

Investigating Virtual Financial Ecosystem: Ascent of Metaverse Economics Research

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Abstract

The growing interest in the concept of the Metaverse causes a significant increase in academic publications covering different facets and sectors of the virtual economy. While still in its nascent phase, the academic literature addressing the financial dimensions of Metaverse advancements has experienced a significant rise in publications over the preceding year. The paper undertakes a comprehensive scientific analysis to systematically navigate the existing literature concerning finance in the Metaverse. This study employs bibliometric analysis techniques to study academic publications, addressing a research gap and providing a comprehensive overview of the current scholarly discourse on Finance in the Metaverse. By accurately examining 267 documents and leveraging Biblioshiny and VOSviewer applications, the analysis identifies impactful publications, influential authors, and promising research trajectories within this domain. Such an analytical approach sheds light on Finance's emergent and prospective nature in the Metaverse, affirming its significance as a burgeoning area of scholarly interest both presently and in the foreseeable future.

Keywords: *Metaverse, Finance, Bibliometric Analysis*

JEL Codes: *G00, O33, L86*

Sanal Finansal Ekosistemin İncelenmesi: Metaverse Ekonomi Araştırmalarının Yükselişi

Öz

Metaverse kavramına artan ilgi, sanal ekonominin farklı yönlerini ve sektörlerini kapsayan akademik yayınlarda önemli bir artışa neden olmaktadır. Henüz başlangıç aşamasında olsa da, Metaverse gelişmelerinin finansal boyutlarını ele alan akademik literatür, geçtiğimiz yıl yayınlarda önemli bir artış yaşadı. Bu çalışma, Metaverse'de finansla ilgili mevcut literatürü sistematik bir şekilde incelemek üzere kapsamlı bir bilimsel analiz gerçekleştirmektedir. Bu çalışma, akademik yayınları incelemek için bibliyometrik analiz tekniklerini kullanmakta, bir araştırma boşluğunu ele almakta ve Metaverse'de Finans konusundaki mevcut bilimsel söyleme kapsamlı bir genel bakış sağlamaktadır. Analiz, 267 belgeyi doğru bir şekilde inceleyerek ve Biblioshiny ve VOSviewer uygulamalarından yararlanarak, bu alandaki etkili yayınları, etkili yazarları ve umut verici araştırma yörüngelerini tanımlamaktadır. Bu tür bir analitik yaklaşım, Finans'ın Metaverse'de ortaya çıkan ve ileriye dönük doğasına ışık tutmakta ve hem şu anda hem de öngörülebilir gelecekte gelişen bir bilimsel ilgi alanı olarak önemi teyit etmektedir.

Anahtar Kelimeler: *Metaverse, Finans, Bibliyometrik Analiz*

Jel Kodları: *G00, O33, L86*

Introduction

In the aftermath of the global COVID-19 pandemic and the rapid digital transformation across diverse domains, the Metaverse has surfaced as an attractive yet controversial subject. Promising substantial and diverse impacts on our lives, the Metaverse seeks to revolutionize business practices and service consumptions. Similar to the Internet evolution represented by the introduction of Web 3.0, the Metaverse is defined by its decentralized structure that suggests a more inclusive and fairer ecosystem (Wu et al., 2023).

As an emerging topic, the Metaverse still lacks one unified definition. This study accepts and applies the definition developed by Ritterbusch and Teichmann, 2023 in their systematic literature review of Metaverse definitions. According to the authors, the Metaverse is:

a (decentralized) three-dimensional online environment that is persistent and immersive, in which users represented by avatars can participate socially and economically with each other in a creative and collaborative manner in virtual spaces decoupled from the real physical world. (Ritterbusch & Teichmann, 2023, p.12373)

The exact inception of virtual reality is challenging to identify; however, most academic publications on the Metaverse define the launch of the Second Life virtual platform in 2003 as the first practical stage of the Metaverse advancement (Hill, 2021). Unfortunately, the initial popularity of the platform could not provide the long-term success to Second Life due to several factors, the most prominent of which have been technological limitations. The introduction of blockchain-based instruments and as well the further advancement of the Internet have boosted new virtual developments, creating hype in public and investors' attention.

At the same time, the expanding progressions of virtual businesses necessitate the establishment of a resilient and sustainable financial infrastructure. Furthermore, the ongoing digitization of payment and financial systems works as a robust foundation for the transition from physical-world finance to its virtual counterpart. Additionally, the evolution of blockchain-based technologies, including cryptocurrencies, smart contracts, and non-fungible tokens (NFTs), indicates a critical step in developing the virtual financial ecosystem. This emerging financial system has a strong potential to further disrupt and revolutionize conventional monetary and economic systems (Kumar et al., 2023).

In exploring the financial facets of virtual reality, considerations regarding the ownership, acquisition, and utilization of digital assets become paramount. Alongside, the decentralized nature inherent to the Metaverse holds the promise of eliminating intermediaries, including those of a financial nature. However, this decentralization creates new issues on regulation, security, and trust (Belk, Humayun & Brouard, 2022).

The scholarly interest in the Metaverse has witnessed a notable increase parallel with its growing advancement. Moreover, the spread of academic literature addressing the Metaverse mirrors the comprehensive nature of the topic itself. In its initial stages, scholarly publications predominantly centered on the technological side underpinning virtual reality (Davis et al., 2009; Park & Kim, 2022). However, as the Metaverse has evolved, the landscape of academic discourse has substantially diversified, encompassing various subjects ranging from virtual education, healthcare, and the gaming industry to ethical issues and regulatory aspects.

The digitalization of financial services has led to a proliferation of scholarly literature and scientific literature reviews in the field of Fintech and related domains (Dosso and Aysan, 2022; Aysan and Unal, 2023). Equally, academic literature exploring financial instruments and systems within the Metaverse has experienced a remarkable surge in the last year. Key areas of research include the matters of virtual ownership (Belk et al, 2023), the dynamics of platform-based cryptocurrencies (Vidal-Tomas, 2022), issues of the liquidity of virtual currencies (Chen et al., 2023), regulatory frameworks (Ooi et al., 2023), cybersecurity (Mackenzie, 2022), and virtual financial frauds (Dwivedi et al., 2023). These complex topics gain substantial attention from practitioners, investors, and policymakers involved in financial services within the Metaverse (Kumar et al., 2023; Wu et al., 2023).

The expansion of scholarly publications relating to the Metaverse has prompted a number of the Metaverse-related papers employing various literature review methodologies. Notably, a conference paper by Abbate et al. in 2022 has garnered recognition from Scopus as the most highly cited bibliometric analysis within the general theme of the Metaverse (as of January 2024). Innovative methodologies for literature review have been implemented as Aydin (2023) conducted a review of Metaverse literature utilizing Google Bard. Furthermore, numerous bibliometric analyses had been undertaken on specific sectors of the Metaverse economy, such as education (Tlili et al., 2022) and healthcare (Liu et al., 2022b). An interesting bibliometric analysis of the application of blockchain technology in the realms of banking conducted by Patel et al. in 2022. Nonetheless, to the best of the author's knowledge, no bibliometric analysis has yet been undertaken on the subject of finance in the Metaverse.

