

Assessing the pertinence of the meta-verse and augmented reality : A bibliometric study and its research implications

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Abstract

In the context of the Fourth Industrial Revolution, the pervasive adoption of Meta-verse and Augmented Reality technologies is revolutionizing the landscape of user experiences. These cutting-edge technologies have demonstrated their effectiveness across various industries, with the promise of even broader applications. As they lay the foundation for future innovations, it becomes imperative to assess the existing literature on Meta-verse and Augmented Reality comprehensively. This research aims to illuminate the diverse

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dimensions of these technologies and outline prospective avenues for further investigation. We conducted a bibliometric analysis, drawing data from the Scopus database to achieve this objective. Leveraging R-studio Biblioshiny and VOSviewer software, we analyzed a dataset comprising 301 scholarly articles. Our analysis spans 2007 to 2023, revealing the evolving landscape of research production in this field.

Additionally, we identified the most influential journals, authors, and publications that have shaped the discourse surrounding Metaverse and Augmented Reality. Furthermore, co-citation analysis unveiled connections among documents, authors, and keywords. This allowed us to uncover the intellectual structure of this field and identify pivotal research trends. This study provides a comprehensive overview of the current Meta-verse and Augmented Reality literature while offering valuable insights for future research endeavours.

Subject Classification: 01A90.

Keywords: Metaverse, Augmented reality, Virtual reality, Bibliometric analysis.

1.1 Introduction

Symbolizing the 4th Industrial Revolution, meta-verse or augmented reality technology has gained unprecedented popularity in recent times. Augmented Reality and Metaverse are the buzzwords discussed among academicians, industry experts and economists. The technology is believed to revolutionize multiple beneficiaries' like interactive teaching-learning, market, market presence and consumer experience. The technology offers contactless market space and a teaching platform allowing real-time interaction and coexistence Lim, S. F., & Kamin, Y. (2023). AR Augmented Reality can improve the consumer experience, desirability, and mentally stimulating food consumption, increasing the likelihood of food purchases Fritz, W., Hadi, R., & Stephen, A. (2022). Reviewing the diverse applicability of the technology, online marketers can gain considerably by creating attractive online stores using cool AR technology Zhang, M., Li, Y., Li, Y., & Ren, X. The studies focused on highlighting the beneficiaries of the technology, factors creating positive and negative perception towards the technology such as privacy and emotions Yin, Y., & Hsu, C. (2023). The selection and rejection of the technology using the Appraisal Tendency framework

The biggest beneficiaries of technology are the online shopping industry, vocational training, music industry, gaming industry, etc. AR enhances utilitarian and hedonic shopping experiences by generating interactivity, vividness, and informativeness, a collaborated publication in the year 2022, by the authors M. Riar, N. Xi, J. J. Korbelt, R. Zarnekow, and J. Hamari. Research advancement is guided by synthesizing findings from past research. Scholars followed two popular conceptual and judgmental

methods: Systematic Literature Review and meta-analysis. Recently, a scientific method has evolved: Science Mapping. Science mapping allows for the spatial representation of research outcomes, similar to how geographic maps depict physical locations. (Calero-Medina & van Leeuwen, 2012; Small, 1999). The absence of the researcher's bias fortifies the research, making it purely scientific and objective. Bibliometric methods employ a quantitative approach for describing, evaluating and monitoring published research Zupic, I., & Čater, T. (2015). The availability of online databases enhanced the attractiveness of the technique.

1.2 Research Process

In 2021, Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., and Lim, W. M., along with Zupic, I., and Čater, T. in 2015, contributed to the research adhered to the bibliometric analysis procedure. A high level of similarity was identified. The process is discussed in Figure 1,

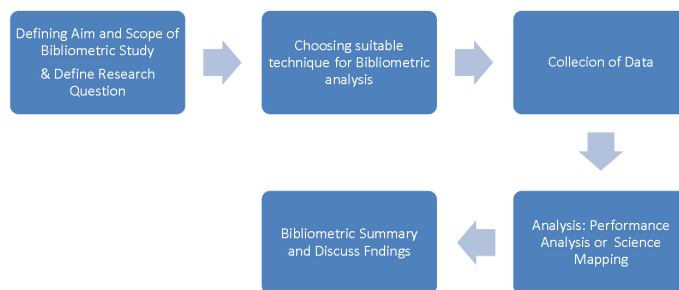


Figure 1
Bibliometric Analysis Process

The study focused on performance analysis of the available literature by evaluating its publication presence, and science mapping evaluated the dynamics of critical fields.

