Girişimcilik İnovasyon ve Pazarlama Araştırmaları Dergisi
Yıl: 2023, 7(14): 109-125

Journal of Research in Entrepreneurship Innovation and Marketing
Year: 2023, 7(14): 109-125

Makale Türü: Araştırma Makalesi
Paper Type : Research Paper

Geliş Tarihi / Received: 27.11.2023
Kabul Tarihi / Accepted: 05.12.2023

Bibliometric Analysis of the Academic Development Process of the "Metaverse" in the World and Turkey

Leyla BEZGİN EDİŞ*
Sabiha KILIÇ**
Kübra Müge DALDAL***

https://doi.org/10.31006/gipad.1396827

Abstract

In this study, a bibliometric analysis was carried out to reveal the development process of academic studies on Metaverse in the world and in Turkey. The aim of the analysis is to examine the development process of the Metaverse concept in the academic world and to guide future research and studies on this subject. In the bibliometric analysis process, relevant publications were searched in Web of Science (WoS) and Scopus databases using the keyword "Metaverse" on 30.05.2023 and a total of 2201 publications were obtained from both databases between 1995 and 2022. The publications were analysed according to research areas, years, countries, institutions, keywords and number of citations. VOSviewer programme was used for keyword analysis. It was observed that the most studies on metaverse were conducted in the field of computer science in 2022. It was determined that the most publications were made at Sabancı University in our country and at the Chinese Academy of Sciences in the world. It can be said that the most cited publications on metaverse are the study of Davis et al. in 2009 and the study of Dionisio et al. in 2013.

Keywords: *Metaverse, web of science, scopus, metagalaxy, solipsis, bibliometrics, VOSviewer.*

Türkiye'de "Metaverse"ün Akademik Gelişim Sürecinin Bibliyometrik Analizi

Öz

Bu çalışmada, Metaverse konusunda dünyada ve Türkiye'de yapılan akademik çalışmaların gelişim sürecini ortaya koymak amacıyla bibliyometrik bir analiz gerçekleştirilmiştir. Analizin amacı, Metaverse kavramının akademik dünyadaki gelişim sürecini incelemek ve bu konuda gelecekte yapılacak araştırma ve çalışmalara yol göstermektir. Bibliyometrik analiz sürecinde 30.05.2023 tarihinde "Metaverse" anahtar kelimesi kullanılarak Web of Science (WoS) ve Scopus veri tabanlarında ilgili yayınlar taranmış ve her iki veri tabanından 1995-2022 yılları arasında toplam 2201 yayın elde edilmiştir. Yayınlar araştırma alanlarına, yıllara, ülkelere, kurumlara, anahtar kelimelere ve atıf sayılarına göre analiz edilmiştir. Anahtar kelime analizi için VOSviewer programı kullanılmıştır. Metaverse ile ilgili en çok çalışmanın 2022 yılında bilgisayar bilimleri alanında yapıldığı görülmüştür. En çok yayının ise ülkemizde Sabancı Üniversitesi'nde, dünyada ise Çin Bilimler Akademisi'nde yapıldığı tespit edilmiştir. Metaverse konusunda en çok atıf alan yayınların 2009 yılında Davis ve arkadaşlarının çalışması ile 2013 yılında Dionisio ve arkadaşlarının çalışması olduğu söylenebilir.

Anahtar Kelimeler*: Metaverse, web of science, scopus, metagalaksi, solipsis, bibliometri, VOSviewer.*

* ORCİD Dr, leyla.bezgin@hotmail.com,
** ORCİD Prof. Dr., Hitit Üniversitesi, İİBF, İşletme Bölümü, sabihakilic@hitit.edu.tr
*** ORCİD Dr. Öğr. Üyesi, Hitit Üniversitesi, İİBF, İşletme Bölümü, kmugedaldal@hitit.edu.tr

1. Introduction

The term "Metaverse" refers to a parallel virtual reality environment created by computer graphics that individuals around the world can access and connect to using virtual reality goggles and headsets (Stephenson, 2007; Dionisio et al., 2013). It was first used in Neal Stevenson's 1992 science fiction novel Snow Crash. The Street Protocol is the foundation of the metaverse. The street can be thought of as an analog highway that connects many digital neighborhoods and destinations. The information superhighway provides a framework in which data can be moved quickly between computers via Internet networks. In the metaverse, users can have virtual bodies called avatars. Although the metaverse is digital, its experiences can have real effects on the physical person (Dionisio et al., 2013). The OASIS in Ernest Cline's 2011 science fiction book Ready Player One serves as the first literary representation of the Metaverse in contemporary literature (Mystakidis et al., 2021). A multi-user virtual reality game called The OASIS prioritizes work, education, and leisure. Users connect to The OASIS through headphones, haptic gloves, and custom suits. It is an open-access game environment. A global open-access literature collection serves as the OASIS education system. There are a large number of opulent public school campuses scattered around the globe. Physical classrooms are inferior to those used in online schools. The human body, other planets, famous museums, and historical civilizations can all be visited virtually by students while they are in the classroom. This is more interesting for students (Mystakidis, 2022).

The Metaverse, brilliantly imagined by Stephenson in 1992, has now evolved into an extremely large and densely populated virtual world that parallels the physical world in both form and function, not as a game environment with specific parameters and objectives, but as an open-ended digital culture (Dionisio et al., 2013). In 2007, the Metaverse Roadmap Project provided a multifaceted understanding of the metaverse, linking both simulation technologies that create physically persistent virtual spaces, such as virtual and mirror worlds, and technologies that virtually augment physical reality, such as augmented reality, i.e., connecting network information and computational intelligence to physical objects and spaces (Smart et al., 2022). In 2008, Solipsis created the Contemporary Metaverse, an open-source framework for building large-scale virtual environment systems using a peer-to-peer typology. Solipsis is a massive infrastructure of interconnected virtual worlds, combining both 2D and 3D in an Internet environment, accessible through a common user interface (Frey et al., 2008). Solipsis has enabled the transition from the individual virtual world to the metaverse virtual universe, using concepts and terminology compatible with a physical universe (Burns, 2022).

