METAVERSE: A BIBLIOMETRIC ANALYSIS

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ABSTRACT

The 'metaverse' refers to a virtual space where augmented reality services help to perform activities. It integrates the fifth generation of the internet, cloud computing, blockchain, artificial intelligence, the internet of things, etc. It has multidimensional implications affecting individuals and corporations in several ways. The study analyses the research publications in the field of metaverse using bibliometric techniques to uncover current trends and pinpoint potential topics for further study. The study considers publications from 2006 through 2023. In total, 203 publications were taken into account for analysis. R program's biblioshiny has been used to analyze the data. The countries which contributed most in this area are South Korea followed by China, United States, United Kingdom and Germany. The top three journals in the area are IEEE Access, Sustainability and Computer in Human Behavior. The top three institutes to publish the research in this area are University of Zilina from Slovakia, Smart Learning of Beijing from China and University of Georgia from USA.

Keywords: Metaverse, Bibliometric Analysis, Research Area, Top Journals, Top Institutes

1. Introduction

Chris Cox, Chief Product Officer, Meta at World Economic Forum, mentioned that the 'metaverse' would become necessary and essential in our lives (Bhaimiya, 2023). Metaverseis adapted from a science-fiction, Snow Crash (Dwivedi et al., 2022). Metaverse combines two words, 'meta' meaning virtual and 'verse' meaning universe (Tliliet a., 2022). It is a blend of the virtual and augmented real world. It is a social medium in which individuals can communicate and collaborate. It is an integration of reality, information, actions, and interactions between the real and digital world which could influence each other (Buchholz et al., 2022).

The 'metaverse' refers to a virtual space where augmented reality services help to perform activities. It integrates the fifth generation of the internet, cloud computing, blockchain, artificial intelligence, the internet of things, etc. It has multidimensional implications affecting individuals and corporations in several ways. It allows corporations to take their marketing, especially advertising, to the next level. Few consumer brands sold non-fungible tokens on metaverse platforms (Kim, 2021).

Metaverse has not only had applications in advertising; instead, it has far-reaching commercial applications. Likewise, it allows individuals to engage socially in three-dimensional virtual spaces. Metaverse will enable individuals to choose their avatars in virtual space and build homes, run businesses, conduct meetings, attend classes, and even perform impossible tasks (Srushti IMX 2021 as Kim, 2021).

Metaverse is the central idea for research in various areas such as technology, consumer research, sociology, and psychology. Big and large corporations are collaborating to develop an ecosystem for the metaverse. Consumer research focuses on implementing the metaverse in all possible commercial fields. Sociological and Psychological research is being conducted to consider the ethical and moral issues arising as an aftermath of applying the metaverse.

In this study, a bibliometric analysis was conducted to understand the current trend and to explore the potential area for future research.

2. Research Methodology

The study analyses the research publications in the field of metaverse using bibliometric techniques to uncover current trends and pinpoint potential topics for further study. To determine the current trends in research activities, bibliometric analysis is the quantitative examination of bibliographic information (Lu et al., 2021). In the previous few decades, scholars were more aware of this methodology, which was developed in the library and information science (Merigo & Yang 2017). Literature on bibliometric analysis has been published in almost every field, including tourism (Leong et al., 2020), social science (Nasir et al., 2020), economics (Bahoo et al., 2021), finance (Goyal & Kumar, 2021), marketing (Gao et al., 2021), library science (Ahamad et al., 2018), environmental science (Guan et al., 2019), psychology (Setiawan 2022), and management (Rao & Shukla 2022).

2.1 Source of data

An early stage of bibliometric analysis involves finding a database and extracting data from that database. The research's data source must be relevant and trustworthy (Rueda et al., 2007). Many available databases include Scopus, Web of Science, ERIC, PubMed, IEEE Xplore, JSTOR, Directory of open access journals, and Google Scholar. The Scopus database was used as the data source in this paper for extracting research papers. Using a Metaverse search term, the research papers are extracted. The study considers publications from 2006 through 2023.