To address the existing research gap and to define the foundation for further research, the study thoroughly examines existing literature concerning Finance in the Metaverse to identify and categorize related publications. In pursuit of a refined and systematic literature review and to increase the accuracy and comprehensiveness of the foundational knowledge base, this paper adopts the methodology of bibliometric analysis.

Conducting the bibliometric analysis, the study aims to address the following key research questions:

R.1: What is the extent and composition of the academic literature relating to Finance in the Metaverse?

R.2: What are the most influential papers, authors, and sources of publication on the topic of Finance in the Metaverse?

R.3: What are the main keywords or phrases defining the topic of Finance in the Metaverse?

R.4: What prevailing and emergent patterns and developments characterize the landscape of Finance in the Metaverse?

R.5: What prospective research trajectories and areas of exploration are evident for advancing the study of Finance within the Metaverse?

By conducting a bibliometric analysis of 267 thoroughly chosen publications, this study examines the extant literature on Finance in the Metaverse and addresses the identified research questions. Subsequently, the rest of the chapter is structured as follows:

Section 1 explains the methodology employed in this study. Section 2 describes the data collection and cleaning process. The cornerstone of the study, section 3, encompasses a comprehensive account of the research outcomes derived from the conducted analysis. Furthermore, within section 3, the following subsections present the various parts of the analysis: citation analysis, co-citation analysis, bibliographic coupling analysis, co-word analysis, and co-authorship analysis. Section 4 concludes the study, presenting a comprehensive discussion of the findings and concluding remarks.

1. Methodology

In contrast to a narrative review, a scientific literature review suggests the application of accurate research methods and emphasizes clarity in reporting analysis results (Linnenluecke, Marrone & Singh, 2020). While two common types of literature reviews are author-centric and theme-centric, this paper concentrates on field of Finance in the Metaverse as the theme-centric approach. The objective of the research employs a science mapping techniques to delineate the publications within the defined field of study, allowing a comprehensive overview of the knowledge structure within the scientific literature. Additionally, this approach enables the identification of prevailing trends and future research directions (Donthu et al., 2021).

The conventional approach to systematic literature review has traditionally entailed manual processes when rigorous systematic procedures were applied to evaluate existing scholarly works (Palmatier et al., 2018, as cited in Donthu et al., 2021). The introduction of bibliometric analysis has notably streamlined this process. Bibliometric analysis enables the application of quantitative techniques to diverse bibliometric datasets derived from prominent scientific databases like Scopus and Web of Science (Donthu et al., 2021). Furt-

hermore, creating various bibliometric software tools, such as Leximancer and VOSviewer, has additionally added convenience and analytical effectiveness to the review process.

Moreover, the research utilizes the capabilities of the R statistical programming language. Specifically, from the various R packages available for systematic literature review, this study employs the popular Bibliometrix package developed by Aria and Cuccurullo in 2017. Several statistical and graphical techniques of the Biblioshiny package, such as citation analysis or bibliographic coupling, ensure proper extant literature study (Janik et al., 2020).

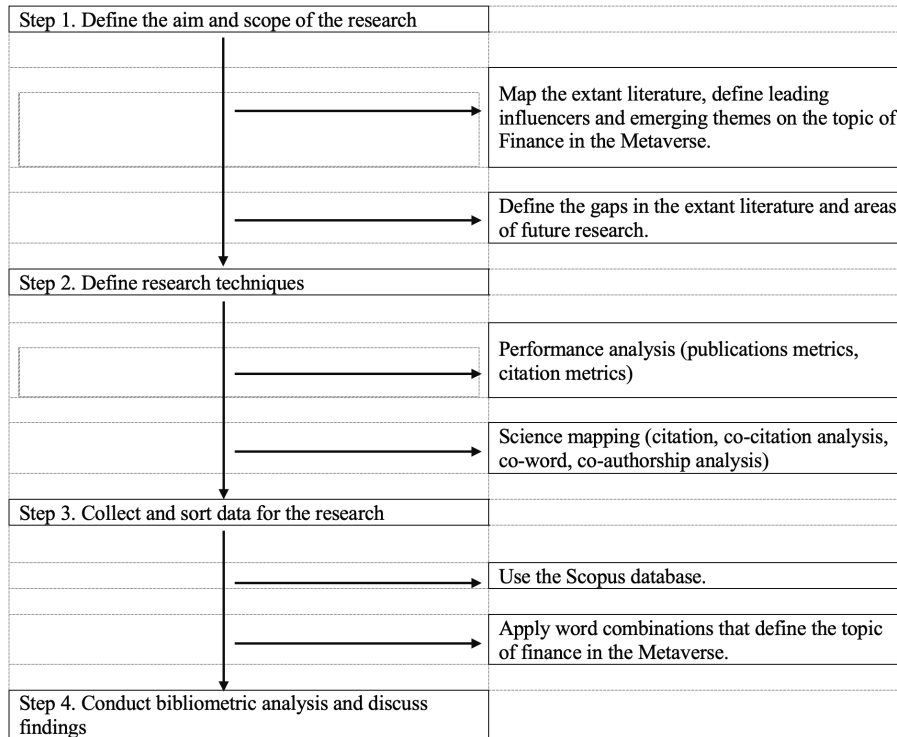
Furthermore, to enhance the visual representation of research findings, the study incorporates VOSviewer software as a valuable tool for creating illustrative visualizations (Van Eck & Waltman, 2010).

This study utilizes data obtained from Scopus metadata repository, recognized for its substantial content storage capacity of 3.7 TB, and thus known as a robust foundation for scientific analyses (Biancone et al., 2020).

Typically, the bibliometric analysis comprises two principal categories: performance analysis, which defines the contributions made by varied elements within the research domain (such as authors, countries or publication sources), and science mapping, which describes the links and associations between these elements (Donthu et al., 2021). Accordingly, the paper is structured around these two core bibliometric techniques and undertakes the following consecutive steps, as depicted in Figure 1:

1. Identifying the scope and aims of the research.
2. Defining the methodology.
3. Data collecting and cleaning.
4. Conducting bibliometric analysis and presenting the results.

Figure 1. Research methodology framework



2. Data collection and cleaning

To conduct bibliometric analysis, the Scopus search engine was probed with the Boolean combination of the following terms: “metaverse” AND (“financ*” OR “bank*” OR “money” OR “NFT” OR “Cryptocurrency*” OR “DeFi”). As of January 4th, 2024, this search yielded 317 documents when applied to article titles, abstracts, and keywords. Subsequently, upon restriction of the database to only English language articles and those categorized as articles, conference papers, book chapters, reviews, conference reviews, and books, the resulting dataset was narrowed down to 300 documents.

Through further manual filtering, each publications’ abstracts have been carefully reviewed to exclude papers not directly relevant to the subject of Finance in the Metaverse and duplicates and conference overviews. Following this alteration, 267 publications have been extracted to conduct bibliometric analysis in Biblioshiny and VOSviewer (Table 1).