This development has led to the emergence of MetaWorlds, which allow transition between worlds, from virtual universes that do not have an inter-world transition, such as Second Life, Entropia Universe, and Hipihi Chinese Virtual World. Later, MetaGalaxies emerged, where multiple virtual worlds come together under a single authority. MetaGalaxies, such as Activeworlds and OpenSim hyper grid-enabled virtual environments, allow for teleportation and space travel. In such environments, users can teleport from one planet to another. Thus, a metaverse system with multiple metagalaxies and meta worlds has emerged. Within the framework of standardized protocols, it has become possible for users to move seamlessly between virtual worlds, this development has led to the emergence of MetaWorlds, which allow transition between worlds, from virtual universes that do not have an inter-world transition, such as Second Life, Entropia Universe, and Hipihi Chinese Virtual World. Later, MetaGalaxies emerged, where multiple virtual worlds come together under a single authority. MetaGalaxies, such as Activeworlds and OpenSim hyper-grid-enabled virtual environments, allow for teleportation and space travel. In such environments, users can teleport from one planet to another. This has created a Metaverse system with multiple metagalaxies and meta

worlds. Within the framework of standardized protocols, it has become possible for users to move seamlessly between virtual worlds, from one virtual region to another (Dionisio et al., 2013). These developments in the Metaverse world have attracted the attention of the academic world, and many articles have been published on the subject since 1995. Many papers on the metaverse have been published in the fields of engineering, social sciences, education, business and management, decision sciences, economics and finance, psychology, environmental sciences, physics and astronomy, chemistry, and especially computer science.

This study aims to reveal the profile of academic studies on the metaverse around the world and in Turkey. For this purpose, the analyses carried out by searching publications in the Web of Science and Scopus databases are described in detail in the following sections. Considering the international studies related to the metaverse, it is believed that this study will both contribute to the related literature and guide the researchers who will work in this field.

2. Materials and Methods

2.1. The Bibliometric Analysis of Metaverse Publications

Bibliometrics can be defined as the application of statistical and mathematical methods to books and other communication media (Umut and Coştur, 2007). Bibliometric analysis is a quantitative method used to retrospectively analyze and identify published articles to help researchers evaluate academic studies in a particular field. Using secondary data, bibliometric analysis analyses secondary data obtained from a numerical database from a quantitative and objective point of view (Ding and Yang, 2020). Bibliometric analysis, or citation analysis, is used to evaluate performance in a field by examining publications published by authors, institutions, universities, or countries (Thelwall, 2008). The results of bibliometric analysis give an idea of how far the discipline concerned has developed. At the same time, it provides an opportunity to identify problems and deficiencies, to make corrections to eliminate problems and to develop proposals (Yılmaz, 2017).

Bibliometric analysis can be divided into two categories: performance analysis and science mapping. Performance analysis analyses the contribution of research components to a particular field. This analysis shows the performance of different research components (e.g. authors, institutions, countries, and journals). Science mapping analyses the relationships between research components. Bibliometric analysis consists of four steps: defining the purpose and scope of a bibliometric study, selecting a bibliometric analysis technique, collecting data, and evaluating the results (Donthu et al., 2021).

2.1. Methods

Web of Science and Scopus are recognized as the most trusted literature indexing platforms for scientific and technical research. Clarivate Analytics' Web of Science (WoS) and Elsevier's Scopus are critical components of today's research system. Web of Science and Scopus form the basis of university and global rankings and bibliometric research (Tennant, 2020). The information provided by these databases covers current and relevant research and shows active journals that are prominent in shaping potential research areas (Chadegani et al., 2013). WoS was for a long time the only source of bibliographic data until 2004 when Scopus was launched by Elsevier. Over the years, Scopus has proven to be reliable by improving its coverage (Pranckutė, 2021). Scopus covers a wider range of journals, which is useful for both keyword searching and citation analysis but is currently limited to recent articles (published after 1995) compared to the Web of Science (Falagas et al., 2008). Accordingly, the research was conducted

by searching the Web of Science and Scopus databases. The data were obtained by searching the Web of Science and Scopus databases for the word "Metaverse" on 30/05/2023. The research process is shown in Figure 1.