There are approximately 82.4 million articles in the Scopus database. Because of their extensive coverage, the researcher considered the Scopus databases into account. Scopus is a systematic, well-known indexing database for scientific work (Kipper et al., 2020). Research area, authors, publication date, affiliation, countries, keywords, citations, and journal information are all provided by Scopus databases (Meho and Yang 2007; Falagas et al. 2008).

The standards and keywords used for data searching are crucial since they significantly impact the results (Khan & Mukhtar, 2020). The researcher used the keyword "Metaverse" to retrieve the data from Scopus. The search has been restricted to articles and reviews written in social science, art, humanities, business management, and accounting. The articles are written in English. In total, 232 articles are discovered in the Scopus database. After that, the researcher read each article's abstract and eliminated any studies that were not relevant. Finally, 203 publications were taken into account for analysis.

R program's biblioshiny has been used to analyze the data. The instrument investigates the relationship between the author, affiliation, publications, nations, and trending keywords (Hoppen& de Souza Vanz 2016). Additionally, this tool examines the relationship between co-authors, the geographic location of affiliation, and the coupling of co-citations (Khan & Mukhtar 2020).

3. Data Analysis

Because the research published from 2006 to January 2023 was taken into consideration for the study, it was discovered that the first article was written in 2006. Table 1 gives a summary of the information used for bibliometric analysis. As shown in Table 1, a total of 203 articles from 129 sources, including journals, books, and conferences, were discovered.

Table: 1 Overview of Data

Description	Result
Main Information	
Time span	2006-2023
Sources (Journals, Books, etc.)	129
Documents	203
Average years from publication	1.98
Average citation per document	5.394
Average citation per year per	1.845

Description	Result
document	
References	10121
Document types	
Articles	191
Review	12
Document contents	
Authors keywords	454
Keywords plus	730
Authors	
Authors	511
Authors appearances	585
Authors of single authors documents	66
Authors of multi-authored documents	445
Authors collaboration	
Single authored document	67
Documents per authored	0.397
Authors per document	2.52
Co-Authors per documents	2.88
Collaboration index	3.27

We find that the median time between document publishing is 1.98 years. The average number of citations for a single document is 5.394, whereas the number of sources for an individual item every year is 1.845. The total of 203 materials that were obtained can be split down as follows: 191 are articles, and 12 are review papers. In addition, keywords can be broken down into two categories: author keywords, which are provided by the writers themselves, and keyword plus, which are generated automatically by the software. Four hundred fifty-four authors' keywords and 730 keywords plus are found in this investigation. It was discovered that a total of 585 authors had authored publications in the connected field; of them, 445 articles have been written by two or more authors, and 66 articles have only one author. Co-authors make up an average of 2.88 for each document, whereas writers make up an average of 2.42 per document. The level of author collaboration is indicated by the collaboration index, which is 3.27, which is shown in table 1.

Figure 1 show that research in the field of metaverse is getting more and more popular. As, over 90 per cent of all publications were found from 2020 to 2023, the result suggests that the metaverse gained popularity after 2019. Around 78% of all articles, or the majority, will be published in 2022. 7 per cent of papers were discovered in 2020–2021, and 5 percent of research publications will be published until January 2023. This upward trend suggests that academics and researchers are paying more attention to the metaverse.

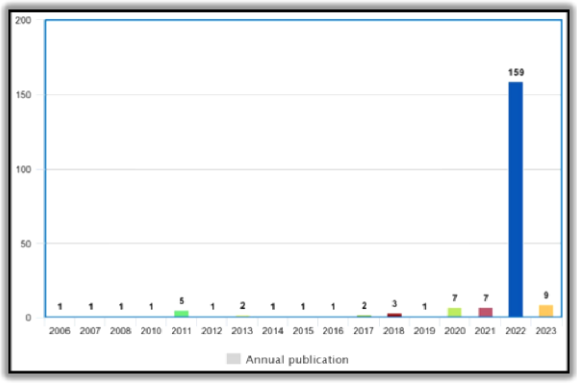

Figure: 1 Annual publication on Metaverse

Figure 2 depicts the top ten journals, based on citations, in which metaverse-related articles have been published. According to the graph, IEEE Access, Sustainability, and Computer in Human Behavior are the three most cited journals.