Table 1. Main data information

Description	Results
MAIN INFORMATION ABOUT DATA	
Timespan	2008:2024
Sources (journals, books, etc)	189
Documents	267
Annual Growth Rate %	14.72
Document average age	1.42
Average citations per doc	5.839
References	12191
DOCUMENT CONTENTS	
Keywords Plus (ID)	1122
Author's Keywords (DE)	735
AUTHORS	
Authors	799
Authors of single-authored docs	48
AUTHORS COLLABORATION	
Single-authored docs	49
Co-Authors per doc	3.4
International co-authorships %	26.59
DOCUMENT TYPES	
Article	120
Book	5
Book chapter	29
Conference paper	90
Review	23

3. Results of the conducted analysis

The topic of Finance in the Metaverse can be characterized as an emerging and novel field of research, as evidenced by the relatively small and only recently increasing number of academic publications, as illustrated in Figure 2. The number of publications started to rise in 2022, reaching its peak in 2023. The observed decline in 2024, explained by the January 3 cut-off date, still yielded 12 documents, signifying sustained academic interest in the subject.

The first identified document on this topic, titled “Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverse” (Papagiannidis, Bourlakis & Li, 2008), explores business opportunities, virtual ownership, trade, and ethical considerations based on observations of Second Life platform. Being the earliest identified publication on the defined topic, this paper supports the recognition of Second Life as the initial phase of the Metaverse development.

Figure 2. Documents by year

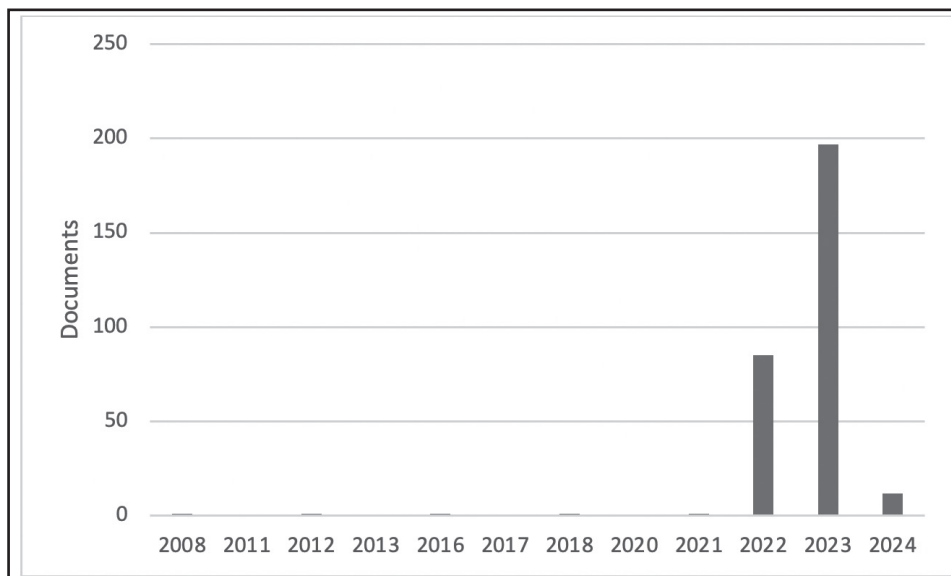
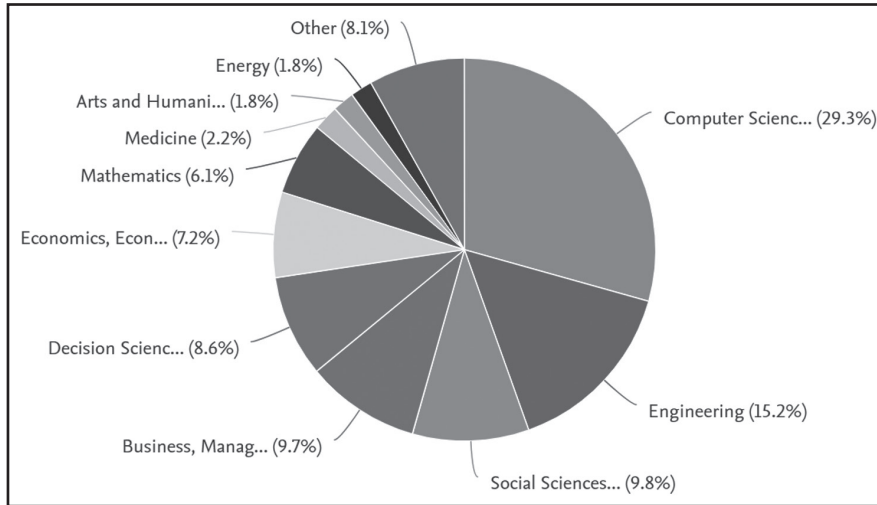


Table 1 illustrates that documents on the topic of Finance in the Metaverse predominantly consist of articles (constituting 40% of the total number of documents) and conference papers (30%). The notable prevalence of these document types may be attributed to the nascent nature of the research field. At the same time, the release of five books within a brief time duration serves as evidence of pronounced academic interest in the defined research domain.

The subject area of the publications reflects the diversity inherent in the Metaverse topic itself. The association of the Metaverse with the next stage of the Internet and technological advancements explains the dominance of publications (30%) in the field of Computer Science (refer to Figure 3). At the same time, documents within Business, Management, Accounting, Economics, Econometrics, and Finance collectively account for 17% of all publications, setting out the financial dimensions of the chosen topic. Thus, the study of Finance in the Metaverse mainly aligns with technological considerations rather than solely focusing on financial aspects, like the thematic scope of study on Fintech (Aysan & Nanaeva, 2022).

Figure 3. Documents by subject area



3.1. Citation analysis

Citation analysis is employed to identify robust scholarly connections among publications, assuming that citations serve as indicators of the strength and influence of specific documents and authors within a defined research area (Donthu et al., 2021).

