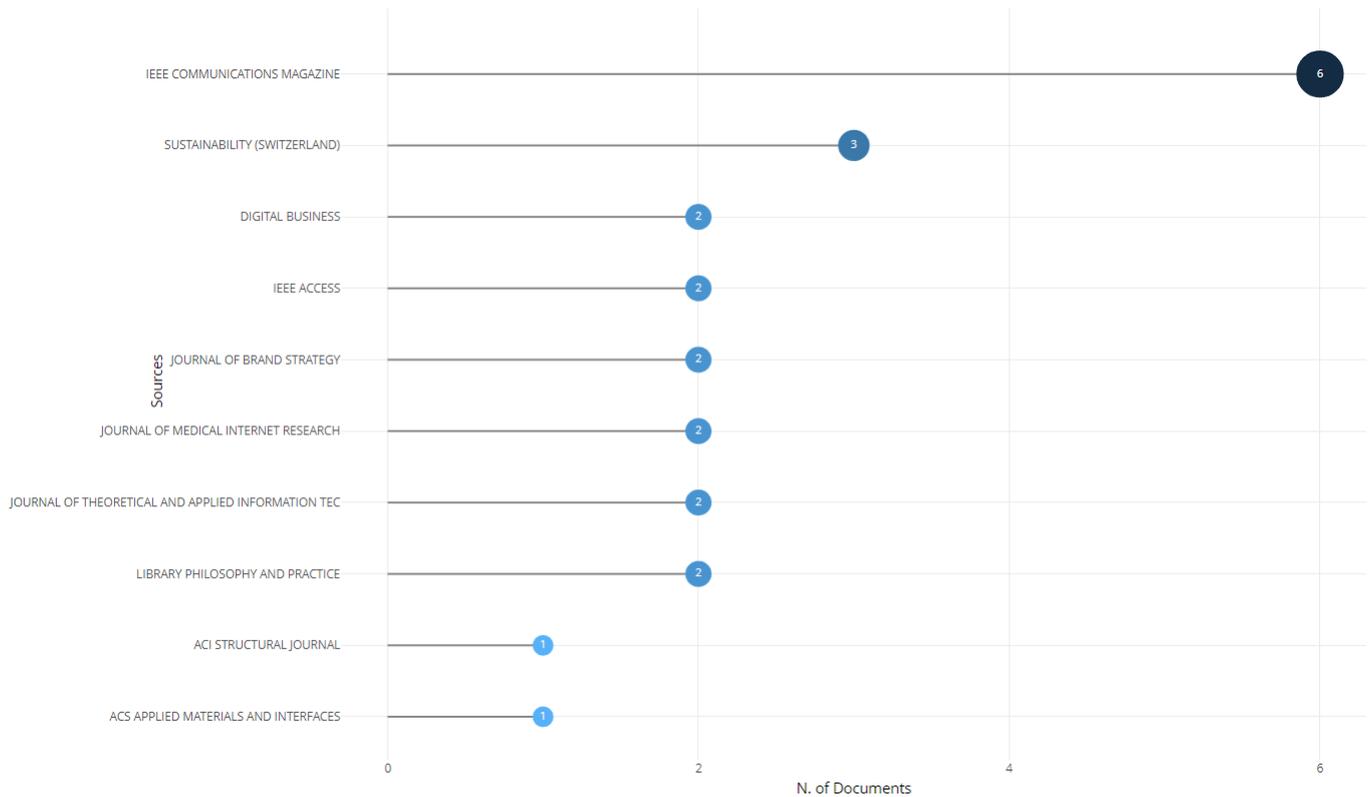
### What is the general distribution of journals?

The journal distribution of studies published in WoS is given in Figure 2. In this graph, the journals that published the most articles on the subject are. IEEE Access, Sustainability, Applied Science-Basel and International Journal of Emerging Technologies in are the journals with the highest number of publications. Thus, the journals that publish the most articles on Web3 are given below according to publication frequency. The scope of these journals can be considered in line with Web3 studies.



**Figure 2. Journals reviewed in WoS**

The journal distribution of studies published in SCOPUS is given in Figure 3. Similarly, in this graph, the journals that published the most articles on the subject are. IEEE Commnations Magazine, Sustainability, Digital Business, IEEE Access were the journals with the highest number of publications.



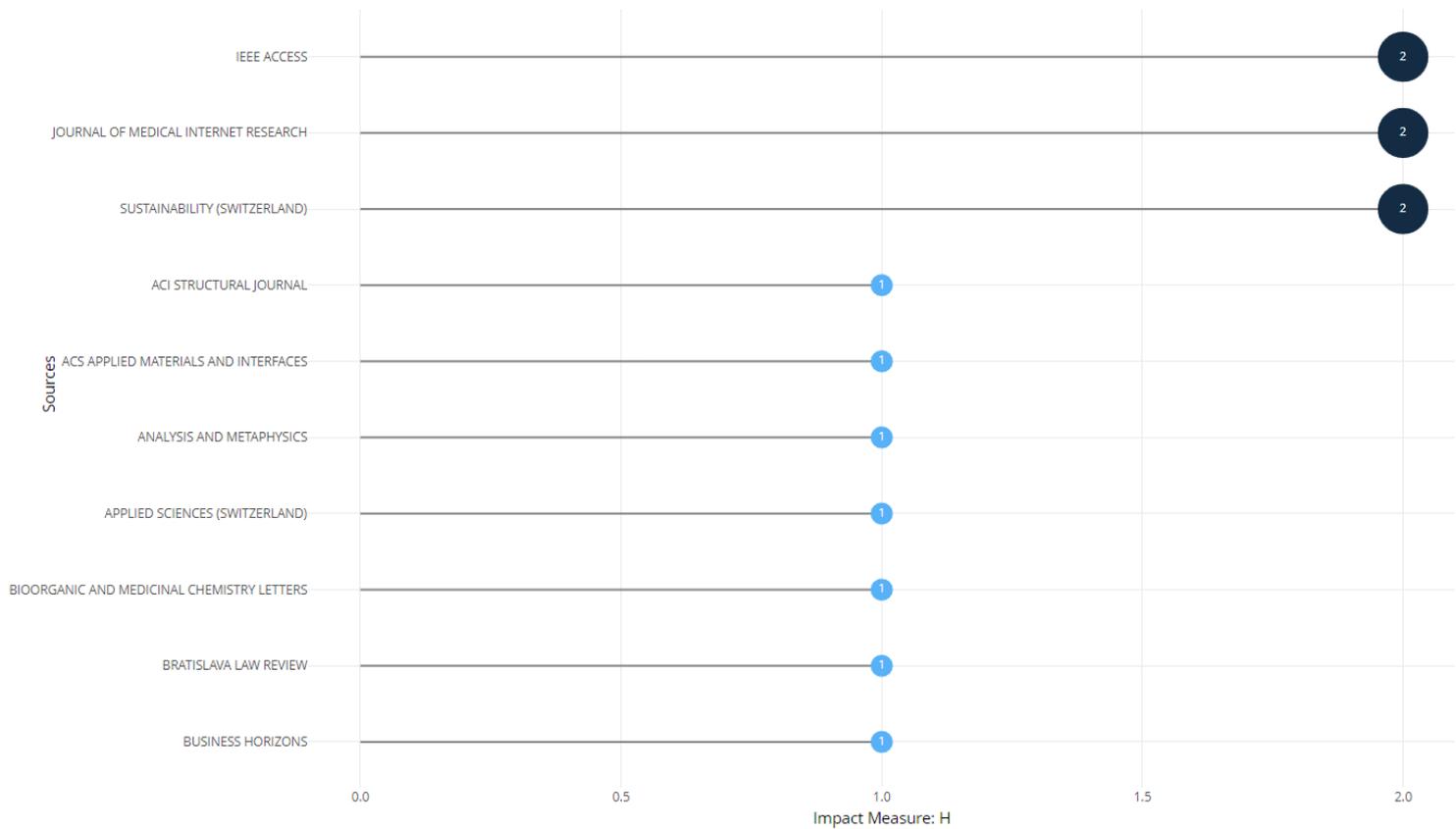
**Figure 3. Journals reviewed in SCOPUS**

### How are the impact factors of journals?

Figure 4 and Figure 5 show the local impact factors of these journals with the highest number of publications. According to these graphs, IEEE Access, Journal of Medical Internet Research and Sustainability have higher impact factors than the others in WoS and SCOPUS databases. In terms of the impact factors of the journals, the journals and impact factors of the articles published in both databases were similar.