1.3 Selection of dataset

The researchers decided to adopt a two segmented approach for compiling bibliometric data for the research. Initially, researchers identified research articles from the comprehensive Scopus database. Scopus database provides extensive coverage of social science papers. Subsequently, a search query was formulated using various filters in order to pinpoint pertinent literature which ensured alignment with the

research objectives. The ultimate search query, ‘TITLE-ABS-KEY (“Meta Verse” OR “Augmented Reality” AND (LIMIT-TO (SUBJAREA, “Soci”)) AND (LIMIT-TO (SUBJAREA, “Busi”)) AND (LIMIT-TO (SUBJAREA, “Arts”)) AND (LIMIT-TO (LANGUAGE, “English”)) (LIMIT-TO (PUBYEAR> 1998))), generated a comprehensive list of total of 7165 research articles. Later, bibliometric analysis, was confined to articles in the English language only. Lastly, a manual analysis was conducted on the research articles, which resulted in the exclusion of 301 articles. These articles were found to be not aligned with the objective of the research.

1.4 Analysis

Descriptive statistics of the available data included the analysis of 301 research articles. From 2007 to 2023, 680 authors published 220 research papers. In contrast, 81 single-authored articles indicated a high level of collaboration among authors in this subject area. The average citation per doc is 9.33, which is considered very good. The annual growth rate of 24% in this subject area shows that it is an emerging study area for researchers.

Annual Publication Trend:

The annual publication trend and annual mean total citation per year on the topic “meta-verse” and “augmented reality” revealed that in the initial five years ranging from 2007 to 2012, no significant contribution was made by the authors in this area due to the slow diffusion and adoption of the technology by the society & shown in Figure 2. However, the literature has experienced exponential growth since 2013. The

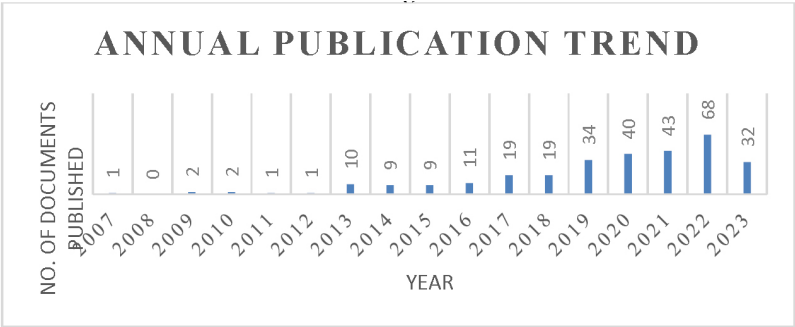


Figure 2
Annual Publication Trend

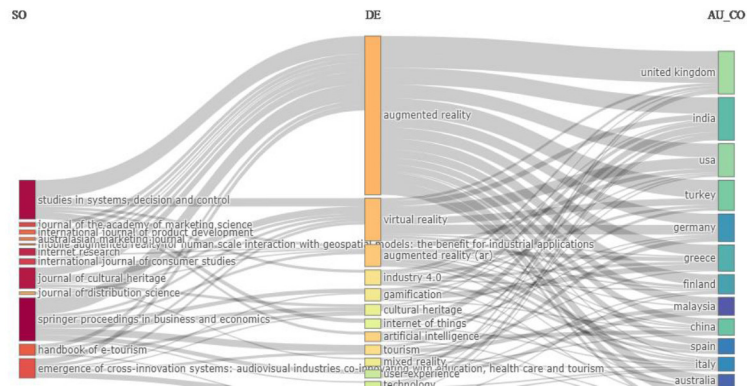


Figure 3
Three Field Plot

maximum research contribution was made in the year 2022. The annual mean total citation trend for the research articles from 2007 to 2023. It is observed that the available literature was cited the most in the year 2009, followed by 2014 and 2017.