3.1.1. Most cited documents

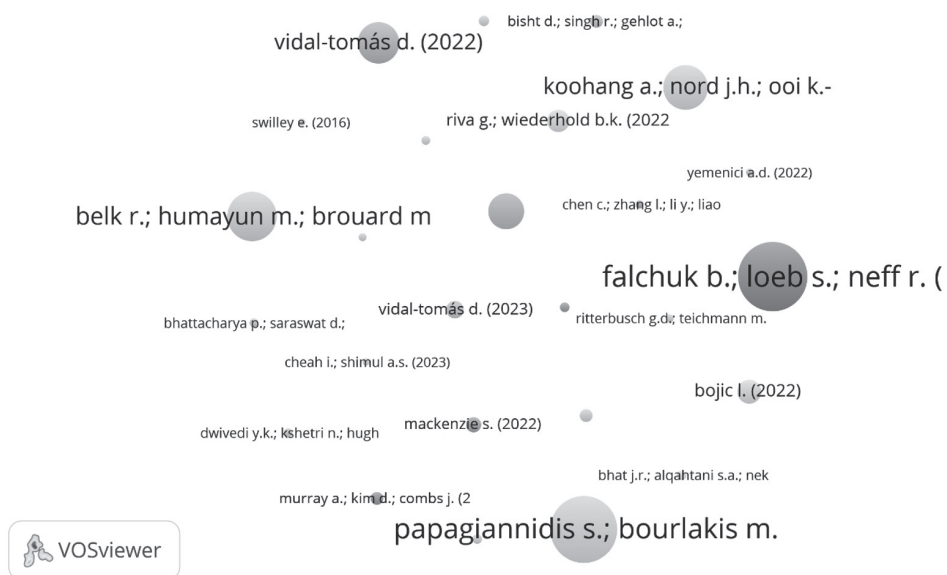
Table 2 reveals that the paper by Falchuk, Loeb, and Neff, published in *IEEE Technology and Society Magazine* in 2018, has collected the highest number of 139 citations. Titled “The social metaverse: Battle for privacy,” this paper explores the privacy mechanisms within the expansive Metaverse’s big data ecosystem. The second most cited paper, authored by Papagiannidis, Bourlakis, and Li, was published in the *Journal of Technological Forecasting and Social Changes* in 2008, creating 135 citations. Lastly, the paper authored by Belk, Humayun, and Brouard, published in the *Journal of Business Research* in 2022, secures the third highest number of citations. This work examines issues of ownership and financial transactions within the Metaverse, employing an analysis of NFTs and cryptocurrencies. Furthermore, Figure 4 visually presents the most cited documents, with bubble size proportional to the number of citations they have received.

Aysan, A. F., & Nanaeva, Z. (2024). Investigating virtual financial ecosystem: Ascent of Metaverse economics research. *Efil Journal of Economic Research*, 7(3), 10-39.

Table 2. Most cited documents

Paper	Total citations
Falchuk B, 2018, IEEE Technol Soc Mag	139
Papagiannidis S, 2008, Technol Forecast Soc Change	135
Belk R, 2022, J Bus Res	100
Koohang A, 2023, J Comput Inf Syst	90
Vidal-Tomás D, 2022, Finan Res Lett	84
Joy A, 2022, Strateg Change	72
Bojic L, 2022, European J Futures Res	48
Riva G, 2022, Cyberpsychol Behav Soc Networking	46
Vidal-Tomás D, 2023, Int Rev Financ Anal	36
Mackenzie S, 2022, Br J Criminol	31
Hwang Y, 2023, Comput Educ	27
Bisht D, 2022, Electronics (Switzerland)	26
Murray A, 2023, Bus Horiz	26
Ersoy M, 2023, Trans Emerg Telecommun Technol	21
Gauttier S, 2022, J Bus Strategy	20

Figure 4. Most cited documents



The list of locally cited documents presented in Table 3 is different from the one presented in Table 2. Local citations focus on the number of citations within the pool of defined documents on the subject of Finance within the Metaverse. Notably, Belk, Humayun, and Brouard’s paper, titled “Money, possessions, and ownership in the Metaverse: NFTs, cryptocurrencies, Web3 and Wild Markets,” emerges as the most prominently locally cited document, collecting a total of 19 citations. The second most cited document within this local context is “Digital future of luxury brands: Metaverse, digital fashion, and non-fungible tokens” authored by Joy et al. and published in the Strategic Change Journal in 2022. Surprisingly, the paper by Lee and Kwon, titled “Sustainable and Safe Consumer Experience: NFTs and Raffles in the Cosmetics Market after COVID-19,” which holds the third position in local citations, does not feature among the top 15 globally cited documents as presented in Table 2.

Table 3. Most locally cited documents

Document	Local citations
Belk R, 2022, J Bus Res	19
Joy A, 2022, Strateg Change	11
Lee J, 2022, Sustainability	9
Papagiannidis S, 2008, Technol Forecast Soc Change	9
Falchuk B, 2018, Ieee Technol Soc Mag	8
Far Sb, 2022, Procedia Comput Sci	6
Maksymyuk T, 2022, IEEE Access	4
Zainurin Mzl, 2023, J Financ Rep Account	3
Liu Z, 2022, Int J Environ Res Public Health	3
Katterbauer K, 2022, J Metaverse	3
Koohang A, 2023, J Comput Inf Syst	3
Hirsch Pb, 2022, J Bus Strategy	3
Swilley E, 2016, Dev Mark Sci	3
Wang Y, 2023, Front Robot Ai	3
Chen C, 2022, Ieee Open J Comput Soc	2

3.1.2 Most productive and cited authors

Figure 5 depicts the top 15 authors who have received the highest rate of citations within the defined research area. Among these authors, Brouard M. from the University of Ottawa (Canada) and Papagiannidis S., affiliated with New Castle University, UK, emerge as the most prominently cited contributors. Subsequently, the following three authors, Falchuk B., Loeb S., and Neff R. share an equal number of citations, as they are co-authors of the most cited paper on Finance in the Metaverse.

Figure 5. Most cited authors

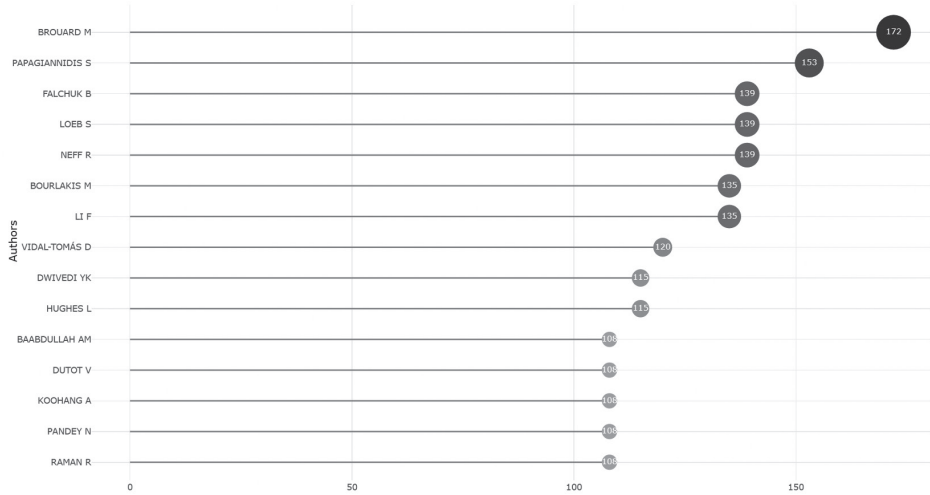
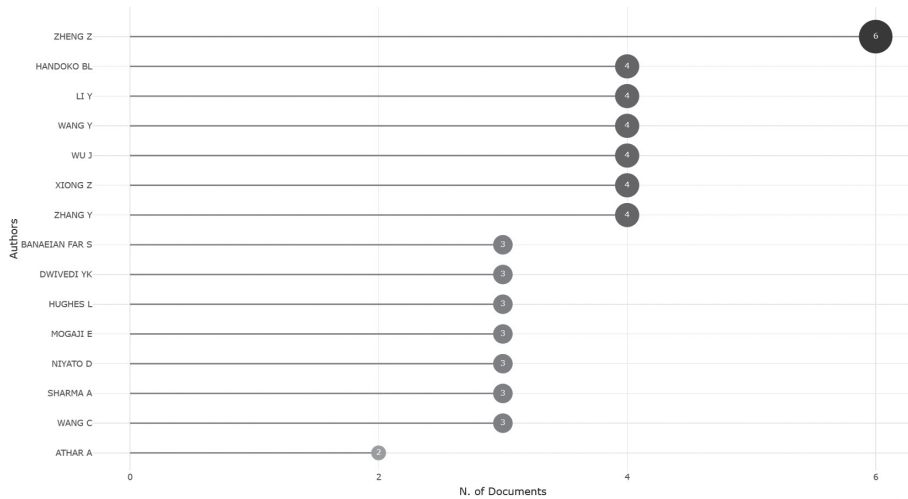