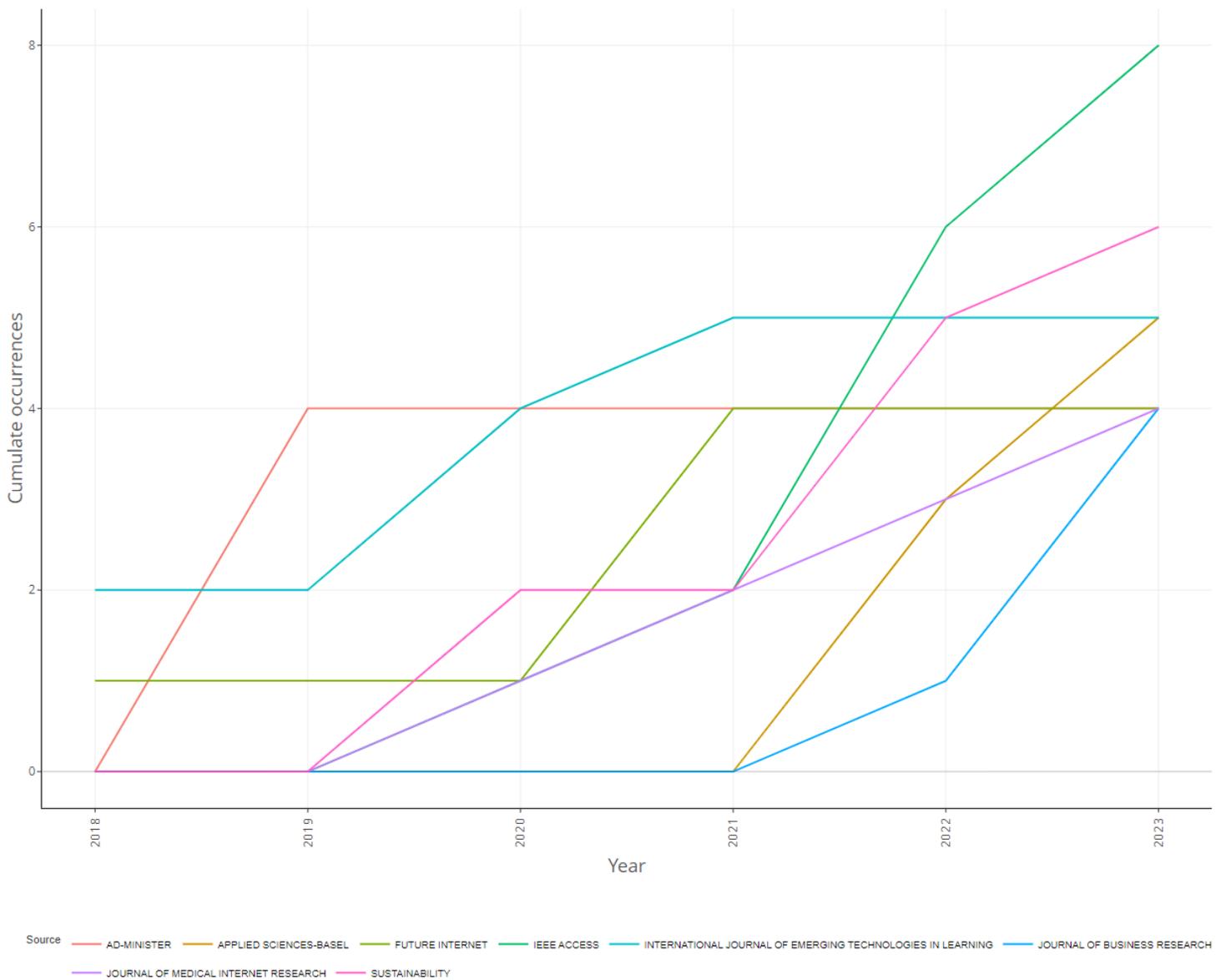
**Figure 4. Impact factor of journals reviewed in WoS**



**Figure 5. Impact factor of journals reviewed in SCOPUS**

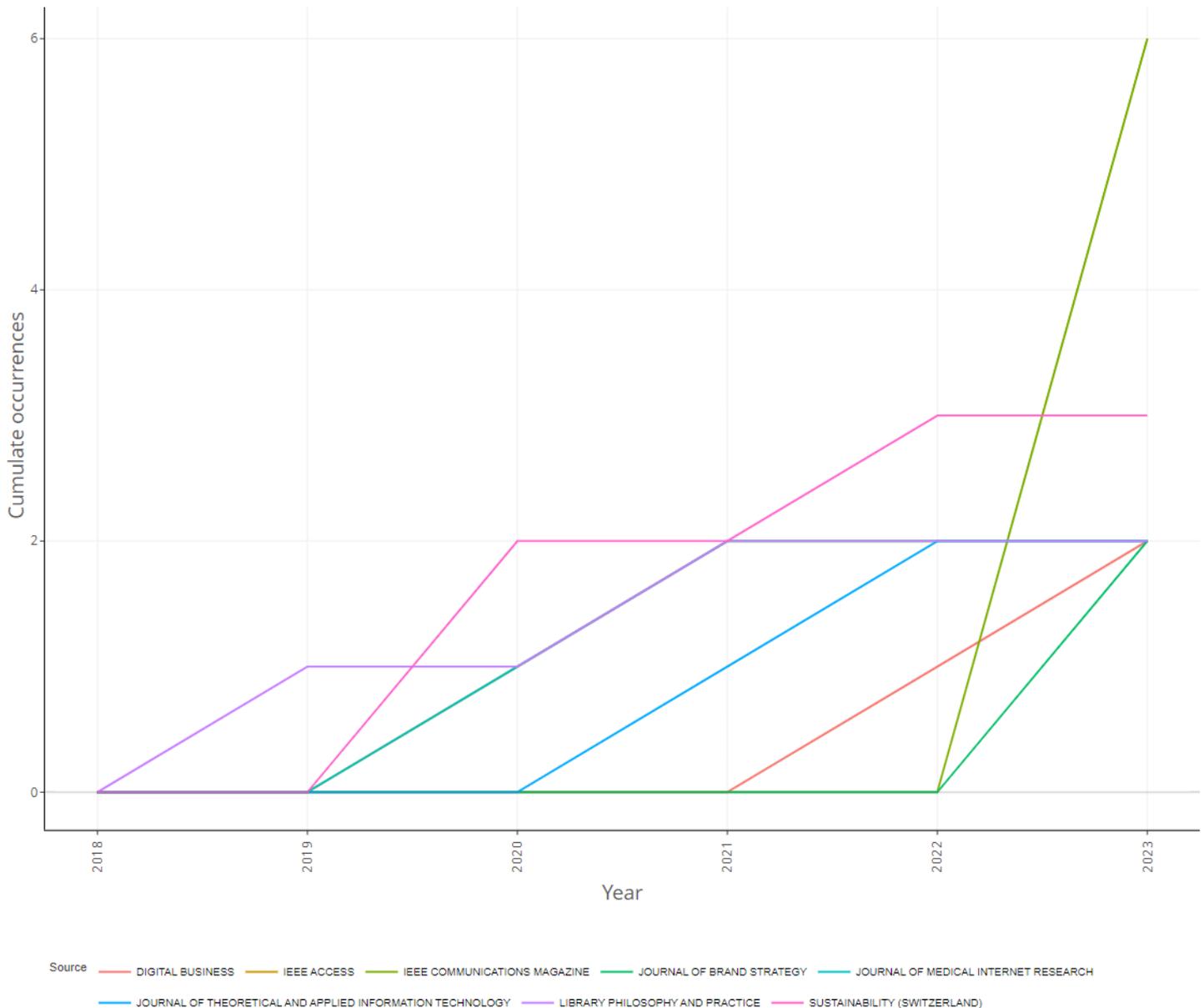
**How is the publication frequency of journals according to years?**

The publication status of the journals with the highest number of publications in WoS over time is given in Figure 6. This graph shows the publication status of journals between 2018 and 2023. It has been observed that the journals in general have increased in publication frequency in the time interval. IEEE Access, Journal of Medical Internet Research and Sustainability, Journal of Business Research, Applied Science-Basel, Journal of Medical of Internet Research have shown a continuous increase in publications. However, it has been observed that Ad-minester, Future Internet, International Journal of Emerging Technologies in Learning have stagnated as of 2021. It can be said that the Journal of Medical of Internet Research has shown a continuous increase as of 2019.



**Figure 6. Publication frequency of journals reviewed in WoS**

The publication status of the journals with the highest number of publications in SCOPUS over time is given in Figure 7. This graph shows the publication status of journals between 2018 and 2023. It was observed that the journals in general showed an increase in publication frequency in the time interval. Digital Business, Journal of Brand Strategy showed a continuous increase in publications. However, it was observed that the journals of Library Philosophy and Practise, Sustainability, Jornal of Theoretical and Applied Information Technology stagnated as of 2022. It can be said that IEEE Communications Magazine has shown a continuous increase as of 2022.

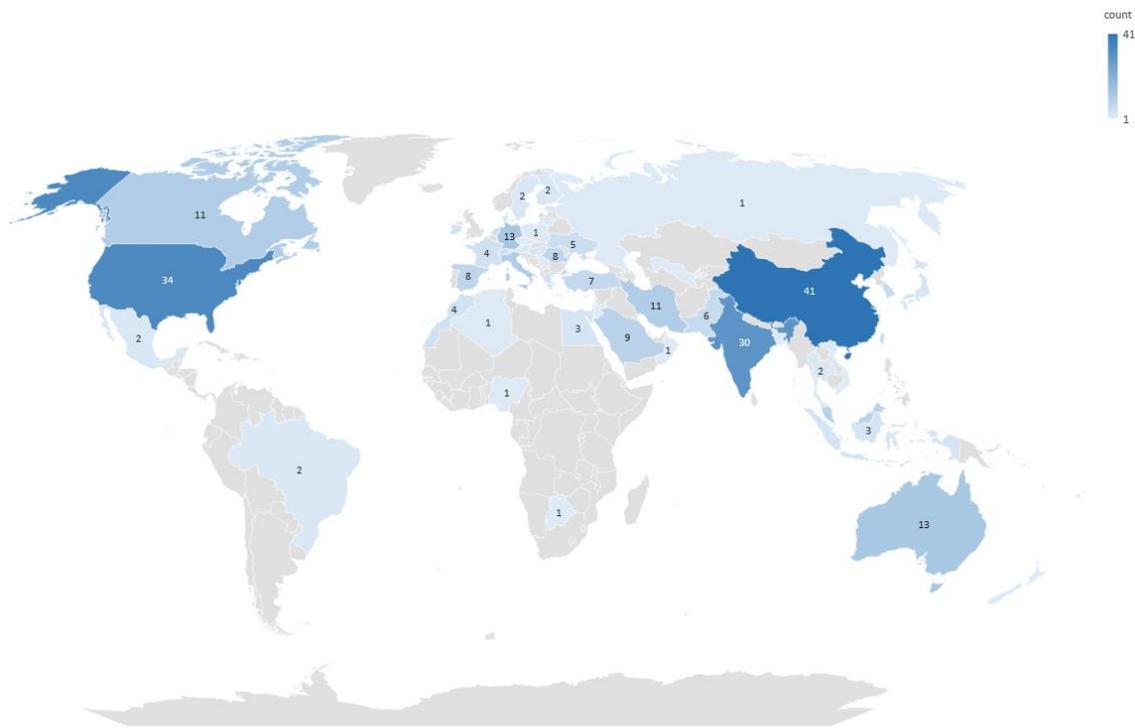


**Figure 7. Publication frequency of journals reviewed in SCOPUS**

**Which countries and institutions contributed the most to Web3 literature?**

**How is the general distribution of countries according to Web3 studies?**

The studies were analyzed according to the countries with the most publications. As seen in Figure 8, the top five countries that produced the most publications were the China (n=41), The USA (n=34), India (n=30), England (n=23), Germany(n=13), Australia (n=13), Canada (n=11), Iran (n=11), Italy (n=11), Saudi Arabia (n=9).