The number of articles published by the top 10 journals in the metaverse area is shown in Figure 3. The top 10 journals create about 32 percent of all articles, and further top three journals, which are linguistic and philosophical investigations, sustainability, and review of contemporary philosophy, contribute around 20 percent of the publications.

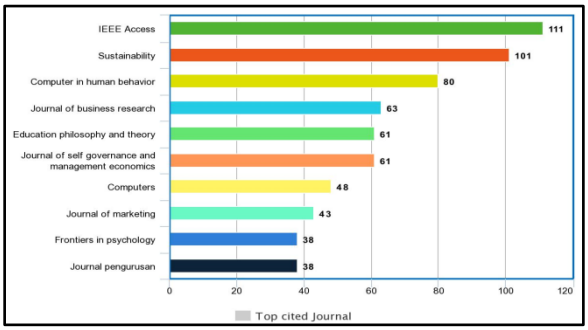

Figure: 2 Top 10 cited journal

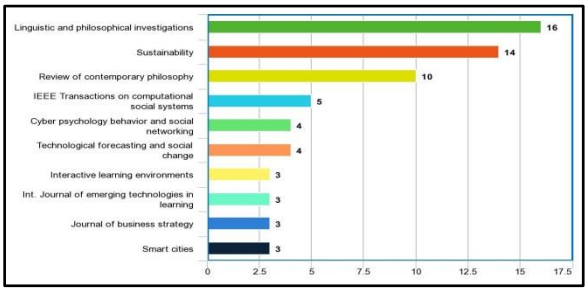

Figure 3: Top 10 most published journals

3.1 Authors'Analysis

Table 2: Top authors in the metaverse

S. No	Authors	Articles
1	Kim J	7
2	Buhalis D	4
3	Ahn SJ	3
4	Bibri SE	3
5	Park S	3
6	Tan TM	3
7	Alfaisal R	2
8	Allam Z	2
9	Ansari M	2
10	Arpaci I	2

The most published authors and articles were examined in bibliometric data analysis. The list of top authors in the metaverse from Scopus-indexed publications from 2006 to 2023 is shown in Table 2. The top 10 authors created almost 15 percent of the magazines, and the top three authors, Kim J, Buhalis D, and Ahn SJ, produced approximately 7 percent of the articles.

3.2 Author co-citation analysis

The importance of a study in the literature, or the paper's popularity, can be determined by looking at the authors and articles that have been cited (Ye et al., 2020). When two authors, P and Q, are referenced in article R, their respective studies are referred to as co-citations (Fahimnia et al., 2015). Figure 4 shows the analysis of the top 50 authors, where the minimum number of edges is two. The authors are divided into two clusters in the figure, which are colored red and blue. Compared to the blue cluster, the red cluster is larger. The box size determines the density of co-citations; a large box denotes a frequently quoted author. The most often co-cited authors are Wang, Liu, and Lee in the red cluster and Park, Zhang, and Liu in the blue cluster.

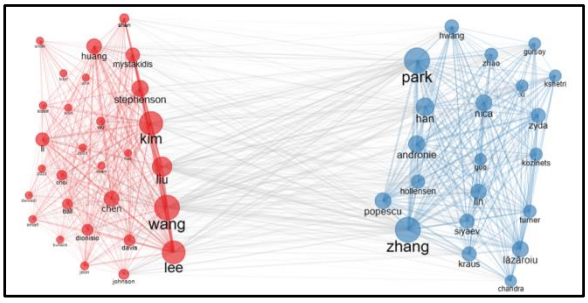

Figure 4: Author co-citation

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Consequently, Park, Wang, and Liu are the most well-known authors. These authors, who have betweenness scores of 229.7389, 210.0041, and 149.4885, respectively, are the most well-known and esteemed in the metaverse. The betweenness centrality index quantifies the number of times a node is located within the closest probable distance to other nodes in a network. A node's betweenness significantly impacts its ability to collaborate with a network (Leydesorff et al., 2018).