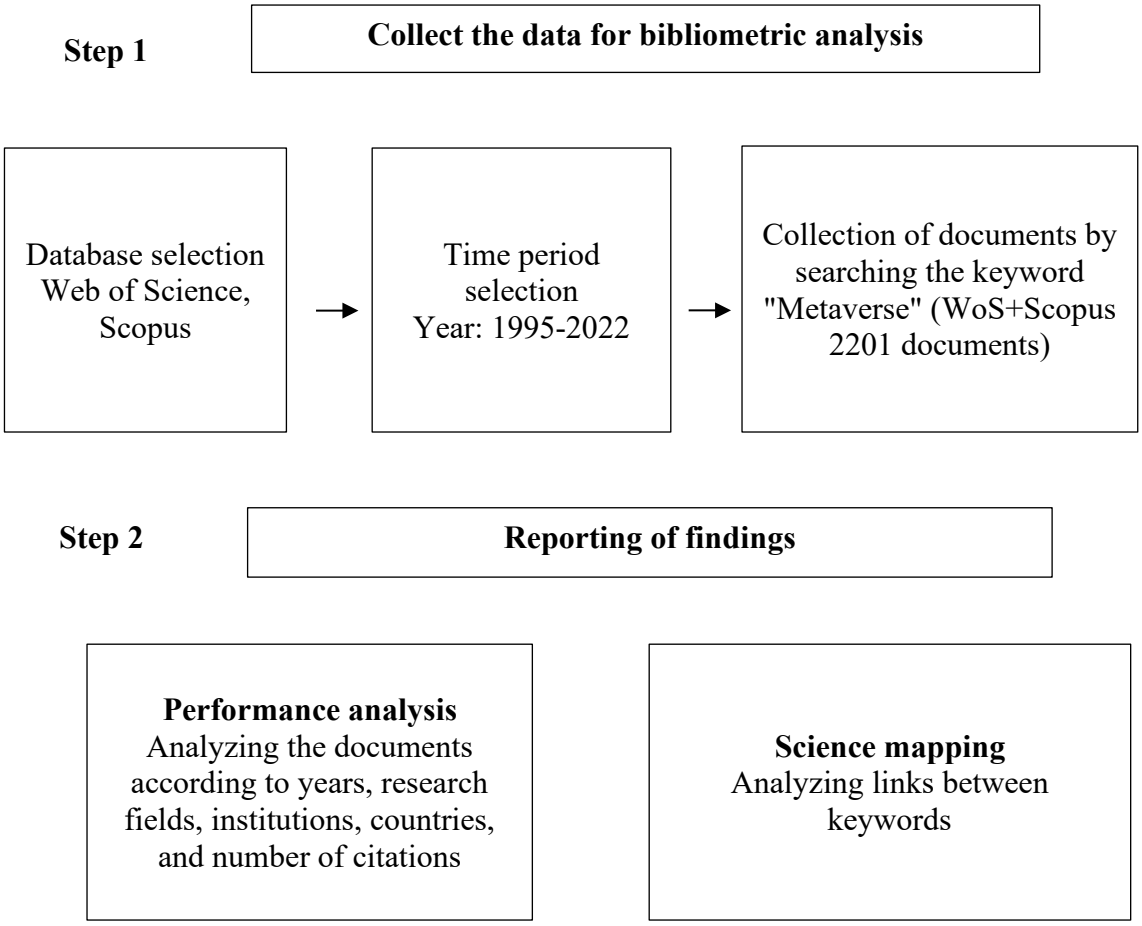

Figure 1. The Research Process

There are a total of 2201 documents related to Metaverse in the WoS and Scopus databases between 1995 and 2022. The research started with performance analysis, followed by keyword mapping. The VOSviewer software was used for the keyword mapping. VOSviewer uses a text mining technique to analyze the content of titles, keywords, and abstracts. This allows researchers to find different clusters of closely related articles, indicated by the same cluster colors. The larger the article, the greater its importance and popularity relative to other articles (Tennant, 2020). Descriptive statistical analyses were used in the study. The questions to be answered in the study are the following:

- What is the distribution of publications about the metaverse in the Web Of Science and Scopus databases according to years?
- What is the distribution of publications on metaverse in Web Of Science and Scopus database according to research fields?
- What is the distribution of publications about metaverse in Web Of Science and Scopus database by countries and institutions?
- What is the distribution of publications on metaverse in Web Of Science and Scopus database by universities?

- What is the distribution of publications related to metaverse in Web Of Science and Scopus database by keywords?
- What is the distribution of publications related to metaverse in Web Of Science and Scopus database by citation status?

3. Results

The research involved searching for the word "metaverse" in the Web of Science and Scopus databases and analyzing the distribution of publications by year, country, journal, research area, and subject using various metrics. In the Web of Science database, there are a total of 874 DOCUMENTS related to the metaverse on a global scale. The most frequently produced document types are articles (N:473), papers (N:231), editorial material (N:79), and reviews (N:51). The languages in which most documents are produced are English (N:828), Spanish (N:25), Portuguese (N:5), Korean (N:3), Chinese (N:4), Italian and French (N:1), German (N:3), Russian and Turkish (N:2). The Scopus database contains a total of 1327 documents related to the Metaverse. The most frequently produced document types are articles (N:530), papers (N:530), reviews (N:72), book chapters (N:46), and editorial material (N:44). The languages in which most documents are produced are English (N:1254), Chinese (N:34), Spanish (N:18), Korean (N:6) and German (N:5).

3.1. Distribution of Metaverse Publications by Year and Field

It was observed that between 1995 and 2022, publications on the metaverse were published in the Web of Science and the Scopus database. The distribution of publications between 1995 and 2022 by year is shown in Table 1.

Table 1. Distribution of Metaverse Publications by Years (1995-2022)

Web of Science		Scopus	
Publication Year	**Publication Count**	**Publication Year**	**Publication Count**
2022	665	2022	1098
2021	42	2021	47
2009	21	2020	16
2010	21	2019	3
2013	18	2018	11
2011	16	2017	4
2015	15	2016	10
2012	13	2015	9
2016	11	2014	8
2008	10	2013	17
2014	9	2012	16
2020	7	2011	18
2017	6	2010	22
2018	6	2009	15
2007	3	2008	17
2019	3	2007	5
2006	1	2006	5
2005	1	2005	2
2004	1	2004	1
2001	1	2003	2
2000	1	2002	1
1996	1	2000	1
1995	1	1995	1
Total	874	Total	1327

An analysis of Table 1 shows that publications on Metaverse reached their highest level in 2022. Especially between 2021 and 2022, there was a significant increase in the number of publications. The database with the highest growth rate is Scopus. This increase shows us that more research should be done in the field of Metaverse and shows that studies in this field will gradually increase. Table 2 shows the data on the areas where more research is being done.

Table 2. Top 15 Most Intensive Research Areas

	Web of Science			**Scopus**	
	Research Area	**N**		**Research Area**	**N**
1	Computer Science	341	1	Computer Science	873
2	Engineering	22	2	Engineering	423
3	Telecommunications	86	3	Social Sciences	294
4	Business Economics	60	4	Maths	198
5	Education	52	5	Decision Sciences	140
6	Science and Technology	47	6	Medicine	112
7	Chemistry	42	7	Art and Human	110
8	Material Sciences	40	8	Physics and Astronomy	107
9	Psychology	35	9	Business and Management	101
10	Communication	33	10	Material Sciences	69
11	Physics	32	11	Energy	56
12	Imaging Science and Photographic Technology	31	12	Psychology	48
13	Environmental Sciences	29	13	Environmental Sciences	36
14	International Law	25	14	Economics and Finance	34
15	Automatic Control Systems	7	15	Chemistry	22

An analysis of Table 2 shows that studies on the metaverse in the Web of Science and the Scopus database are mainly carried out in the fields of computer science and engineering. This is followed by education and social sciences. In the Web of Science database, the first five fields in which metaverse studies are carried out are computer science, engineering, education, economics, and psychology. In the Scopus database, the top five fields for metaverse studies are computer science, engineering, social sciences, mathematics, and decision sciences.

3.2 Distribution of Metaverse Publications by Institutions and Countries

The distribution of metaverse-related publications published in Web of Science and Scopus by the university is shown in Table 3, and the distribution by country is shown in Table 4.