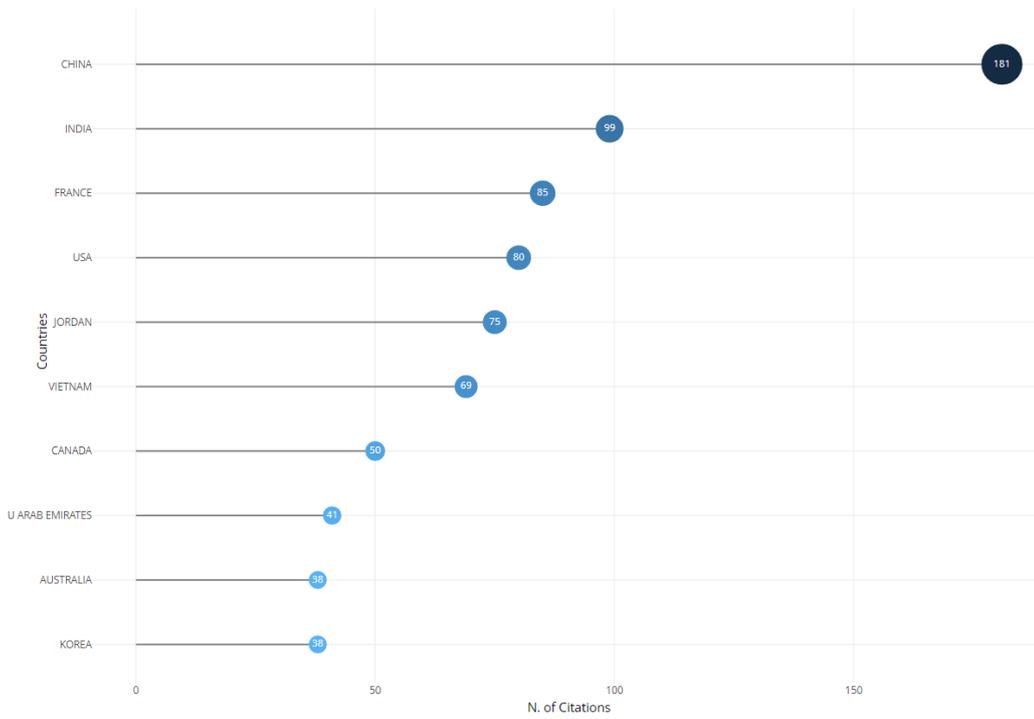


**Figure 8. General distribution of countries**

The distribution of the countries of the research conducted in the last twenty years in the world is shown in Figure 8. It has been seen that the researches are more frequent in China and the USA.

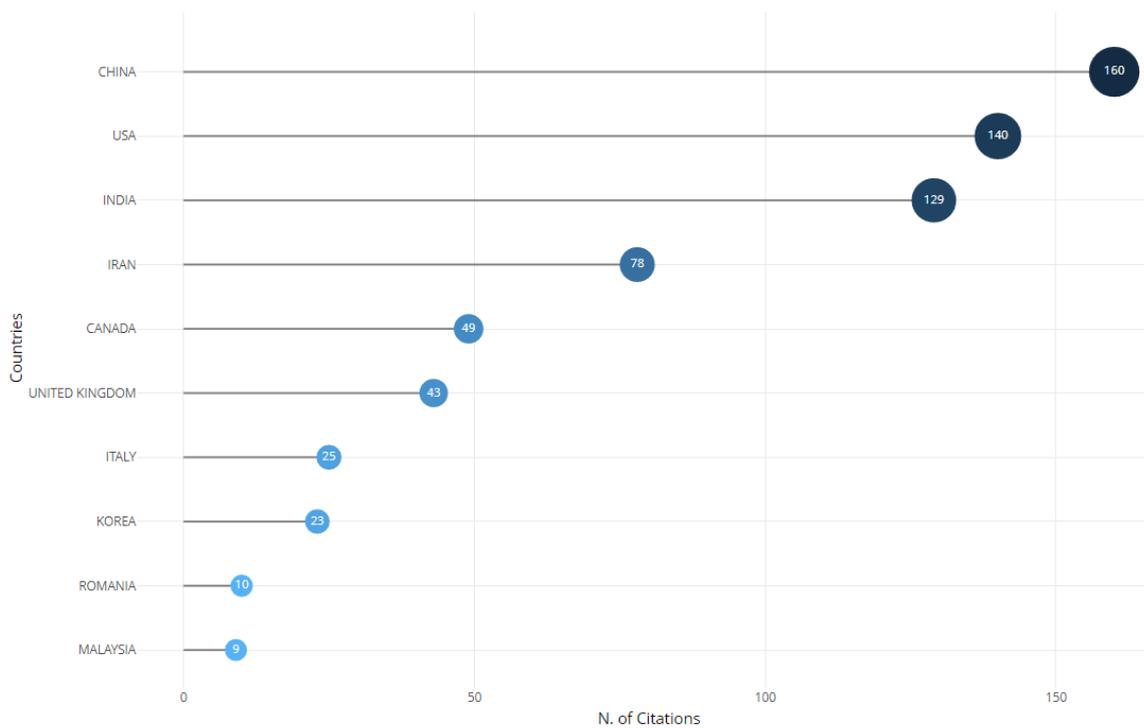
**What is the situation of countries according to the number of citations?**

The most cited countries in articles published in Wos and SCOPUS databases were analyzed and given in Figure 9 and Figure 10. According to this analysis, China is the country with the highest number of publications. This finding is normal since China has the most publications. China was followed by India and France. These countries were followed by the USA, Jordan, Vietnam, Canada, The Arab Emirates, Australia and Korea.



**Figure 9. Most cited countries in Journals reviewed in WoS**

The most cited countries in the research published in SCOPUS differed and China and the USA were the most cited countries. These countries were followed by India, Iran, Canada, UK, Italy, Korea, Romania, Romania and Malaysia.



**Figure 10. Most cited countries in Journals reviewed in SCOPUS**

### What is the general distribution of institutions according to Web3 studies?

The most cited institutions in articles published in Wos and SCOPUS databases are analyzed and presented in Figure 11 and Figure 12. The University of Tehran was the institution that conducted the most research. This was followed by the Automat Institute and the University of Cambridge. Unlike the analysis based on the SCOPUS database, Dublin City University was also one of the most cited institutions.