Figure 6 portrays the authors who have exhibited the highest productivity in publications. Zheng Z. from China occupies the top position on this list, having contributed six papers to the list of publications on the topic of Finance in the Metaverse. It is worth noting that the relatively limited number of publications per author can be attributed to the nascent nature of the research topic.

Figure 6. Most productive authors



As depicted in Figure 7, Zheng Z. demonstrates the highest local h-index, emphasizing his significant influence within the specialized field of Finance in the Metaverse. Zheng

Aysan, A. F., & Nanaeva, Z. (2024). Investigating virtual financial ecosystem: Ascent of Metaverse economics research. *Efil Journal of Economic Research*, 7(3), 10-39.

Zibin is affiliated with Sun Yat-Sen University in China and has a research focus on blockchain, smart contracts, and services computing. His overall h-index is 87, and his most frequently cited paper in the domain of Finance in the Metaverse is a collaborative effort involving five other authors and is titled “Financial Crimes in Web3-Empowered Metaverse: Taxonomy, Countermeasures, and Opportunities.”

Dwivedi and Hughes are following closely, occupying the second and third positions in impact within this research domain. They jointly authored the widely referenced paper “Exploring the Darkverse: A Multi-Perspective Analysis of the Negative Societal Impacts of the Metaverse,” published in the *Journal of Information Systems Frontier* in 2023. This scholarly work delves into challenges and pessimistic perspectives associated with the Metaverse (Dwivedi et al., 2023).

Figure 7. Author’s local impact

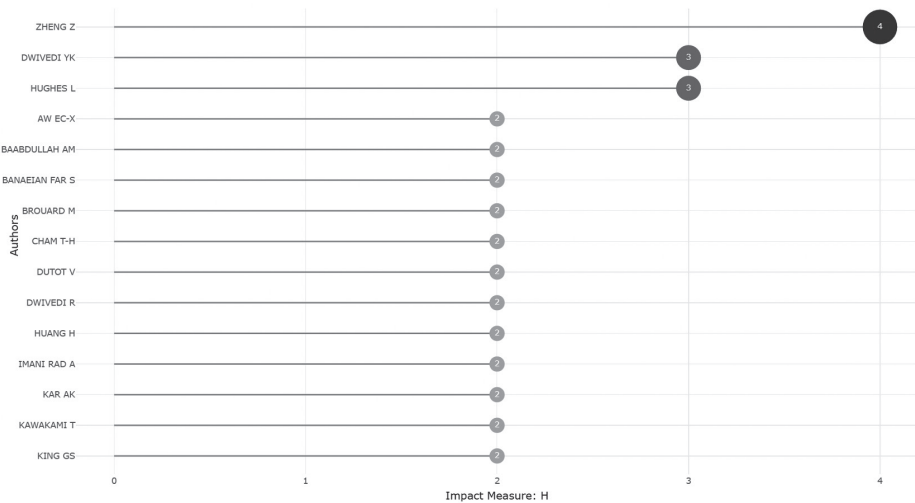


Table 4 illustrates the outcomes governed by Lotka’s law, which postulates that the extent of authors contributing documents within a specific subject area substantially diminishes as the number of papers authored by an individual increases. As evident from both Table 4 approximately 90% of authors have authored a single document within the defined research topic. At the same time, the contingent of authors with two publications in the chosen field of research comprises less than 1% of the entire author pool. It can be anticipated that with the passage of time, this curve will gradually smooth out, witnessing a more significant increase in authors who have authored two or more documents on the subject of Finance in the Metaverse.

Table 4. Lotka's law

Documents written	N. of Authors	Proportion of Authors
1	712	0.891
2	73	0.091
3	7	0.009
4	6	0.008
6	1	0.001

3.1.3. Most cited sources and affiliations

The highest volume of publications in the specified research domain originates from the Proceedings of IEEE conferences, as evident from Figure 8. The acronym IEEE represents the Institute of Electrical and Electronic Engineers, signifying the technological dimension within the Metaverse. Finance Research Letters emerges as the second most productive source of publications within this context.

Figure 8. Most productive sources

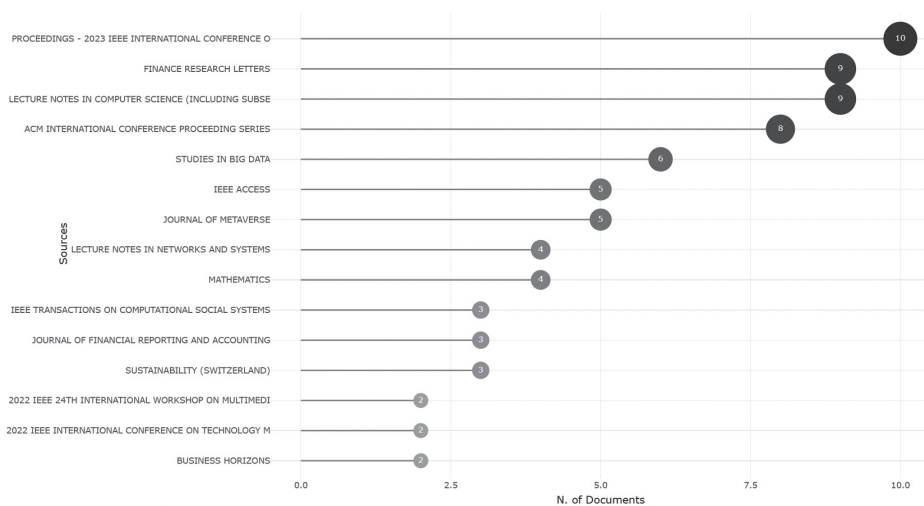


Figure 9 shows that the three most frequently cited sources are IEEE Technology and Society Magazine, Technological Forecasting and Social Changes, and Finance Research Letters. The most cited document in the defined research domain is authored by Falchuk et al. (2018) and is featured in IEEE Technology and Society Magazine, while the second most cited publication by Papagiannidis et al. (2008) finds its place in Technological Forecasting and Social Changes.