Table 3. Top 15 Most Productive Organisations in the Metaverse

Web of Science			Scopus		
Organization	**Country**	**N**	**Organization**	**Country**	**N**
Chinese Academy of Sciences	China	26	Chinese Academy of Sciences	China	24
Research Libraries UK	United Kingdom	19	Nanyang Technological University	Singapore	18
Sejong University	South Korea	18	Sabancı University	Turkey	17
Nanyang Technological University	Singapore	14	Norwegian University of Science and Technology	Norway	16
Unisinons University	Brazil	14	University of Zilina	Slovakia	15
La Salle Centro University	Brazil	11	Sungkyunkwan University	South Korea	15
Sabancı University	Turkey	11	Korea Advanced Institute of Science and Technology	Gumey Korea	15
The Hong Kong Polytechnic University	China	11	Automation Institute	China	12
Automation Institute	China	11	Guangdong University of Technology	China	11
Sungkyunkwan University	South Korea	11	Hong Kong University of Science and Technology	China	11
University College London	United Kingdom	10	Building Nusantara University	Indonesia	11
Electronics and Telecommunications Research Institute	Korea	9	School of Computer and Engineering Sciences	Singapore	10
Macau University of Science and Technology	China	9	Uppsala University	Sweden	9
Norwegian University of Science and Technology	Norway	9	Bejing Institute of Technology	China	9
University System of Georgia	USA	9	South China University of Technology	China	9

When Table 3 is examined, it is seen that the top three institutions with the most metaverse research in the WoS database are Chinese Academy of Sciences, UK Research Libraries and Sejong University. In the Scopus database, the top three institutions with the most research are Chinese Academy of Sciences, Nanyang Technological University and Sabancı University. When the institutions are ranked by country, China, the United Kingdom and South Korea are in the first place. Especially Sabancı University's ranking in the world rankings in metaverse research shows that Turkey is interested in this field. It can be said that this data is a good resource for higher education institutions for cooperation, project development, master's and doctoral students. The distribution of metaverse-related publications published in Web of Science and Scopus according to countries is shown in Table 4.

Table 4. Top 15 Most Productive Countries in the Metaverse

Web of Science			Scopus		
	Country	**N**		**Country**	**N**
1	China	217	1	China	269
2	USA	142	2	USA	204
3	South Korea	122	3	South Korea	148
4	United Kingdom	64	4	United Kingdom	102
5	Spain	46	5	Italy	56
6	Germany	39	6	Turkey	50
7	Italy	35	7	Germany	46
8	Turkey	35	8	Japan	46
9	Canada	26	9	Spain	43
10	Australia	25	10	Canada	39
11	Brazil	25	11	India	37
12	Japan	25	12	Taiwan	37
13	Singapore	23	13	Australia	31
14	India	21	14	Singapore	29
15	Taiwan	20	15	Sweden	27

Analyzing Table 4, the countries with the highest number of metaverse-related publications in the WoS and Scopus databases are the USA, South Korea, and China. Turkey ranks eighth in the WoS database and sixth in the Scopus database. The fact that Sabancı University has the highest number of metaverse-related publications in Turkey shows that other universities should increase the number of international publications by focusing on this field.

3.3. Citation Distribution of Publications Related to Metaverse

The top 10 most cited studies related to Metaverse in Web of Science and Scopus are shown in Table 5 and Table 6 respectively.

Table 5. Most Cited Studies in Metaverse in WoS Database (Top 10)

Year	Title	Authors	Journal	Citation
2013	3D Virtual Worlds and the Metaverse: Current Status and Future Possibilities	Dionisio et al.	Acm Computing Surveys	157
2009	Avatars, People, and Virtual Worlds: Foundations for Research in Metaverses	Davis vd.	Journal Of the Association for Information Systems	151
2022	A Metaverse: Taxonomy, Components, Applications, and Open Challenges	Park and Kim	Ieee Access	135
2022	Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	Dwivedi et al.	International Journal of Information Management	93
2008	Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses	Papagiannidis et al.	Technological Forecasting and Social Change	84
2008	Second Life and the new generation of virtual worlds	Kumar et al.	Computer	71
2021	Educational applications of metaverse: possibilities and limitations	Kye et al.	J Educ Eval Health Prof	69
2017	A content service deployment plan for metaverse museum exhibitions-Centering on the combination of beacons and HMDs	Choi and Kim	International Journal of Information Management	65
2017	Introduction: Virtual, Augmented, and Mixed Realities in Education	Dede et al.	Virtual, Augmented, And Mixed Realities In Education	56
2009	Retail spatial evolution: paving the way from traditional to metaverse retailing	Bourlakis et al.	Electronic Commerce Research	56

An analysis of Table 5 shows that the most cited study on the Metaverse in the Wos database is "3D Virtual Worlds and the Metaverse: Current Status and Future Opportunities" (Dionisio et al., 2013). It can be seen that the research that was scanned with the word Metaverse in the WoS database is cited on the following topics:

- Avatars and virtual worlds, challenges related to the metaverse world (Davis et al., 2009; Park and Kim, 2022).
- An Interdisciplinary View of the Metaverse (Dwivedi et al., 2022).
- Business Opportunities, Opportunities, and Threats, Ethical Issues in Virtual Worlds (Papagiannidis et al., 2008).
- Second Life and next-generation virtual worlds, current situation and future possibilities for the Metaverse (Kumar vd., 2008; Dionisio et al., 2013).
- Virtual and blended realities in education (Dede et al., 2017).
- Retailing in the virtual world and from traditional to metaverse retailing (Bourlakis et al., 2009)

- Metaverse and art (Choi ve Kim, 2017).
- Educational use of metaverse in medicine (Kye et al., 2021).

The research also examines the most cited metaverse-related studies in the Scopus database. Table 6 shows the top 10 most cited studies in the Scopus database.

Table 6. Most Cited Studies in Metaverse in Scopus Database (Top 10)

Year	Title	Authors	Journal	Citation
2009	Avatars, people, and virtual worlds: Foundations for research in metaverses	Davis et al.	Journal of the Association for Information Systems	255
2013	3D Virtual Worlds and the Metaverse: Current Status and Future Possibilities	Dionisio et al.	Acm Computing Surveys	252
2022	A Metaverse: Taxonomy, Components, Applications, and Open Challenges	Park and Kim	Ieee Access	226
2021	Metaverse for Social Good: A University Campus Prototype	Duan et al.	MM 2021 - Proceedings of the 29th ACM International Conference on Multimedia	161
2022	Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	Dwivedi et al.	International Journal of Information Management	139
2021	Educational applications of metaverse: possibilities and limitations	Kye et al.	Journal of Educational Evaluation for Health Professions	120
2017	A content service deployment plan for metaverse museum exhibitions-Centering on the combination of beacons and HMDs	Choi and Kim	International Journal of Information Management	102
2008	Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses	Papagiannidis et al.	Technological Forecasting and Social Change	102
2022	What is XR? Towards a Framework for Augmented and Virtual Reality	Rauschnabel et al.	Computers in Human Behavior	83
2021	Advertising in the Metaverse: Research Agenda	Kim, J.	Journal of Interactive Advertising	80