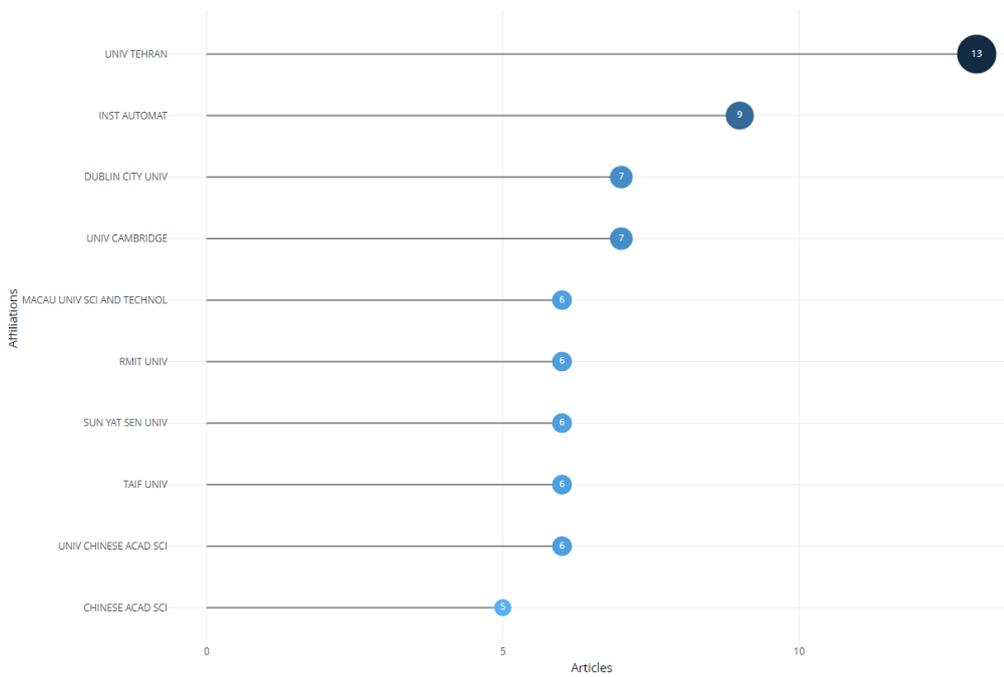
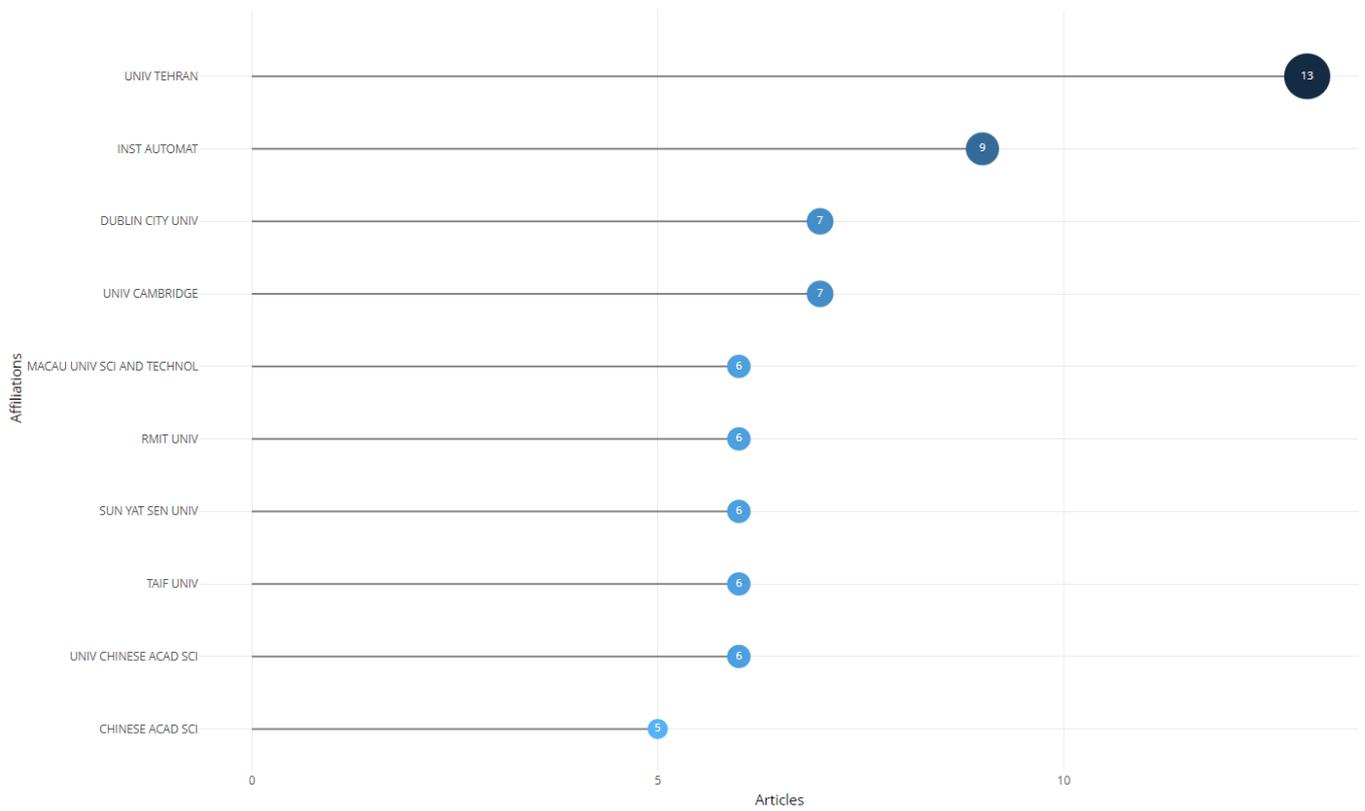


Figure 11. Most cited institutions in journals reviewed in WoS

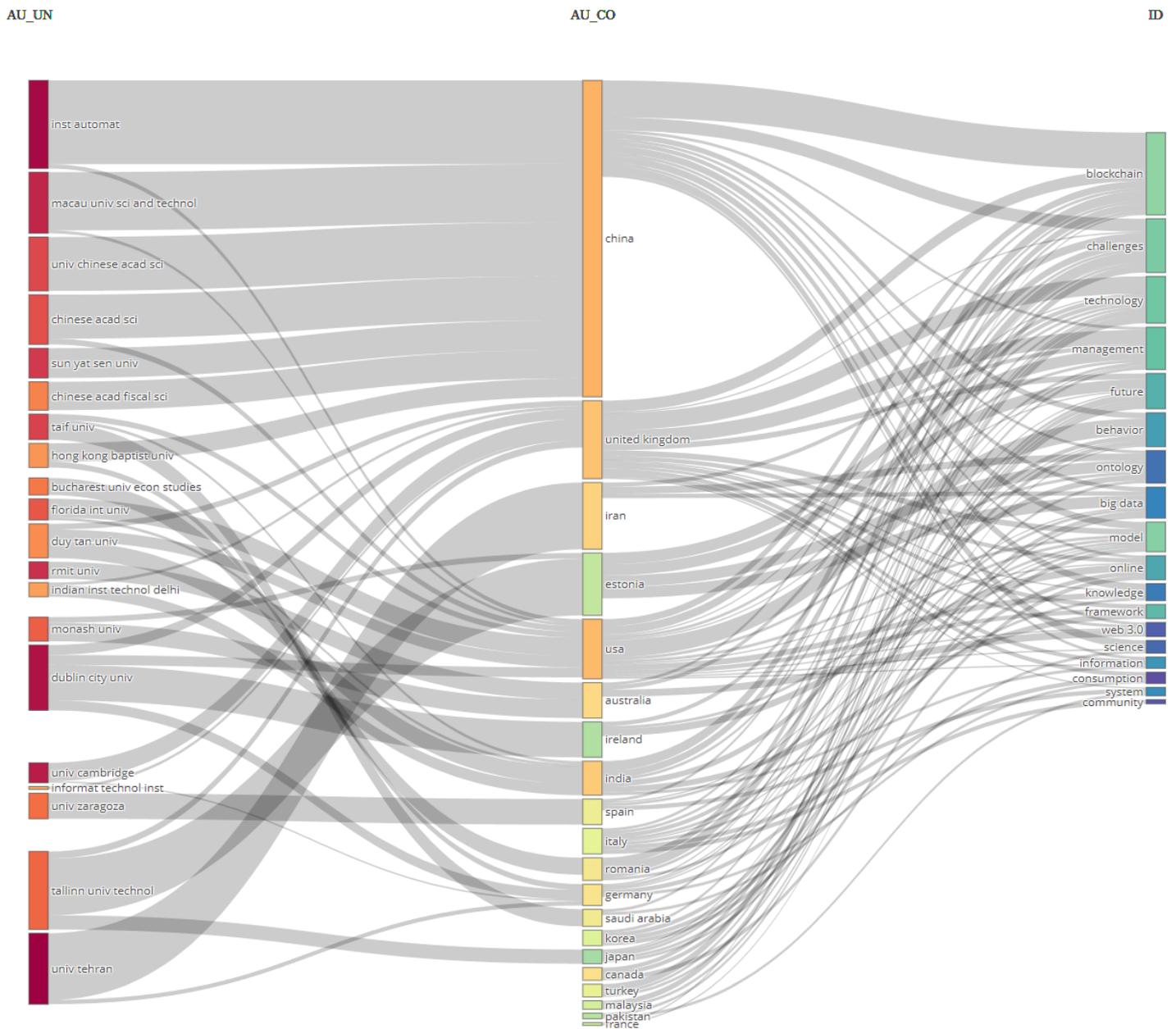


**Figure 12. Most cited institutions in journals reviewed in SCOPUS**

### **What topics have institutions and countries addressed about Web3?**

The topics covered by institutions and countries on Web3 are analyzed and given in Figure 13 and Figure 14. When Figure 13 is analyzed, China accounts for some of the publications on WoS. It is seen that many institutions in China collaborate with other countries and work on all of the prominent topics such as