Figure 9. Most cited sources

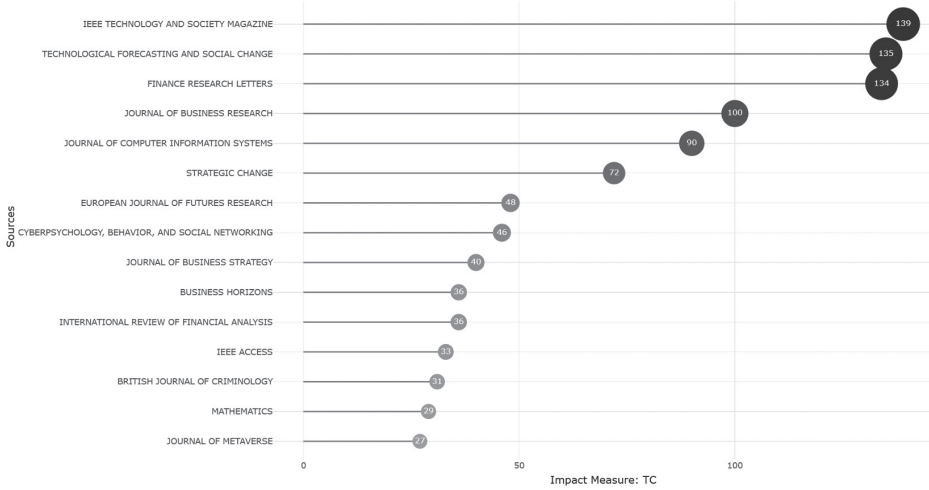
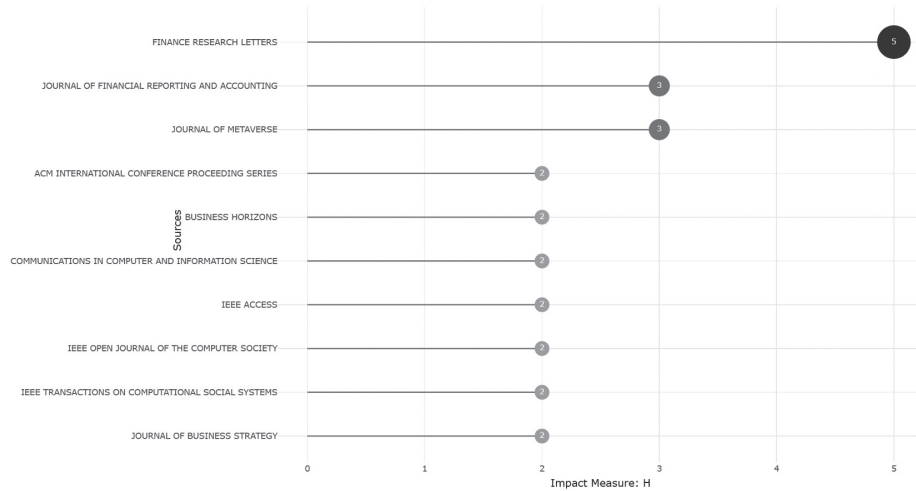


Figure 10 shows that Finance Research Letters (FRS) journal exerts the most substantial impact on the topic of Finance in the Metaverse. This is in line with the observations from the preceding two figures, which point out FRS’s importance as both one of the most frequently cited and productive sources of publications in this research domain. The work authored by Vidal-Tomás (2022), titled “The new crypto niche: NFTs, play-to-earn, and metaverse tokens,” is the most cited document published within FRS.

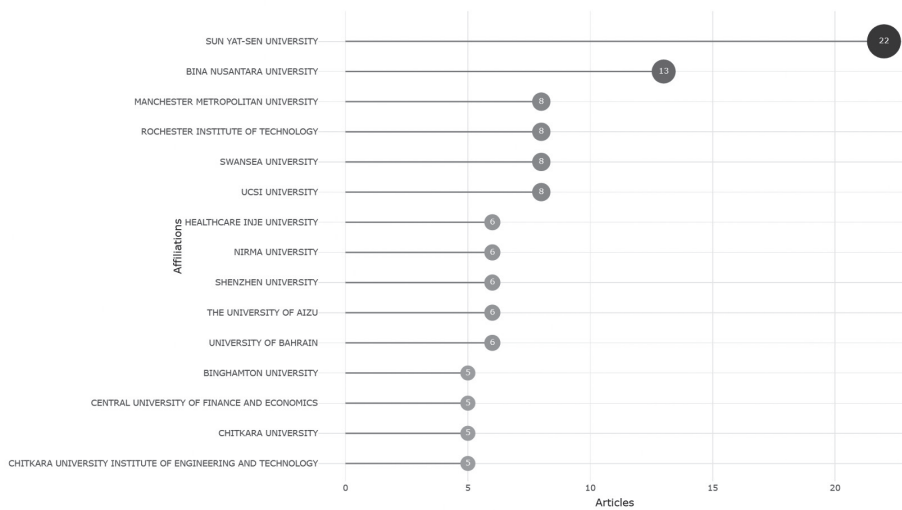
Figure 10. Source’s local impact



Aysan, A. F., & Nanaeva, Z. (2024). Investigating virtual financial ecosystem: Ascent of Metaverse economics research. *Efil Journal of Economic Research*, 7(3), 10-39.

Figure 11 demonstrates Sun Yat-Sen University (China) as the most productive affiliation, with 22 papers on the defined topic produced within this university. One explanation for the high productivity is that several scholars from Sun Yat-Sen University co-authored a highly cited paper titled “When Digital Economy Meets Web3.0: Applications and Challenges,” which includes eight co-authors from the university. Bina Nusantara University (Indonesia) and Manchester Metropolitan University (UK) are the following two most productive affiliations in the field of Finance in the Metaverse.

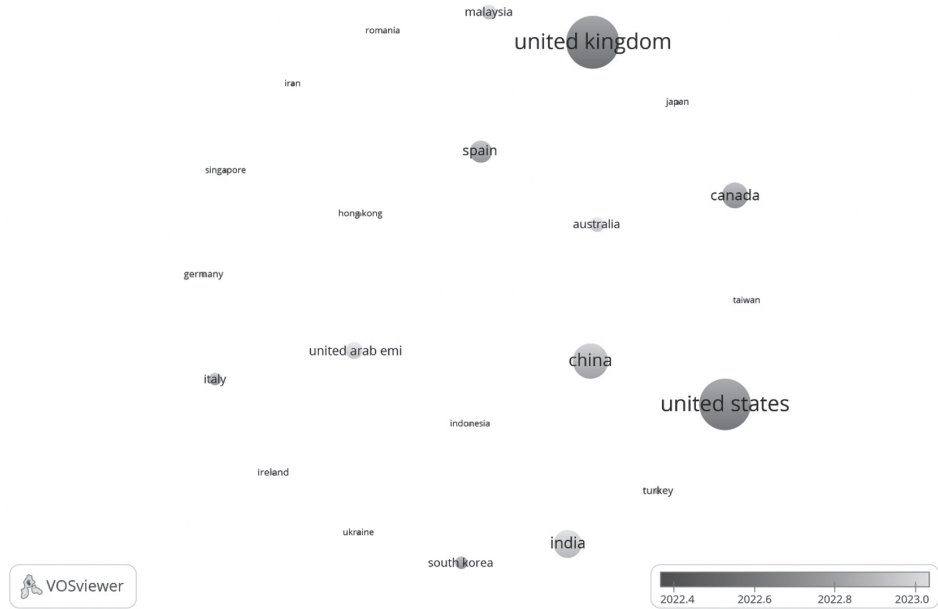
Figure 11. Most productive affiliations



3.1.4. Most cited countries

As seen in Figure 12, publications from the UK, US, China, Canada and India received the most citations. The time gradation allows to see how the initial leaders in citations of the UK and US gave the leadership to Canada and China and new leaders, such as India, UAE and Australia are appearing.