An analysis of Table 6, the most cited study on the Metaverse in the Scopus database is "3D Virtual Worlds and the Metaverse: Current Status and Future Possibilities" (Dionisio et al., 2013). In the Scopus database, it can be seen that research related to the metaverse is of interest and cited in the following topics:

- Avatars and virtual worlds, challenges related to the metaverse world (Davis et al., 2009; Park and Kim, 2022).
- An Interdisciplinary View of the Metaverse (Dwivedi et al., 2022).
- Business opportunities, opportunities, threats, and ethical issues in virtual worlds (Papagiannidis et al., 2008).
- Second Life and new generation virtual worlds, current situation and future possibilities for the Metaverse (Davis et al., 2009).
- Educational use of the metaverse in medicine (Kye et al., 2021), Metaverse and social benefit (Duan et al., 2021).
- Metaverse and art (Choi ve Kim, 2017).
- Virtual Reality and Metaverse in Advertising (Rauschnabel et al., 2022; Kim, 2021).

4. Keyword Network Analysis of Metaverse Publications (Mapping of Keywords)

Keyword analysis of metaverse-related publications in the WoS and Scopus databases is performed using the WOSviewer software.

Network visualization: In network visualization, keywords are represented by their tags and also by a circle. The circle of an element is determined by the weight of the element. The heavier the item, the larger the item's tag and circle. Some items may not have a label. The color of an item is determined by the set it belongs to. The lines between elements represent links. In network visualization in keyword analysis, the size of the circle describes the potential of the keyword, as shown in Figure 2, while the thickness of the line expresses the strength of the link (Halepoto et al., 2022). In this context, larger circles and map labels represent the importance of the cluster. Keywords with similar colors belong to the same cluster (Van Eck and Waltman, 2022). As part of the research, Figure 1 shows the analysis of the most studied keywords related to the metaverse in the Wos database. In the keyword analysis, the minimum number of repetitions of a keyword was set to two.

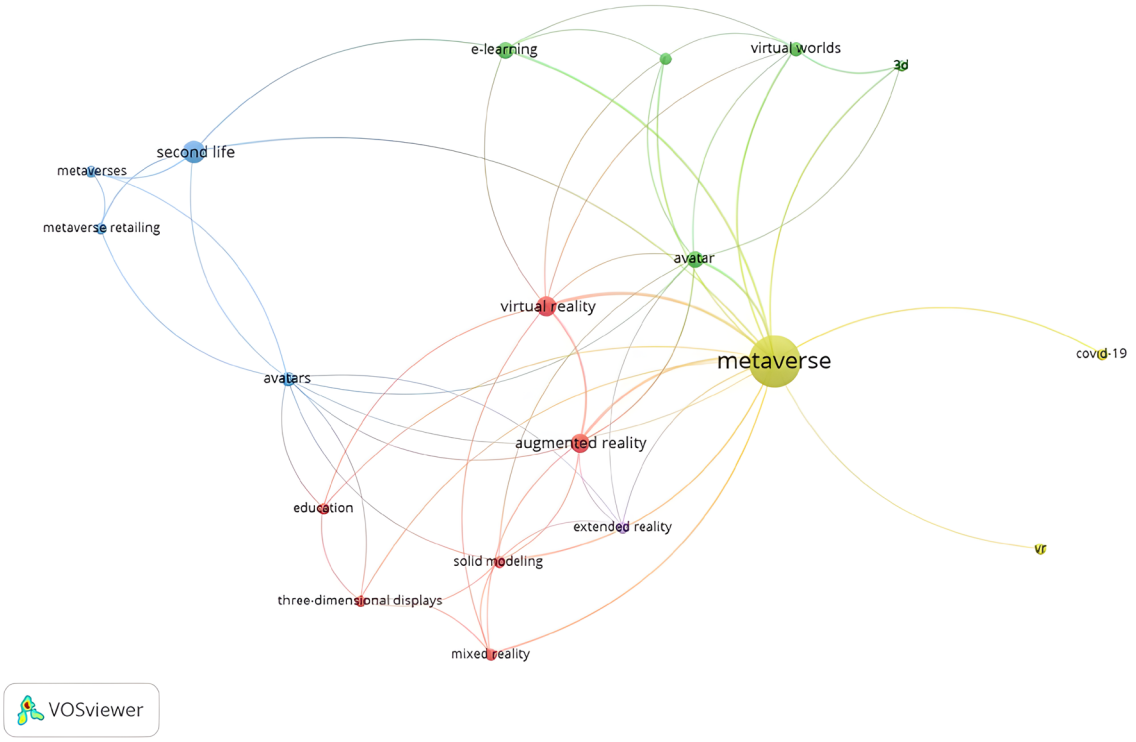

Figure 2. Keyword network map of publications related to the metaverse (WoS)

When analyzing Figure 2, it can be seen that the studies related to Metaverse consist of 212 keywords in the WoS database. The clusters were evaluated based on the three main clusters with the highest connection strength. The clusters consist of the colors red, green, and blue. Considering the size and weight of the clusters, the most frequently used keywords are "metaverse", "virtual reality", "augmented reality", "avatar", "avatars" and "second life". Researchers have explored the metaverse by associating it with virtual reality, avatars, and virtual worlds. As part of the research, Figure 2 shows the analysis of the most studied keywords related to the metaverse in the Scopus database.