3.3 Author collaboration analysis

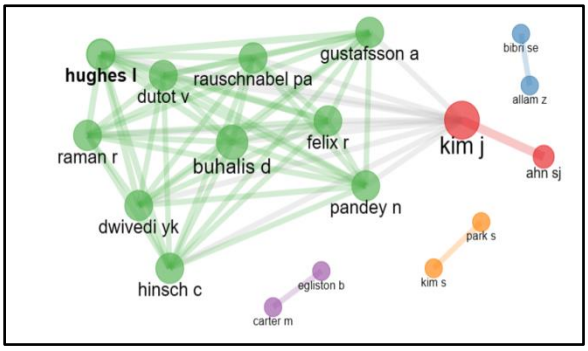

Figure 5: Author collaboration analysis

Biblioshiny software is used to analyze the collected dataset of 203 articles from 2006 to 2023 to demonstrate the author collaboration structure. The top 50 most referenced authors out of a total of 585 authors are shown in the derived figure. In figure 5, the nodes in the filters bar reflect the chosen writers, and the number of edges indicates the minimal number of authors that collaborated; in this context, the number of edges is 2. There are

five clusters created, as seen in the figure. A line's thickness within a cluster shows the level of collaboration. Green and red are the top two clusters of collaboration. According to the values of closeness and PageRank, Kim J., followed by Buhalis D., Dutot V., Dwivedi YK., and Felix R., are the five most collaborative authors. Figure 5 shows that there is relatively little author collaboration; most publications are published autonomously.

3.4 Keyword analysis

A keyword analysis aims to identify the most often occurring phrases and terms in the article titles, abstracts, and keywords. Figure 6 displays the analysis of the top 50 keywords out of 730 keywords plus. Metaverses (frequency 24), virtual reality (frequency 22), sustainability (frequency 10), virtual worlds (frequency 9), humans (frequency 7), sustainable development (frequency 6), augmented reality (frequency 5), decision making (frequency 5), e-learning (frequency 5) and human-computer interaction (frequency 5) are the ten most frequently used keywords, according to Figure 6. Due to its inclusion in the search parameters of the Scopus database, the keyword metaverse has appeared.