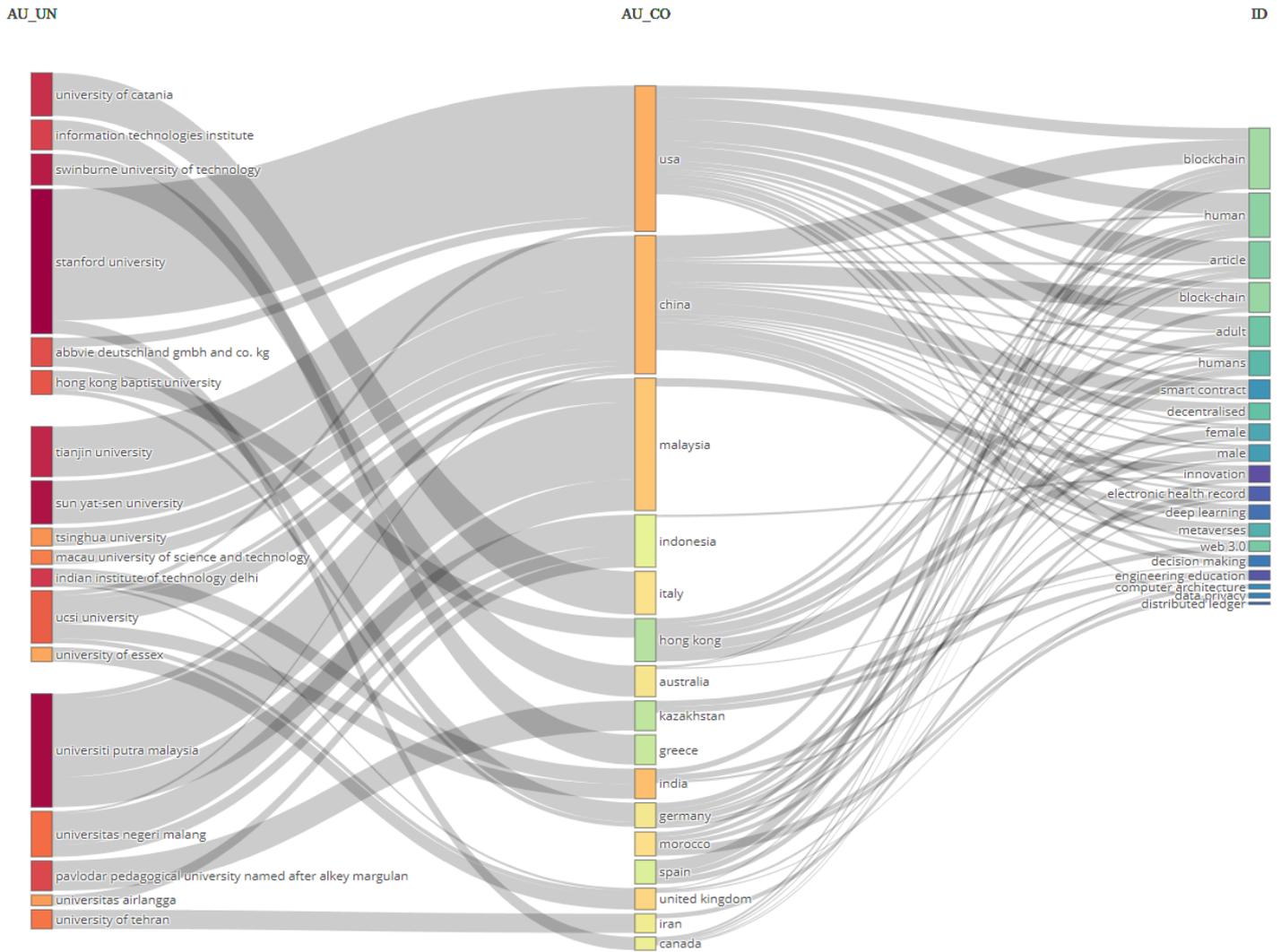
blockchain, challenges, technology, management, future, behavior, ontology, big data, model. The United Kingdom, which follows China, is also working on all of these topics.



**Figure 13. The topics covered in journals reviewed in WoS**

Figure 14 shows that China and the USA account for some of the publications in SCOPUS. It is seen that these two countries and blockchain, human, article, adults, humans, smart contract, decentralization, female, male, innovation, electronic health record, deep learning, metaverse are all related to prominent topics. Malaysia was the country following the United States and China. It was observed that Stanford University in the United States conducted the most research, followed by Catania University. In China, Tianjin University

and Sun Yat-sen University were among the prominent institutions. Universiti Putra Malaysia was the institution that conducted the most research in Malaysia.



**Figure 14. The topics covered in journals reviewed in SCOPUS**

**What are the keywords, topics and themes used in studies on Web3?**

**What is the distribution of research by keywords?**

The frequency of use of the keywords used in the studies was determined as 5 and is presented in Figure 15. When Figure 15 is analyzed, the keywords used in the studies published on Web3 in the last six years are analyzed. In general, the top ten most frequently used keywords are as follows. These are Web3, blockchain, metaverse, block-chain, smart contract, social media, web 2.0, cryptocurrency, smart contracts, virtual reality,





Figure 17 shows all the keywords used in the studies and their frequency of use.

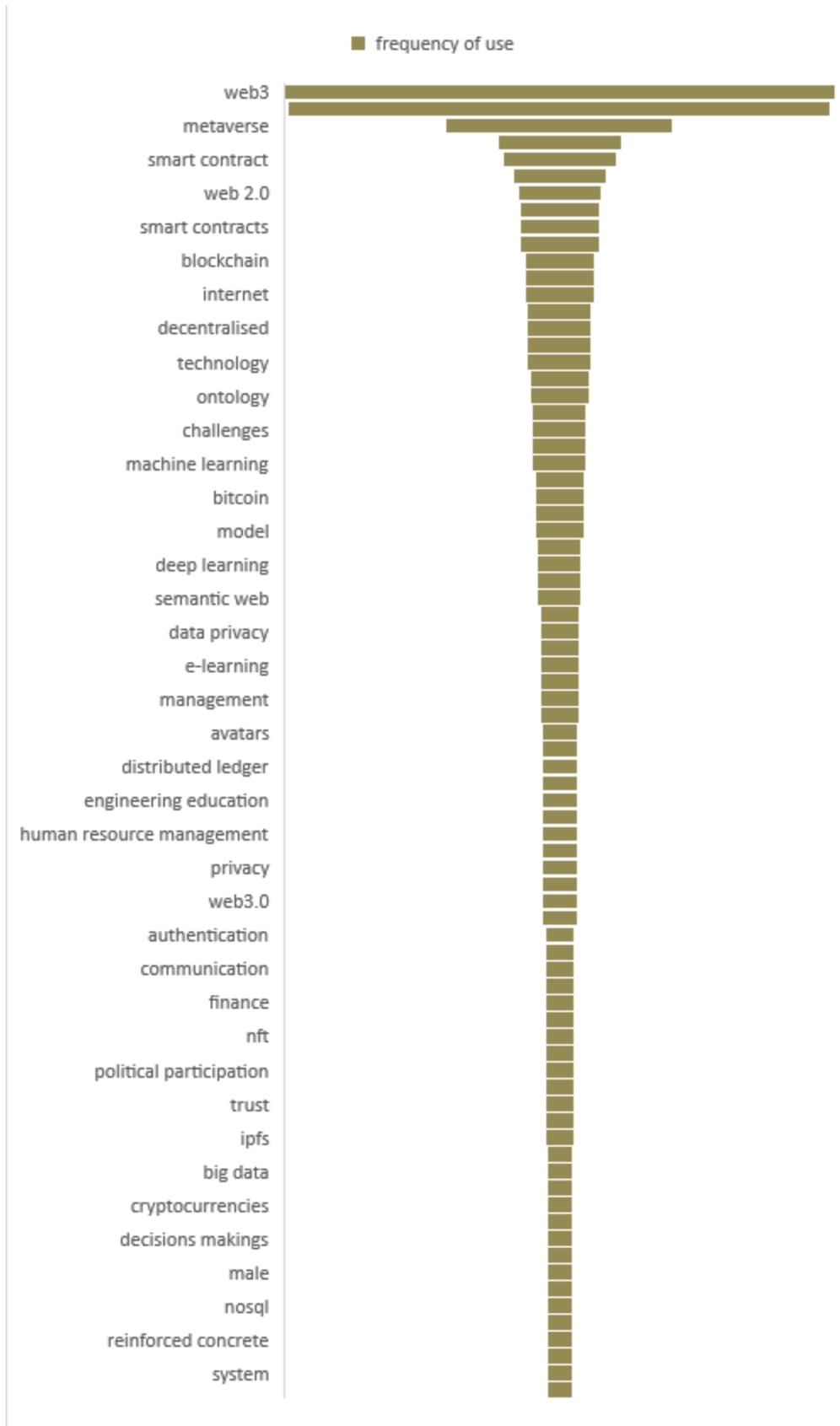
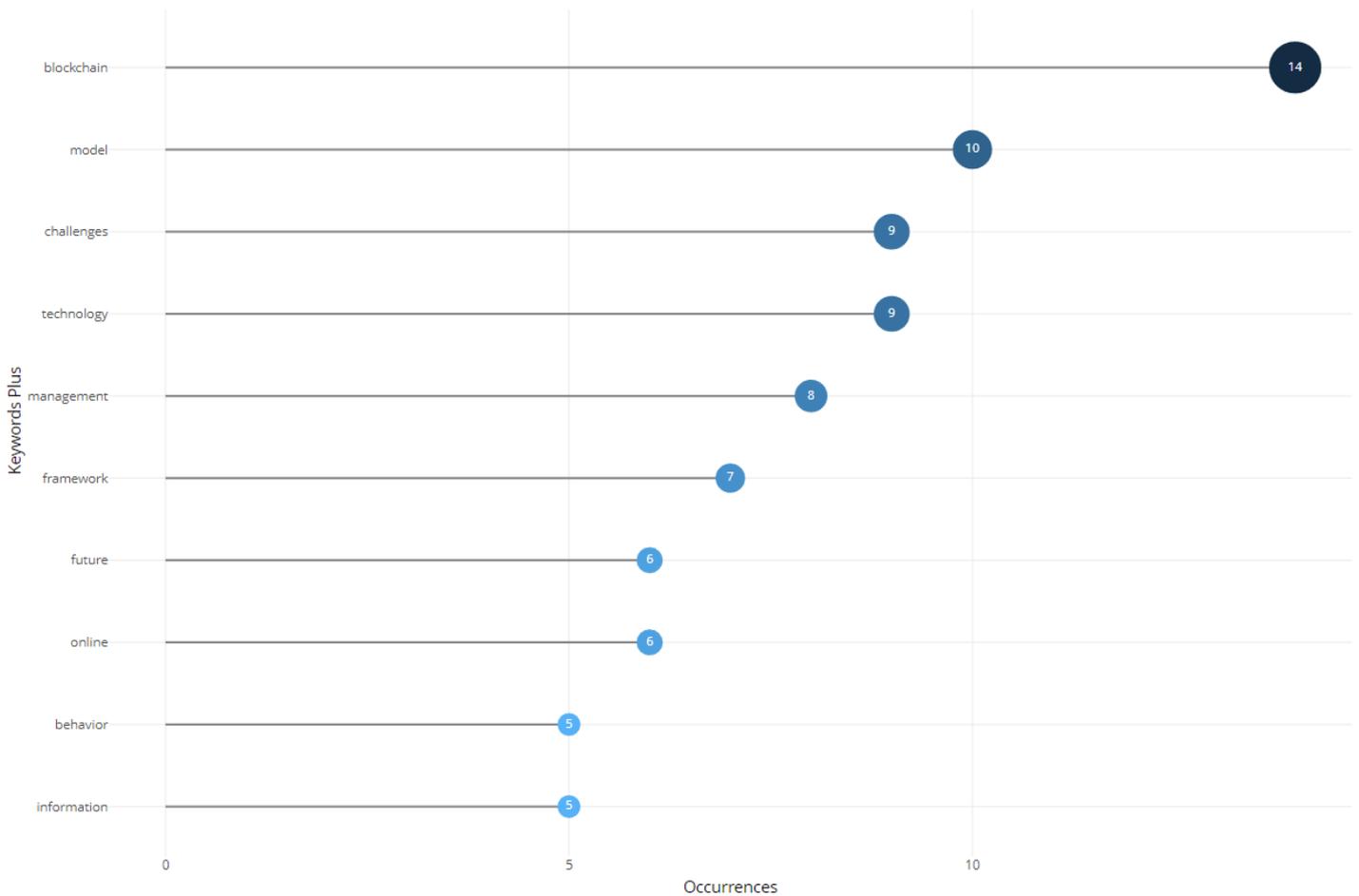