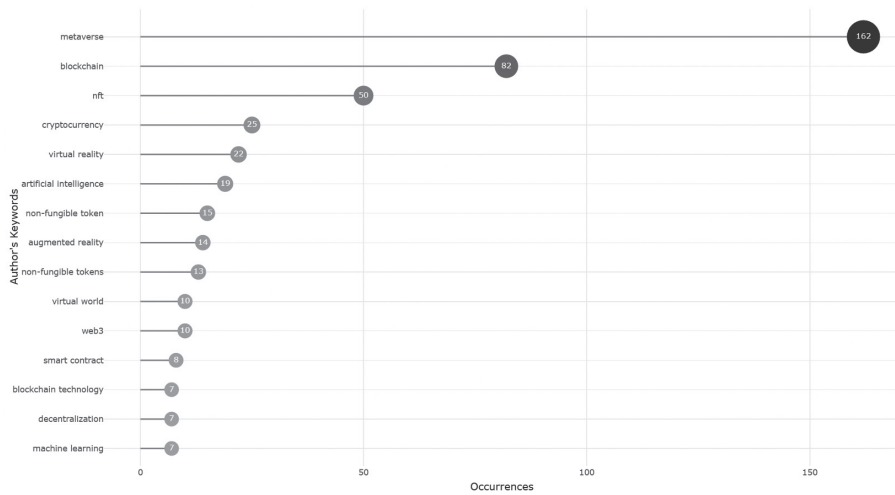
Figure 12. Most cited countries



3.1.5. Most used words

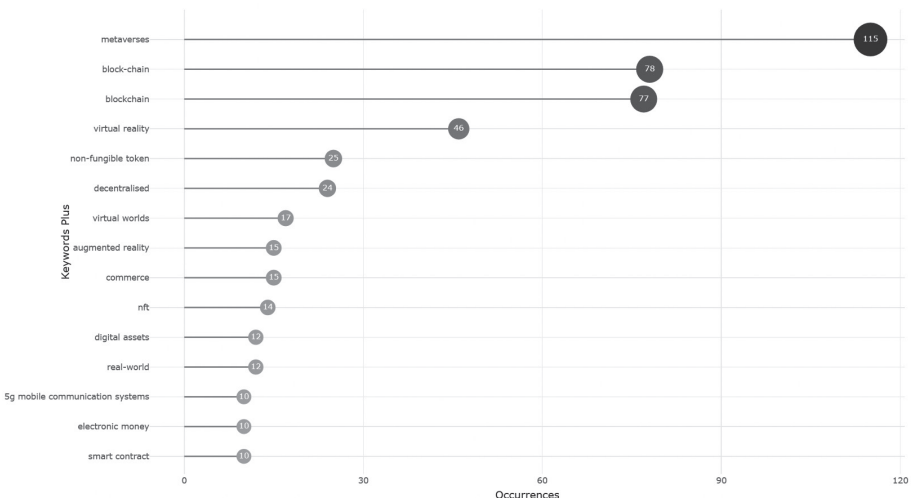
Expectedly, the term “Metaverse” emerges as the most frequently occurring author’s keyword within the research domain of Finance in the Metaverse. Since the terms “Metaverse,” “NFT,” and “crypto” were utilized as search criteria, they occupy the foremost positions among the prevalent keywords, as evidenced in Figure 13. Additionally, “blockchain” holds the second-highest position among the frequently appearing keywords since it is the underlying technology supporting financial instruments within the Metaverse.

Figure 13. Most frequent words (author’s keywords)



Noteworthy distinctions arise upon analyzing the most frequently identified keywords by Scopus, as illustrated in Figure 14, and contrasting them with the author’s frequently used keywords, as presented in Figure 13. While “metaverse” and “blockchain” remain the most prevalent terms in both instances, authors favor the utilization of “NFT” and “cryptocurrency” as their subsequent frequently employed words, whereas Scopus assigns this position to “virtual reality.” Furthermore, the selection of keywords plus exhibits a broader spectrum, encompassing terms such as “commerce,” “digital assets,” “5G mobile communication systems,” and “electronic money,” in addition to the common terms shared by both sets of keywords.

Figure 14. Most frequent words (keywords plus)



3.2 Co-citation analysis

Under the assumption that publications frequently cited together share common research themes, the co-citation analysis serves as a valuable tool for detecting the evolution of primary themes within the selected research domain (Donthu et al., 2021). Furthermore, co-citation analysis aids in the identification of thematic clusters within scholarly literature.

As depicted in Figure 15, the co-citation analysis illustrates the associations among 27 authors who have received a minimum of 40 citations within the topic of Finance in the Metaverse. These co-citations are interconnected through 333 links, forming three distinct clusters. Furthermore, when examining Table 5, it becomes evident that the total number of co-citations is most pronounced for the author Niyato D. Niyato D. holds the position of a professor in computer science and engineering at Nanyang Technological University in Singapore and retain an overall h-index of 125. Notably, the author with the highest local impact, Zheng Z., occupies the second position in this ranking.

Figure 15. Co-citation network (authors)