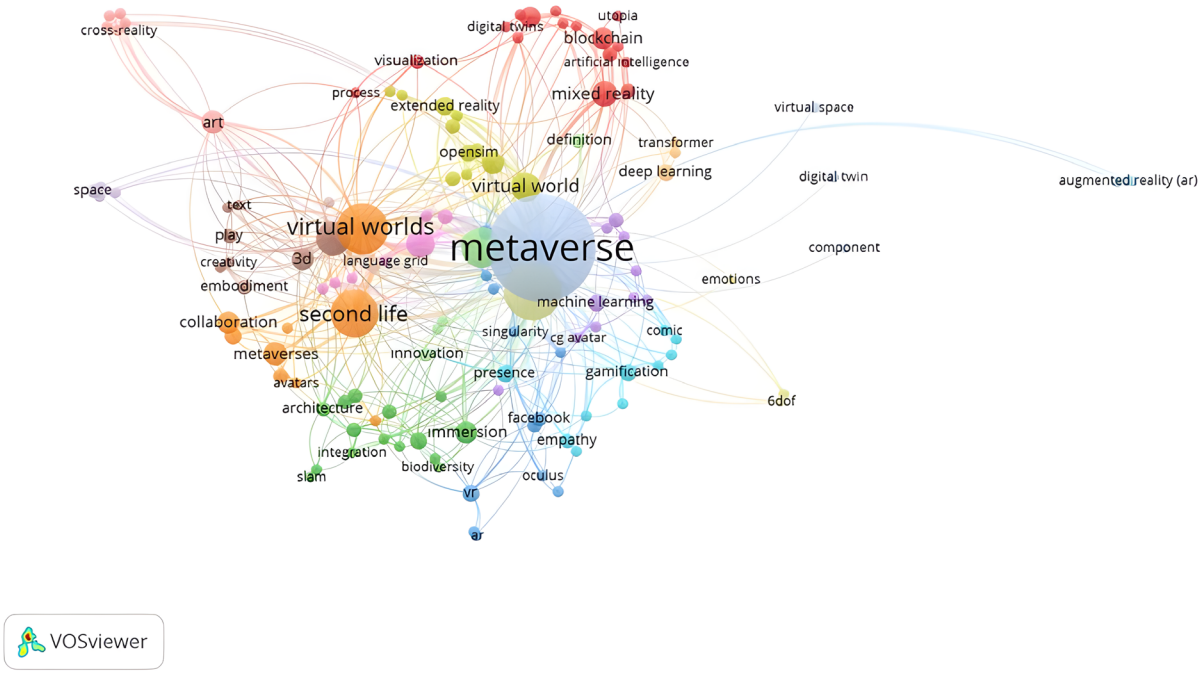

Figure 3. Keyword network map of publications related to the metaverse (Scopus)

When analyzing Figure 3, it can be seen that the studies related to Metaverse consist of 1049 keywords in the Scopus database. The clusters were evaluated based on the three main clusters with the highest connection strength. The clusters consist of the colors red, green, and blue. Considering the size and weight of the clusters, the most frequently used keywords are "metaverse", "virtual reality", "virtual worlds", "second life", "avatar", and "augmented reality". Metaverse has been explored by researchers about virtual reality, avatars, and virtual worlds.

Overlay visualization: The layer visualization is identical to the network visualization, except that the elements are colored differently. The dark blue color represents the keywords used in 2014 and the light yellow color represents the keywords most used in 2020 (Van Eck and Waltman, 2022). As part of the research, the figure shows the analysis of the most studied keywords related to the metaverse in the WoS database by year.

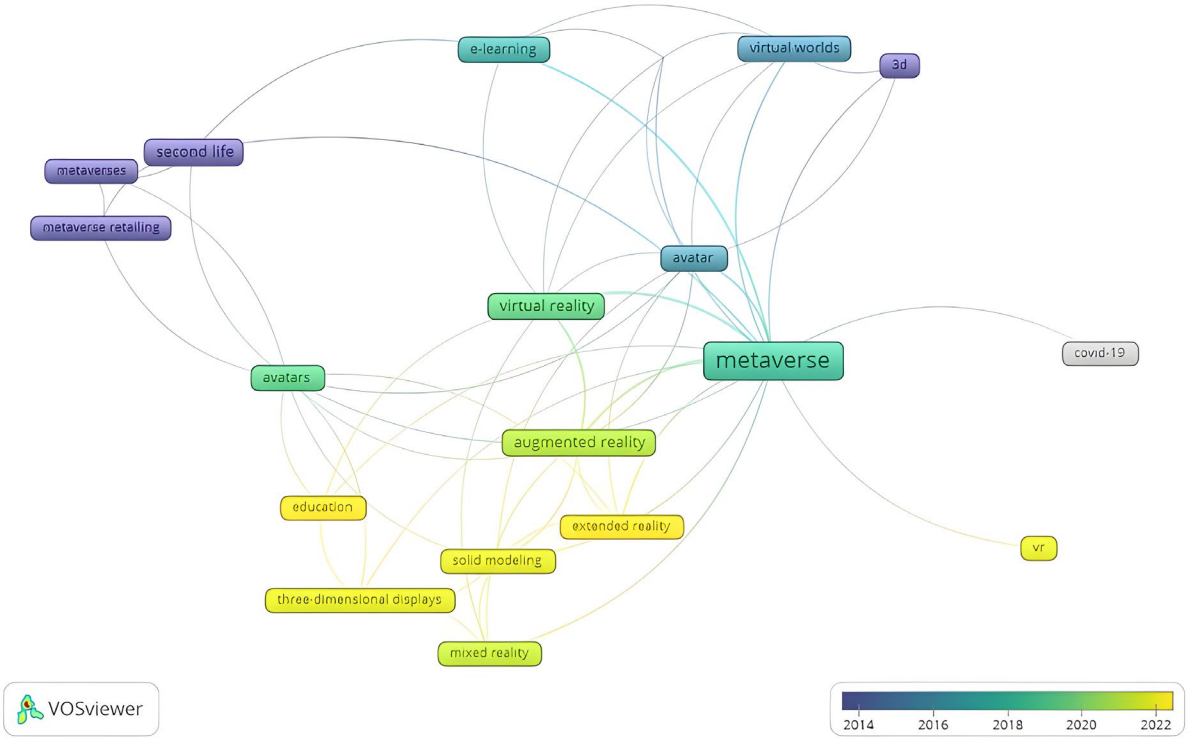

Figure 4. Keyword network of publications related to the metaverse by year (WoS)

An analysis of Figure 4 shows that the keywords “metaverses”, “metaverse retailing”, “second life”, “3D” and “virtual learning environment” were used between 2014-2016, “e-learning”, “avatar”, “virtual worlds” between 2016-2018 and “metaverse” between 2018-2020, It can be seen that the keywords "virtual reality", "avatars", "augmented reality-augmented reality", "education", "solid modeling", "extended reality", "three-dimensional display", "mixed reality", "VR" is used between 2020-2022.