Figure 17. The general distribution of research by keywords

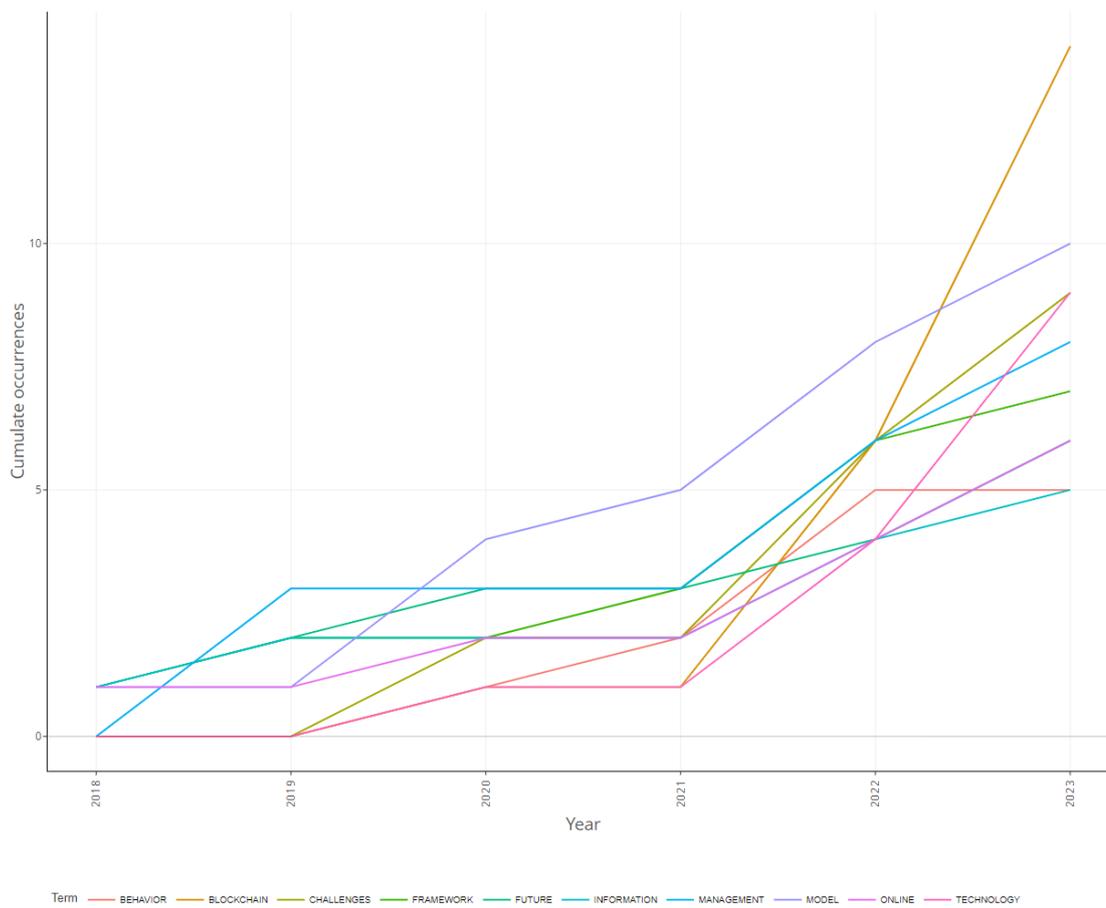
### What are the topics and trends in Web3 studies?

The most frequently used words in the research on WoS were analyzed and given in Figure 18. As seen in Figure 18, the most frequently used words in publications on WoS are blockchain, model, challenges, technology, management, framework, future, online, behavior, information.



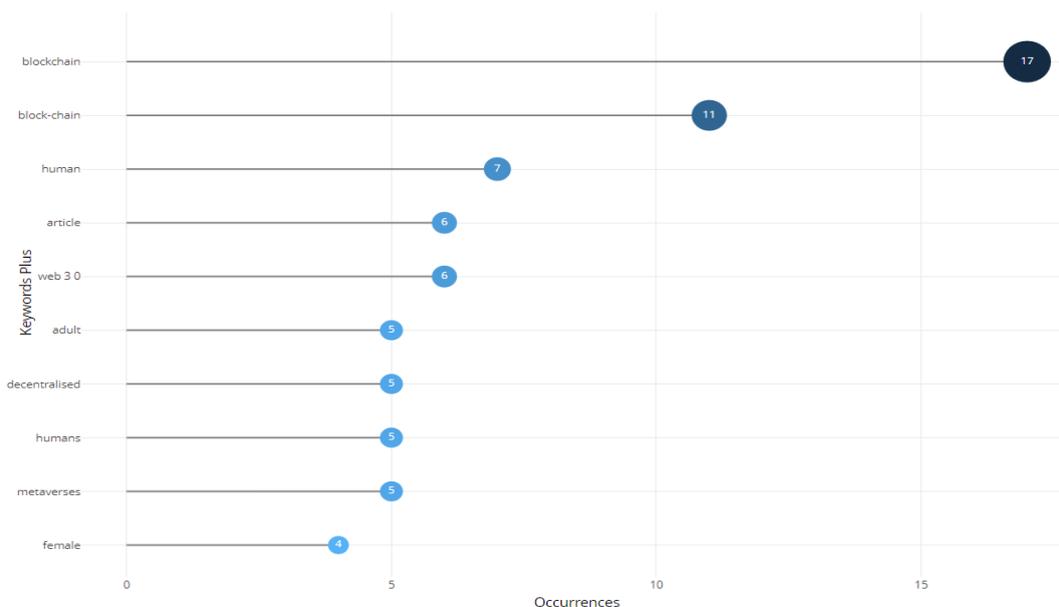
**Figure 18. Most frequently used words in journals reviewed in WoS**

The usage status of these most frequently used words between 2018 and 2023 is given in Figure 19. According to Figure 19, only the use of blockchain stabilized in 2022. It can be said that this topic has reached saturation. The use of other words has gradually increased.



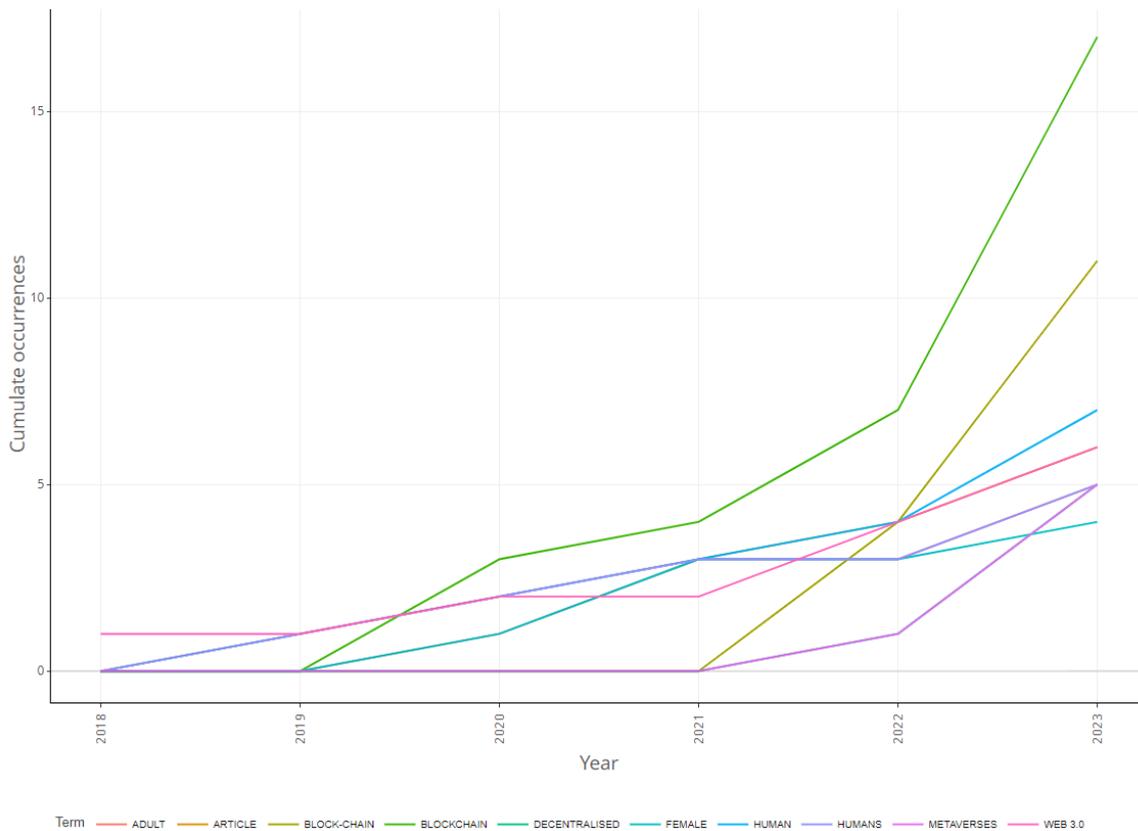
**Figure 19. Status of the most frequently used words in journals reviewed in WoS**

The most frequently used words in the studies on Scopus were analyzed and given in Figure 20. As seen in Figure 21, the most frequently used words in publications in SCOPUS are blockchain, human, article, Web3, adult, decentralized, humans, metaverses, female.