Figure 3 illustrates a three-field analysis of literature pertaining to the research topics “Metaverse” or “Augmented Reality.” The plot is divided into three sections: research journals on the left, on the right side authors’ countries, and research themes in the middle. The visualization highlights that “Augmented Reality,” “Virtual Reality,” and “Industry 4.0” emerge as the predominant research areas in recent times. Notably, a significant portion of contributions originates from India, with the United states and the United kingdom following closely. The primary publication outlets for this research are the Springer proceedings in Business and Economics, with the Journal of Studies in Systems, Decision and Control being the subsequent prominent choice.

Most Influential Research Journals

Table 1 summarizes the ten most influential journals in this area based on their h_index, g_index, total citations, number of publications and publication starting year. The table shows that the Journal of Cultural Heritage is the most influential in this area, with the highest h_index and g_index, and the total citations are 685. However, the number of related papers published by this journal is deficient.

Table 1
Most Influential Journal

Element	H_index	G_index	TC	NP	PY_start
JOURNAL OF CULTURAL HERITAGE	7	9	685	9	2009
STUDIES IN SYSTEMS, DECISION AND CONTROL	6	10	127	27	2014
INTERNET RESEARCH	5	8	269	8	2014
JOURNAL OF THE ACADEMY OF MARKETING SCIENCE	4	5	465	5	2017
AUSTRALASIAN MARKETING JOURNAL	3	3	131	3	2018
INTERNATIONAL JOURNAL OF CONSUMER STUDIES	3	5	52	5	2021
JOURNAL OF DISTRIBUTION SCIENCE	3	3	29	3	2019
JOURNAL OF OPEN INNOVATION: TECHNOLOGY, MARKET, AND COMPLEXITY	3	3	25	3	2021
ACCOUNTING, FINANCE, SUSTAINABILITY, GOVERNANCE AND FRAUD	2	2	5	2	2022
EMERGING INNOVATIVE MARKETING STRATEGIES IN THE TOURISM INDUSTRY	2	2	21	2	2015

Word Cloud

Figure 4 shows the word cloud based on the keyword plus analysis. The size of the word shows the frequency. It is observed from the figure that “augmented reality” is the most frequently used keyword plus, followed by “virtual reality” and “augmented reality system. However, helmets, mounted displays, augmented reality systems, and augmented reality technology are a few of the most frequent keyword pluses available in the sample studies.



Figure 4
Word cloud based on keyword plus

Main Researcher, Research and Countries

Table 2 shows the most relevant author analysis based on several research papers published by the author on this subject and h-index. It is observed from the table that Hassan A has the highest contribution in this subject, having ten published papers with the highest h-index. He has contributed to many chapters, such as “Consuming Innovation in Tourism: Augmented Reality as Innovation Tool in Digital Tourism Marketing”, in the book *Global Dynamics in Travel, Tourism and Hospitality*, and “The Augmented Reality Marketing: a Merger of Marketing and Technology in Tourism” in the book *Mobile computing and Wireless Network* and “Augmented Reality adoption by Tourism Product and Service Consumers: Some Empirical Findings” in the book “Augmented Reality and Virtual Reality.” The second most influential author in this area is Rahimi R., with 4 published papers and a high h-index. However, the most cited authors are Chylinski, M., De Ruyter, K., Hilken, T., Keeling DI and Mahr, D., with a maximum of 367 citations.

Table 2
Most Influential Authors

Element	h_index	g_index	TC	NP	PY_start
HASSAN A	4	8	66	10	2015
CHYLINSKI M	3	3	367	3	2017
DE RUYTER K	3	3	367	3	2017
HILKEN T	3	3	367	3	2017
KEELING DI	3	3	367	3	2017
MAHR D	3	3	367	3	2017
RAHIMI R	3	4	43	4	2016
AYDIN S	2	2	4	2	2022
HAMARI J	2	2	7	2	2022
HEBBEL-SEEGER	2	2	26	2	2012

Table 3 provides information regarding the top 10 countries' contribution to the topic of research. The countries that contributed the maximum number of publications and those cited maximum are listed in the table. It is observed that the UK and the USA published the most articles on the topic, followed by Portugal and Turkey. Italy, Netherlands and China are the most cited countries for the work done in this area.