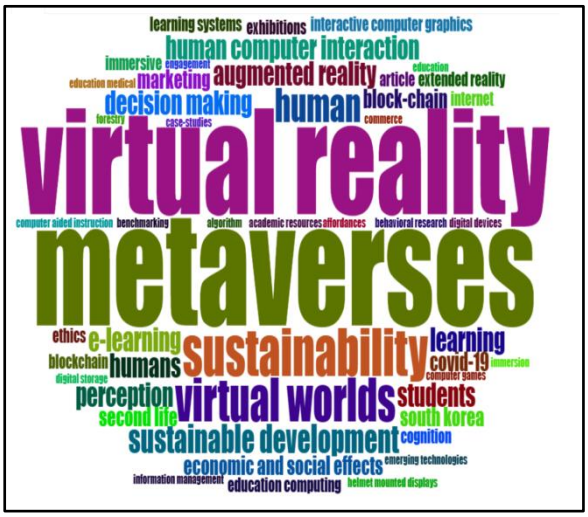

Figure 6: Frequency of keyword

3.5 Co-occurrence keyword analysis

A research paper's keywords highlight the paper's key findings. The intensity and co-occurrence analysis of terms is used to determine the boundaries and research hotspots (Ye et al., 2020). The top 50 keywords are represented by 50 nodes in the analysis done with the biblioshiny software. The minimum number of edges is 2, representing the frequency of the keywords that appear together. Only four clusters of green, blue, purple, and red have appeared in Figure 7, and only 43 keywords have at least two co-occurrences. The size of the circle reflects the frequency of keyword co-occurrence. Sustainability and sustainable development are the top two keywords in the red cluster; metaverse and perception are the top two keywords in the blue cluster; virtual reality and virtual world are the top two keywords in the green cluster; and human and human-computer interaction are the top two keywords in the purple cluster. Metaverse (609.4662 and 0.156848), virtual reality (260.1155 and 0.107693), human (122.6361 and 0.049781), sustainability (100.25 and 0.045832), and e-learning (50.76175 and 0.03791) are the five terms with the highest betweenness and PageRank.

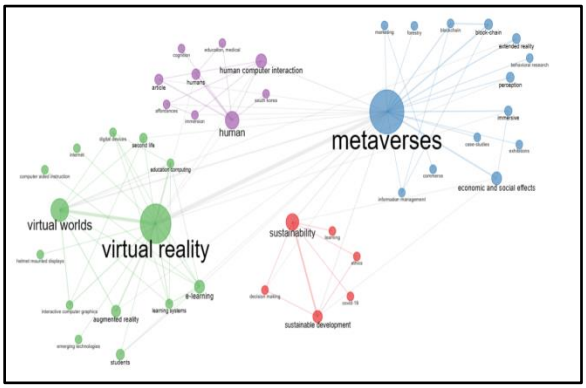

Figure 7: Co-occurrence of keywords

3.6 Affiliation and global analysis

The institution's output of articles is used to determine which affiliation is the most significant. Out of 277 affiliations and 203 papers, the top 10 most pertinent institutions are shown in Table 3. Most papers were contributed by the University of Zilina in Slovakia (12), followed by Smart Learning of Beijing Normal University in China (11) and the University of Georgia (9). Maastricht University and the Polytechnic University of Turin each contributed six papers. According to the findings in Table 4, six out of ten affiliations come from Europe, and these European countries and their institutions contributed a total of 39 articles. The evidence suggests that these European nations and their institutions are more concerned with the metaverse.

Table 3: Top affiliation in metaverse

S. No	Affiliation	Country	Total no. of publication
1	University of Zilina	Slovakia	12
2	Smartlearning of Beijing Normal University	China	11
3	University of Georgia	United States	9
4	Maastricht University	Netherland	6
5	Polytechnic University of Turin	Italy	6
6	Sejong University	South Korea	5
7	Swansea University	United Kingdom	5
8	UniversityBrunei Darussalam Country	Brunei	5
9	University of Craiova	Romania	5
10	The University of Kassel	Germany	5

3.7 Affiliation Collaboration Analysis

Collaboration of affiliation is a crucial part of bibliometric analysis, as it assists in identifying the joint contribution of the institutions. The software biblioshiny was used to carry out this study, with the minimum number of edges being one and the minimum number of nodes being 50, representing the top 50 affiliations. According to the analysis, only 19 affiliations with atleast one collaboration were detected, and five clusters were generated, as shown in figure 8. Red and green make up the top two most prominent groups. The University of Zilina, Sejong University, Universität der BundeswehrMünchen (Bundeswehr University Munich), University of Georgia, and Swansea University are the top 5 organizations in terms of betweenness and PageRank.

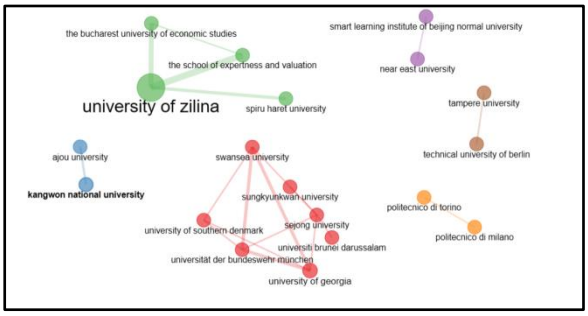

Figure 8: Affiliation collaboration analysis

3.8 Geographical location of Affiliation

The authors' institutions are found in an excel file taken from the Scopus databases. Each institution's precise location is used for research; also, the longitude and latitude of the firms have been identified with the aid of Google Sheets and geocoding. Through Google Maps, the visualization of the global map is obtained, as shown in figure 9. Figure 9 shows the organization's position as a red dot. There are 277 affiliations that have made contributions to the metaverse, and they participate 450 times on average.