**Figure 20. Most frequently used words in journals reviewed in SCOPUS**

The usage status of these most frequently used words between 2018 and 2023 is given in Figure 21. According to Figure 21, the use of these words increased after 2022. Especially the word humans started to be used after 2021.

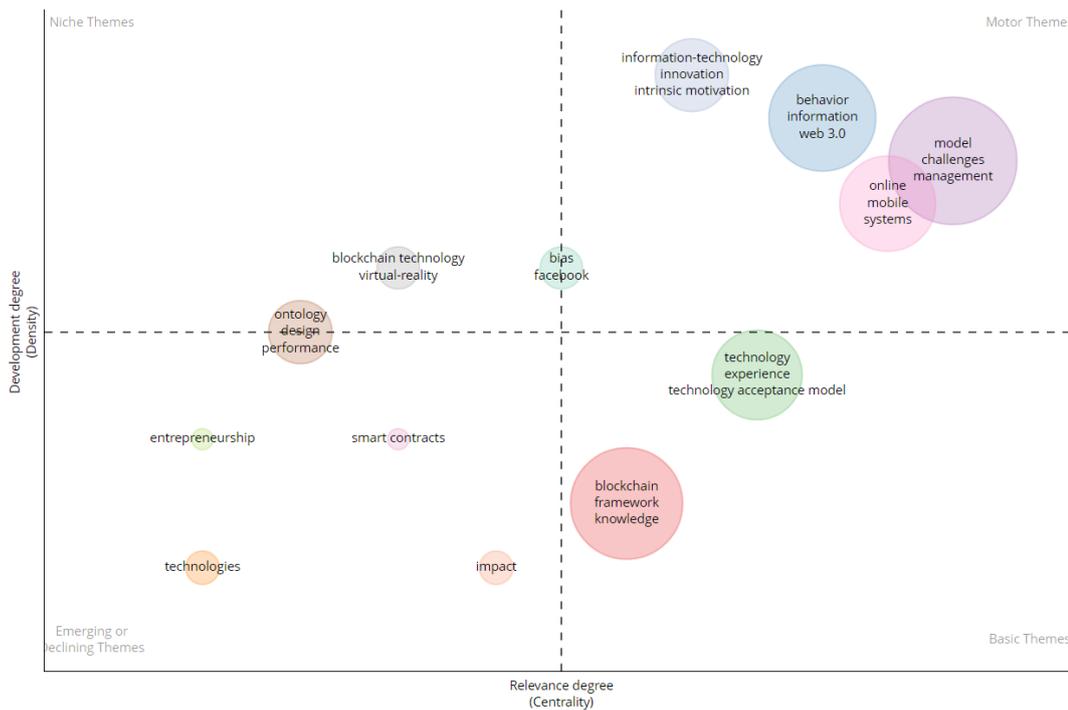


**Figure 21. Status of the most frequently used words in journals reviewed in SCOPUS**

**What are the themes in Web3 studies?**

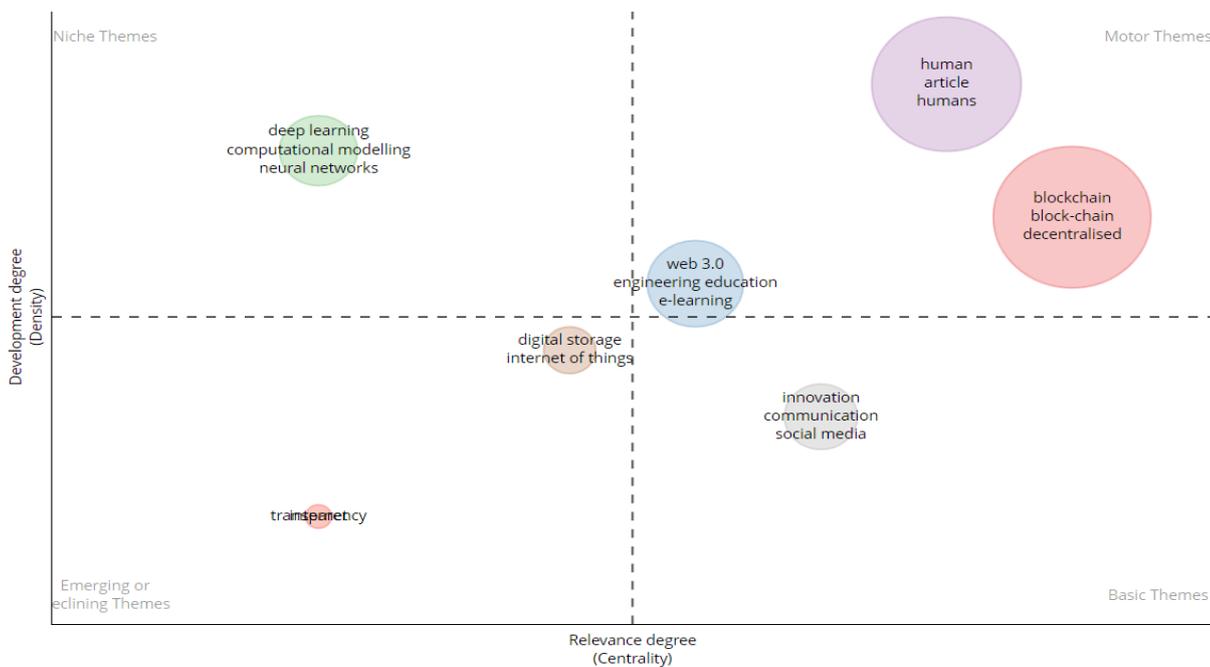
The themes that emerged in the research are given in Figure 22 and Figure 23. In this thematic map, engine themes are grouped as motor themes, basic themes, emerging and declining themes, and niche themes (least covered themes), and are given according to the level of relevance and degree of development.

The themes emerging from the research published in WoS are analyzed and presented in Figure 22. According to this, motor themes are, information-technology, innovation, intrinsic motivation, behavior, information, Web3, online, mobile, system, model, challenges and management. Basic themes are technology, experience, technology acceptance model, blockchain, framework, knowledge. Emerging and declining themes are impact, smart contracts, entrepreneurship, Technologies Niche themes are blockchain technology, virtual-reality, ontology design and performance. Virtual-reality, ontology desing and performance are also related to emerging or declining themes. However, the themes directly at the center are BIAS and Facebook. BIAS and Facebook are also related to motor themes.



**Figure 22. Themes that emerged in journals reviewed in WoS**

The themes that emerged in the research published in SCOPUS are analyzed and given in Figure 23. According to this, motor themes are Web3, engineering education, e-learning, human, article, humans, blockchain and decentralized. Basic themes are technology, innovation, communication and social media. Emerging and declining themes are digital storage and internet of things. Niche themes are deep learning computational modelling and neural networks.



**Figure 23. Themes that emerged in journals in SCOPUS**

### What is the distribution of research by subject area?

The keywords used in the studies were analyzed. During the analysis, the frequency of use was determined as 17. When Figure 24 is analyzed, the highest number of studies were conducted in Computer Science, Engineering, Social Sciences, Business, Management and Accounting, Business Economics, Materials Science, Telecommunications, Mathematics, Arts and Humanities, Mathematics.