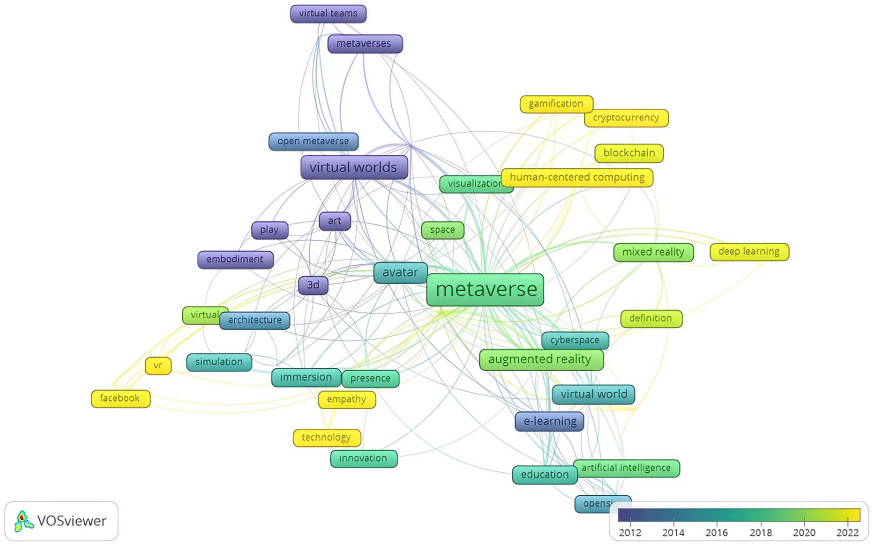

Figure 5. Keyword network of publications related to the metaverse by year (Scopus)

When analyzing Figure 5, it can be seen that in the research related to Metaverse between 2012-2014, the keywords "virtual teams-virtual teams", "metaverse", "virtual worlds", "game", "3D", "art", " open metadata repository" and "e-learning " keywords, "architecture ", "avatar", "cyberspace", "simulation", "presence", "innovation ", "education-education" keywords between 2014-2018, Between 2020-2022, "virtual ", "space", "visualization ", "metaverse", "VR", "Facebook", "empathy", "technology", "augmented reality", "artificial intelligence", "deep learning", "mixed reality", "gamification", "cryptocurrency", "blockchain", "human-centered computing" keywords were used.

Density visualization: There are two types of density visualizations: item and cluster. Each point in the item density visualization has a color that indicates the density of items at that point. The colors range from blue to green to yellow. The more elements that are connected to a point, the closer the color of the point is to yellow. On the other hand, the fewer items in a point's neighborhood, the closer the point's color is to blue. The Cluster Density visualization is only available when elements are assigned to clusters. (Halepoto et al., 2022). The figure shows the element density visualization of the most studied keywords related to the metaverse in the WoS database.

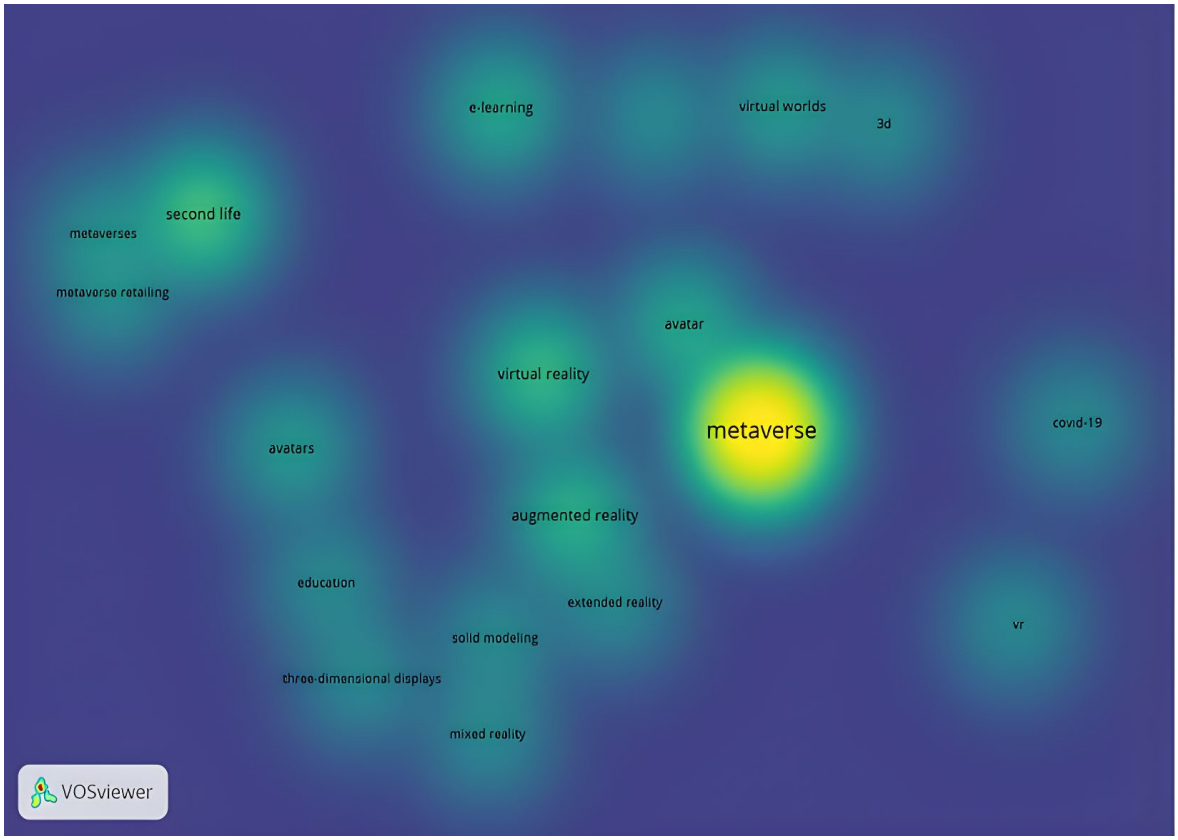

Figure 6. Keyword density map of publications related to metaverse (WoS)

When Figure 6 is examined, it is seen that the research related to the metaverse in the WoS database is concentrated on the keywords "metaverse", "augmented reality", "virtual reality", "virtual reality", and "second life". The density visualization for the most studied keywords related to the metaverse in the Scopus database is given in Figure 7.