Table 3
Countries with the most publications and Citations

Countries	Most Publications	Countries	Most Citations
UK	54	ITALY	387
USA	41	NETHERLANDS	299
PORTUGAL	30	CHINA	263
TURKEY	30	GREECE	255
CHINA	25	GERMANY	222
INDIA	24	HONG KONG	123
GREECE	22	AUSTRALIA	98
FINLAND	21	MALAYSIA	89
GERMANY	19	UNITED KINGDOM	89
ITALY	19	POLAND	53

Metaverse and augmented reality are technological innovations that are gaining importance as areas of interest for researchers across many countries. Therefore, the authors cross borders and are collaborating to explore its prospects and future challenges. Figure 6 shows the countries which are collaborating on the topic under research. It is observed from the figure that the UK and Australia collaborated with a maximum of 4 projects, and the UK and Netherlands had 4 Projects, followed by the USA and Germany had three projects.

Table 4
Most Globally Cited Document

Paper	DOI	Total Citations	TC per Year	Normalized TC
MORTARA M, 2014, J CULT HERITAGE	10.1016/j.culher.2013.04.004	317	31.7	5.89
STYLIANI S, 2009, J CULT HERITAGE	10.1016/j.culher.2009.03.003	242	16.13	2
HILKEN T, 2017, J ACAD MARK SCI	10.1007/s11747-017-0541-x	240	34.29	10.11
STEINHOFF L, 2019, J ACAD MARK SCI	10.1007/s11747-018-0621-6	163	32.6	15.52
CAI Y.J, 2020, INT J PRODECON	10.1016/j.ijpe.2020.107729	123	30.75	10.74
HUANG TL, 2014, INTERNET RES	10.1108/IntR-07-2012-0133	107	10.7	1.99
RATTEN V, 2020, J ENTERPRISING COMMUNITIES	10.1108/JE-C-06-2020-0121	98	24.5	8.56
HUANG TL, 2017, INTERNET RES	10.1108/IntR-11-2015-0321	91	13	3.83
CHYLINSKI M, 2020, AUSTRALAS MARK J	10.1016/j.ausmj.2020.04.004	70	17.5	6.11
SKILTON M, 2017, THE 4TH IND REVOLUT: RESPONDING TO THE IMPACT OF ARTIF INTELL ON BUS	10.1007/978-3-319-62479-2	60	8.57	2.53

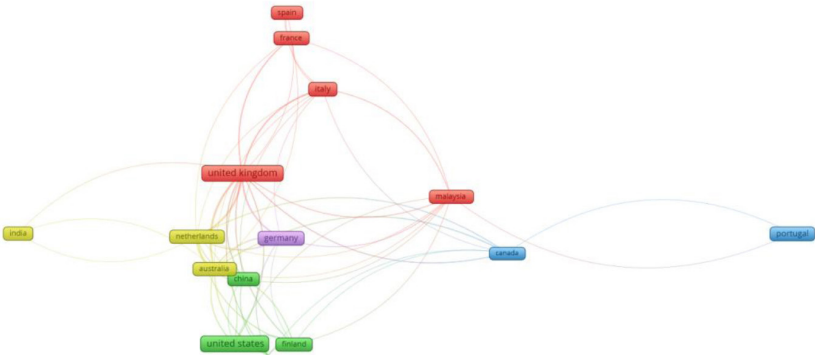


Figure 5
Citation in Countries

In the citation, 17 countries meet the thresholds, with citations of more than 5 as shown in Table 4 for the research under study. It is observed that the UK, followed by the USA, has a maximum number of citations.

The last section of the manuscript describes the co-citation analysis on the basis of a number of times papers are cited together in different studies. In this analysis, we assume that the papers cited together belong to the same subject. After performing co-citation analysis on the available data in Biblioshiny, 4 clusters have been received as output as shown in Figure 5, Figure 6 & Figure 7.