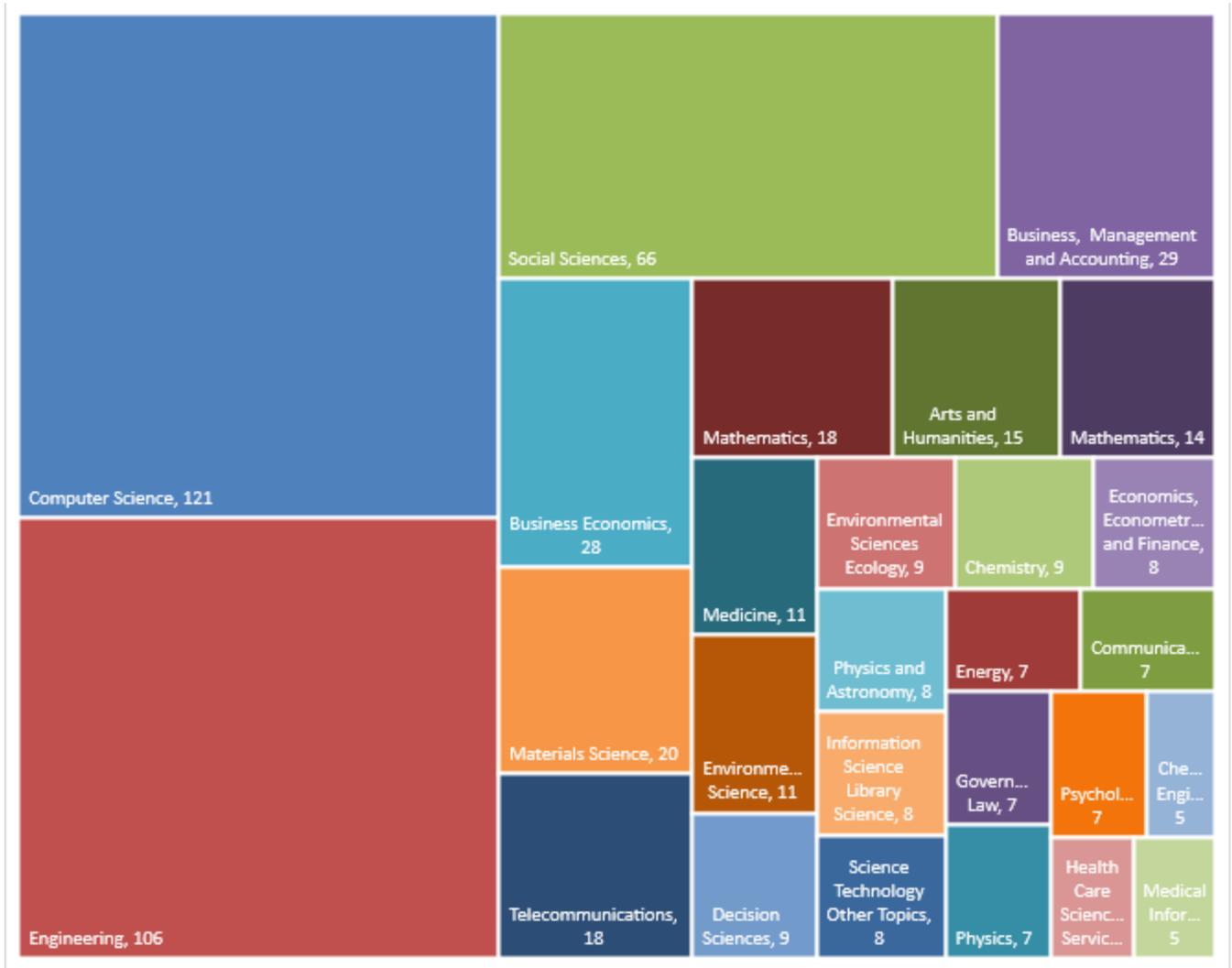


Figure 24. The general distribution of research by subject area

### RESULT, DISCUSSION AND SUGGESTIONS

In this study, the trends of the articles published in any field related to Web3 in the last six years, the trends of the journals in which they were published, the institutions and countries that contributed the most, the keywords used in the studies, the topics and themes and the distribution of research areas were investigated.

When the distribution of studies by years is analyzed, a significant increase was observed in studies related to Web3 in 2022. In case the studies are limited until August 2023, studies have been conducted and continue to be conducted in the first half of 2023. Wang et al. (2022) also stated that Web3 is the most studied topic to date as of 2022.

When the general distribution of journals is analyzed, the journals with the most publications in WoS and SCOPUS differ. However, it is seen that Web3 studies are published more in engineering, health and business journals. Among these journals, IEEE Access, Journal of Medical Internet Research and Sustainability were found to have a higher impact in WoS and SCOPUS databases than the others. IEEE Access is an open access journal that supports interdisciplinary studies on applications (Learn More About IEEE Access - IEEE

Access, n.d.). Journal of Medical Internet Research is an open-access journal that supports research in healthcare, focusing on applications in emerging technologies, medical devices, applications, engineering, telehealth and informatics for patient education, population health and clinical care (Journal of Medical Internet Research, n.d.). Sustainability is an interdisciplinary open access journal on human environmental, cultural, economic and social sustainability. It supports experimental, computational and theoretical research in the natural and applied sciences, engineering, economics, social sciences and humanities (Sustainability, n.d.). What these three valuable journals have in common is that they support applied and interdisciplinary research. Therefore, it can be assumed that most of their studies are applied and interdisciplinary. When the journals are analyzed according to the frequency of publication, there is a general increase after 2022, which is consistent with the finding that Web3 studies increased as of 2022.

The countries that contributed the most to Web3 were China, The USA, India, England, Germany. Looking at the overall distribution, China and the USA have a large part of this distribution. In the study of Belk et al. (2022), it is stated that China and the USA not only research Web3 technologies but also implement them and even develop laws for this purpose. The countries with the highest number of citations were China, USA, India, UK, Iran and Canada. Tehran University, Dublin City University, Automat Institute and Cambridge University were the institutions that published the most. In general, it can be said that countries and institutions have done a lot of work on Web3. China, the USA and the UK have significant cooperation and research on this issue. The prominent Web3 topics in WoS and SCOPUS differed from each other. The studies published in WoS focused on the theoretical structure, future and opportunities of Web3 technology, while the publications in SCOPUS focused directly on Web3 technology and its applications.

In particular, blockchain has been one of the most studied topics as stated by Wang et al. (2022). Metaverse, which means "beyond universe", has been utilized and studied in many fields (Koçak, 2023). Decentralization, on the other hand, is a feature provided directly by the Web3 (Treleaven et al., 2022; Wan et al., 2023), which is expected to be one of the most used words. Smart contracts are a type of digitized contract in the virtual world (Singh et al., 2020). It has been used in business processes due to its automaticity, but its widespread use has decreased due to trust issues (Wan et al., 2023). The effects and benefits of Web3 on humanity have been the subject of some of the research. These studies are generally related to the metaverse and are related to personalization and virtual reality (Kostenko et al., 2022; Boudlaie et al. 2019; Kalita and Deka, 2020; Mourtzis et al., 2022).

When the research is analyzed thematically, information-technology, innovation, intrinsic motivation, behavior, information, Web3, online, mobile, system, model, challenges and management are the main themes in the publications in WoS. Basic Themes are technology, experience, technology acceptance model, blockchain, framework, knowledge. Emerging and declining themes are impact, smart contracts, entrepreneurship, technologies. Niche themes are blockchain technology, virtual-reality, ontology design and performance. Virtual-reality, ontology design and performance are also related to emerging or declining themes. The situation is slightly different in the research in SCOPUS. Motor themes are Web3, engineering education, e-learning, human, article, humans, blockchain and decentralized. Basic Themes are technology, innovation, communication and social media. Emerging and declining themes are digital storage and internet of things. The most prominent themes are information-technology, Web3, online, mobile, system, model, challenges and management, innovation, behavior, engineering education, e-learning, human, article, humans, blockchain and decentralized. Niche themes deep learning computational modeling and neural networks. Thus, the least studied topics were blockchain technology, virtual-reality, ontology design and performance, deep learning computational modelling and neural networks. These topics are open for further research and practical products can be developed.

When the studies are examined according to the subject area, It is a fact that Web3 is an interdisciplinary field. Computer Science, Engineering, Social Sciences, Business, Management and Accounting, Business Economics, Materials Science, Telecommunications, Mathematics, Arts and Humanities, Mathematics are the most studied areas. Besides these areas, Medicine Environmental Science, Decision Sciences, Environmental Sciences Ecology, Chemistry, Economics, Economics, Econometrics and Finance, Physics and Astronomy, Information Science Library Science, Science Technology Other Topics, Energy, Communication, Government Law, Physics Psychology, Chemical Engineering, Health Care Sciences Services, Medical Informatics are also the studied areas. While some of the studies in the field of Computer Science and Engineering have explored

blockchain, security, sensors, decentralization, smart contracts, deep learning (Koochi-Var et al., 2018; Ducreé et al., 2020; Kadadha et al., 2020; Beniiche et al., 2022; Wang et al., 2023; Pervez et al., 2023), studies in the field of social sciences have explored blockchain, decentralized systems, survey, social, participation, political economy.

Studies in the fields of Business, Management and Accounting, Business Economics (Chaveesuk and Suaysukvicha, 2021; Sharafi Farzad et al., 2019; Sun And Qoin, 2023; Potluri And Vajjhala, 2018; Mehdi Sharifi et al., 2018) have conducted research on enabling conditions, Web 3.0 organization; Social Network Analysis; E-commerce, Customer Behavior Model, Online shopping, SMEs, Media Entrepreneurship, Creativity, Public Service and efficient media markets.

Web3 studies address many different disciplines with many topics. However, there is a need to deepen the studies. The policies, practices and even the laws of the countries regarding the Web3 are important for the studies on the Web3. The suggestions brought in this context are as follows:

### **Suggestions**

- Countries can set policies on Web3 and increase their efforts in this direction.
- Blockchain is one of the most studied topics, but it is understood that there are some hesitations about blockchain security. For this reason, Web3 studies can be conducted to increase blockchain security.
- The least studied topics were virtual-reality, ontology design and performance, deep learning computational modeling and neural networks. These topics are open for further research and practical products can be developed.

### **Limitations**

In this study, the studies analyzed by bibliometrics method are limited to WoS and SCOPUS databases. In addition, the fact that the analyzed studies are in English language is another limitation.

#### **Declarations**

#### **Conflict of Interest**

No potential conflicts of interest were disclosed by the author(s) with respect to the research, authorship, or publication of this article.

#### **Ethics Approval**

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The authors provide equal contribution to this work.

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