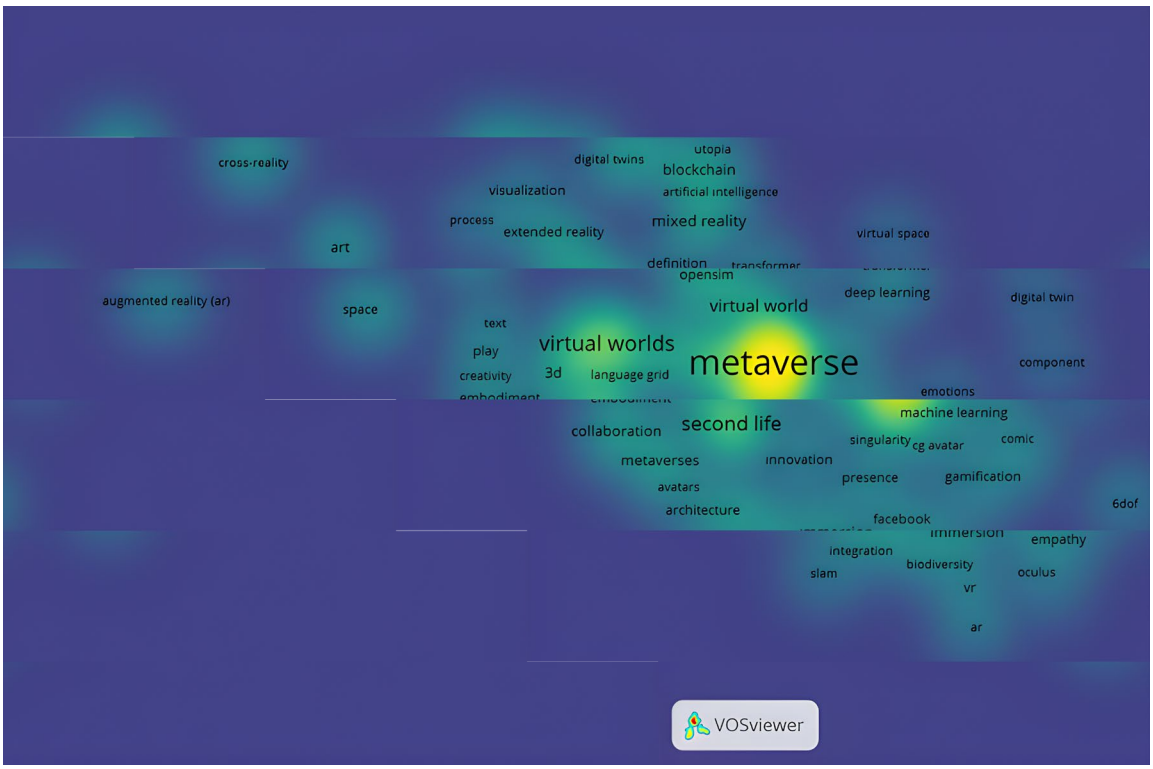

Figure 7. Keyword density map of publications related to metaverse (Scopus)

When Figure 7 is examined, it is seen that the research related to the metaverse in the Scopus database are concentrated on the keywords "metaverse" "virtual worlds", and "second life".

5. Discussion

The term metaverse is increasingly used today. It is particularly important to see how the concept of metaverse is treated in the existing literature and where it is heading. Bibliometric research is used to analyse academic studies in a field. Analysing existing research in the field of metaverse can give us an idea of how the concept of metaverse will change in the future. In this study, a bibliometric analysis of metaverse studies in Web of Science and Scopus databases was conducted and a framework was presented for researchers who want to conduct research in this field in the future. In the study, the interest in metaverse increased from 1995 to 2022. The years with the highest increase are between 2021 and 2022. In 2021, Facebook changed its name to Meta, which contributed to the increasing popularity of virtual universes and the Metaverse.

Research on the Metaverse has been concentrated in the fields of computer science and engineering and has mostly been researched from a technical perspective. Therefore, more research is needed to explore the psychological and sociological effects of the Metaverse on individuals. Especially the uncertainty of the rules and boundaries of living in virtual worlds requires more research in this field. Regulations on the protection of personal rights or personal data and their legal dimensions are important. In addition, when the metaverse literature is examined, it is seen that there is no study on the perception and use of the Metaverse concept according to the development level of countries in the field of social sciences. In the future,

comparative studies can be conducted according to consumer generations, development levels of countries or technology intensity levels of countries.

The most cited studies in Wos and Scopus databases are listed as virtual worlds, avatars, foundations of the metaverse universe, business opportunities in virtual worlds, the future of virtual worlds and metaverse in advertising. The citation density of the studies on the metaverse shows that economic developments and technological changes in virtual worlds are prioritised. Virtual currencies, blockchains and virtual stores show that universes will be economically interconnected. In this respect, it is important to investigate how companies can adapt to the virtual world. For this, companies may need trained labour force in areas such as virtual and augmented reality, simulation technology and blockchain technology. In a study conducted in 2021, Damar found that research on metaverse is intensively processed with virtual and augmented reality technologies, and the education sector and digital marketing field are also interested in this field (Damar, 2021).

In recent years, research has focused on concepts such as 'augmented reality', 'artificial intelligence', 'deep learning', 'mixed reality', 'gamification', 'cryptocurrency', 'blockchain' and 'human-centred computing'. The metaverse is moving from a virtual world image to a more realistic world and more research is needed in many areas. However, research is concentrated in certain regions of the world. Most of the research is carried out in South Korea, the USA and China. In addition to this, research in the field of metaverse is also being carried out in Turkey, especially by Sabancı University. The fact that the Metaverse universe covers a wide world and eliminates borders shows the necessity of conducting research in co-operation with different countries. At the same time, these countries are centres for researchers who want to conduct research in the Metaverse. Metaverse is an important concept not only for the IT world but also for many human-based research area.

6. Conclusion

The results of the research will provide important theoretical contributions to researchers working in the field of the metaverse. Firstly, the published articles and total citation data will provide the opportunity to see the most influential articles. Researchers will be able to see in which countries, institutions and journals metaverse research is concentrated. Bibliometric analysis is an effective way of summarising and synthesising the literature. Bibliometric methods can help researchers overcome their fear of dealing with large bibliometric datasets and better track their research interests. However, bibliometric research provides only a short-term insight into the research field (Donthu et al., 2021), so research can be updated periodically. In the future, researchers may turn to databases such as Google Scholar, JSTOR, Wiley, PubMed, etc. other than WoS and Scopus databases. The research used VOSviewer software for keyword analysis. The VOSviewer software is available for Linux, Windows or MacOS. The VOSviewer software allows data retrieval in SCOPUS (CSV), Clarivate Analytics Web of Science (plain text or tab-delimited), PubMed/MedLine (MEDLINE) and Dimensions (CSV) formats (Arruda et al., 2022). Researchers can turn to mapping tools (CitNetExplorer, CiteSpace, Bibliometrix, etc.) that offer more comprehensive and diverse analyses.

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