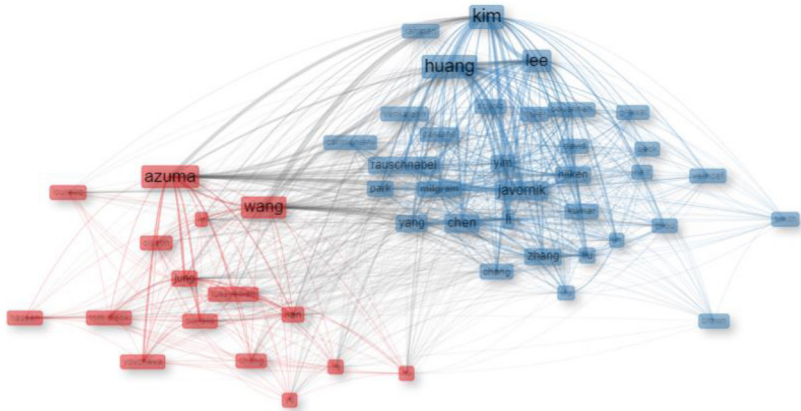


Figure 6
Co-citation Analysis

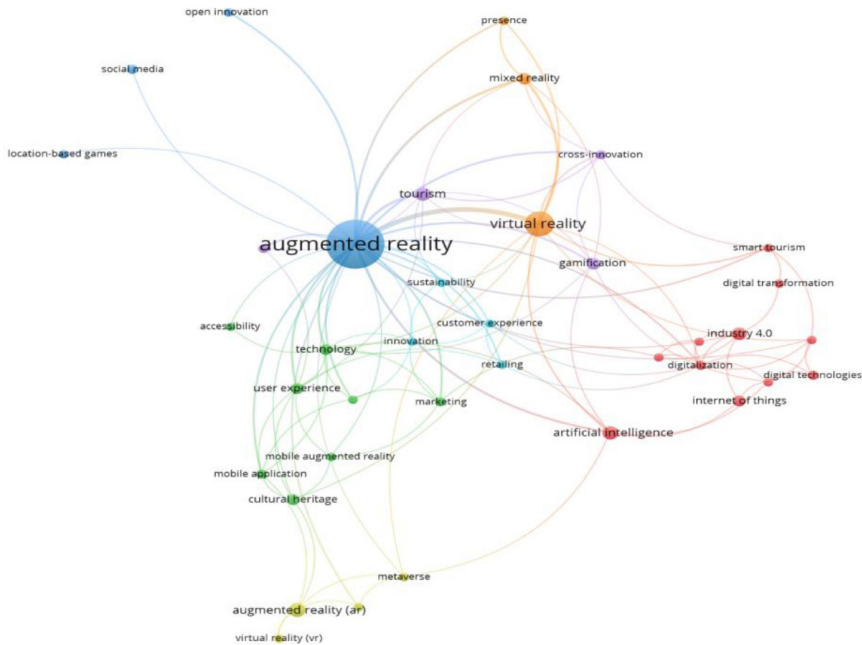


Figure 7
Co-occurrence Analysis

Cluster 1(Red): The first cluster highlighted a total of 16 authors contributing to the same theme. Wang and Azuma appeared to be the most co-cited authors.

Cluster 2 (Blue): The citation indicated 33 authors, of whom Lee, Kim, and Huang are connected with a maximum number of nodes – 41, 33, and 32, respectively. Hence, it can be interpreted that these authors are co-cited with other authors for a maximum number of times.

The co-occurrence analysis based on author keywords is performed in VOSviewer. The minimum number of occurrences of keywords was selected as 3 for analysis, and out of a total of 776 keywords, 38 meet the threshold represented by 7 clusters of different colours. Cluster 1 consists of a maximum of 11 items. Augmented reality, virtual reality, and artificial intelligence are the most common keywords in the analysis.

Conclusion

This study attempts to find out the existing literature around the topic of Metaverse and Augmented Reality for the period 2007 to 2023. For

the study, the contribution made by various authors is collected from the Scopus database using the keywords “Metaverse or Augmented Reality and various filters were applied to narrow down the search. The result of the study shows a significant increasing trend in the publication and citation of this theme over the last ten years. The study’s findings show the most relevant authors, most influential journals, most cited documents, most frequent keywords, countries, and research institutions that contributed the most documents on this topic. Additionally, the co-citation analysis in the study reveals the frequency with which two authors are cited together in various documents. This study can help researchers find new avenues in the metaverse and augmented reality fields. One can perform a Systematic Literature Review on the theme under study from the most influential authors and journals.

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