The United States, with a frequency of 57; South Korea, with a frequency of 49; and the United Kingdom, with a frequency of 39, are the top three contributing affiliation countries. Europe, with a frequency of 226, and Asia, with a frequency of 128, are the two continents that appear the most frequently in the data. As a result, it has been seen that institutions in European and Asian nations are more interested in the metaverse.

Figure 9: Geographical location of institutions

3.9 Relevant Countries

The relevance of a country is determined by the contributions it has made toward the metaverse. The complete output of the nation is taken into consideration in this analysis. Table 4 provides an easy-to-understand breakdown of the top 10 contributors out of a total of 47 nations; the top five most productive nations. The most productive nation is South Korea, which has produced 71 papers. China comes in second with 67 articles, followed by the United States with 62, the United Kingdom with 41, and Germany with 33.

Table 4: Most Productive countries

S. No.	Country	No. of Publication
1	South Korea	71
2	China	67
3	United States	62
4	United Kingdom	41
5	Germany	33
6	Spain	21
7	Romania	19
8	Australia	18
9	Italy	18
10	India	17

3.10 Countries collaboration analysis

In order to develop the country collaboration connection, a country collaboration network is now being created. In order to conduct this research, the biblioshiny program was utilized, and the required number of edges was set at 1, while the number of nodes was set at 50 to reflect the top 50 countries. According to the findings of the analysis, there were only 46 countries that had participated in, at least one collaboration, and figure 10 displays the six clusters that were produced. The top three clusters are blue, brown, and red. United Kingdom, France, South Korea, Portugal, and the United States are the top 5 countries in-betweeness and PageRank.

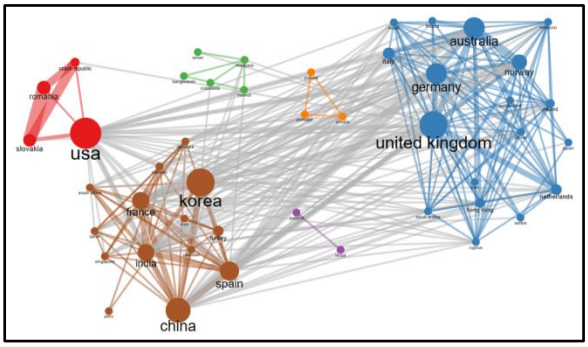

Figure 10: Countries collaboration analysis

4. Conclusion

The study is conducted to reveal the current trends in the area of metaverse in business sector. It has been found that though the research on the topic began way back in 2006 but it gained impetus very recently in 2022. The countries which contributed most in this area are South Korea followed by China, United States, United Kingdom and Germany. The three continents where research is published most are Europe, Asia and North America.

The top three journals in the area are IEEE Access, Sustainability and Computer in Human Behavior. The most contributing authors in the area are found to be Kim J., Buhalis D., Ahn S.J. The most trending keywords in the area used are Metaverses, Virtual reality and Sustainability. The top three institutes to publish the research in this area are University of Zilina from Slovakia, Smart Learning of Beijing from China and University of Georgia from USA. But it has been found in the research that the institutes that participated most frequently in this area are from European nations.

5. Limitations & Scope for future research

As we are aware that no work can be without any limitations, so the same applies to this study also. In this study only the research from Scopus database is considered. So, in future work the studies from other databases or using more than one database can be done. Further, research in different sectors as well as empirical studies can be conducted.

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