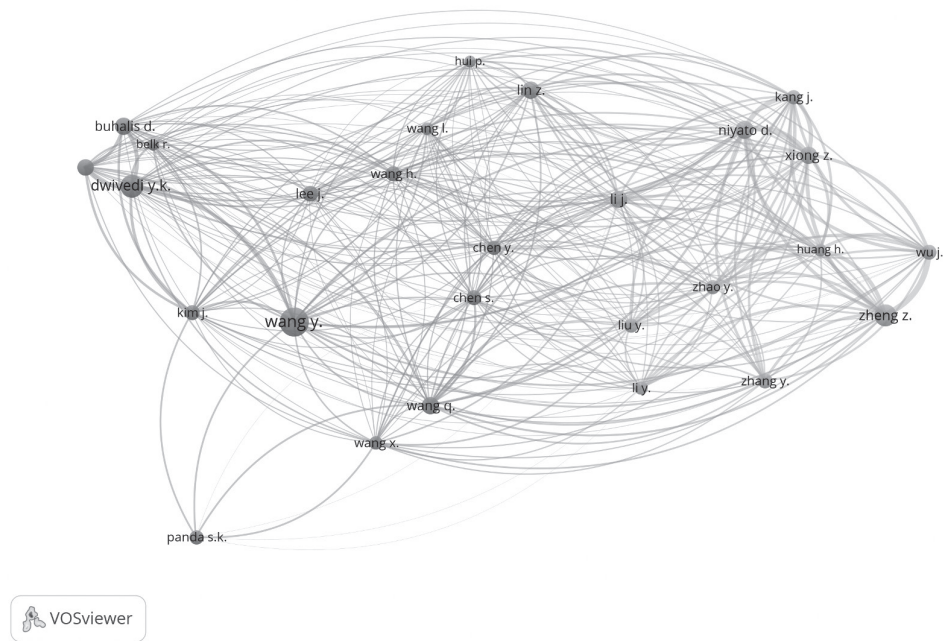


Table 5. Authors' co-citation

Author	Citations	Total Link Strength
Niyato D.	60	1878
Zheng Z.	76	1751
Xiong Z.	57	1740
Kang J.	48	1432
Wu J.	51	1422
Wang Y.	100	1192
Huang H.	42	1122
Dwivedi Y.K.	79	1062
Wang Q.	59	919
Li J.	58	907
Liu Y.	48	854
Zhao Y.	46	854
Kim J.	51	830
Zhang Y.	49	830
Buhali D.	59	815

3.3 Bibliographic coupling

Bibliographic coupling, similar to co-citation analysis, operates under the premise that publications sharing common references typically exhibit similar content. Consequently, examining time-defined relationships among citing publications facilitates the picturing of progressions within the researched topic, enabling the allocation of thematic clusters and the identification of contemporary developments.

Figure 16 visually represents six clusters formed by the 53 connections among 26 documents with a common bibliography. When examining Figure 16 alongside the accompanying Table 6, it becomes apparent that the document titled "The new crypto niche: NFTs, play-to-earn, and metaverse tokens" authored by Vidal-Tomas exhibits the most robust connections with other publications. Following closely, the second document displaying substantial connections is "Shaping the Metaverse into Reality: A Holistic Multidisciplinary Understanding of Opportunities, Challenges, and Avenues for Future Investigation," which was co-authored by a team of 12 authors.

Figure 16. Bibliographic coupling of documents

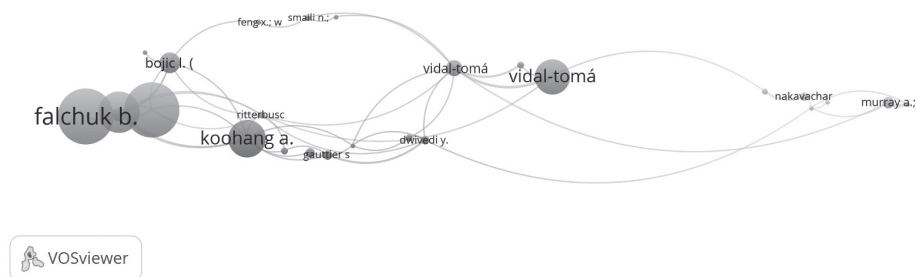


Table 6. Documents bibliographic coupling

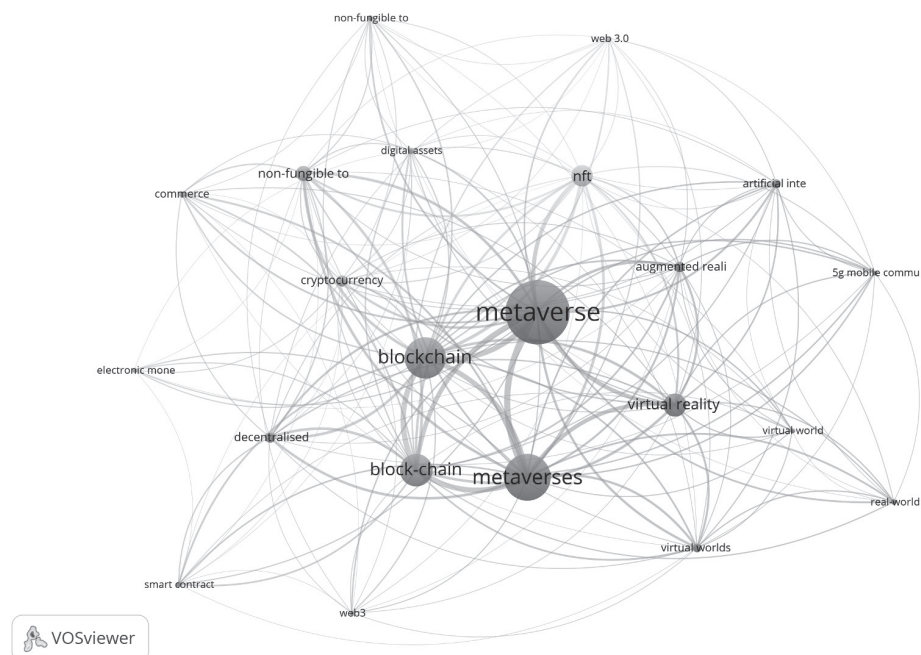
Document	Citati- ons	Total link strength
Vidal-Tomás D. (2023)	36	12
Koohang A.; Nord J.H.; Ooi K.-B. (2023)	90	9
Ritterbusch G.D.; Teichmann M.R. (2023)	16	9
Murray A.; Kim D.; Combs J. (2023)	26	8
Dwivedi Y.K.; Kshetri N.; Hughes L.(2023)	18	8
Park A.; Wilson M.; Robson K.; (2023)	10	7
Mackenzie S. (2022)	31	7
Bojic L. (2022)	48	7
Belk R.; Humayun M.; Brouard M. (2022)	100	7
Vidal-Tomás D. (2022)	84	6
Zainurin M.Z.; Haji M.; Besar M. (2023)	11	5
Papagiannidis S.; Bourlakis M.; Li F.(2008)	135	5
Far S.B.; Bamakan S.M.H.; Qu Q. (2022)	11	5
Nakavachara V.; Saengchote K. (2022)	18	5
Gauttier S.; Simouri W.; Milliat A. (2022)	20	4

3.4 Co-word analysis

Highlighting the textual content of documents enables to establish and forecast relationships among various topics within the researched domain. This approach is built on the assumption that frequently co-occurring words share similar thematic resemblances. Co-word analysis can be employed to enforce other analytical methods in defining thematic clusters and forecast potential research directions within the defined research domain.

Figure 17 shows the co-occurrence of the most frequently used terms with a minimum of 5 occurrences in the specified research domain. The figure reveals the presence of 22 terms organized into four clusters centered around the words “metaverse,” “blockchain,” “nft,” and “non-fungible.” While these words frequently appear together, each forms co-occurring pairs with other terms that can describe distinct trends within the research field. For instance, “metaverse” is found to co-occur with terms such as “virtual reality,” “augmented reality,” “virtual worlds,” “5G mobile communication,” “real world,” and “artificial intelligence,” contributing to the formation of one of the identified trends.

Figure 17. Co-occurrence network



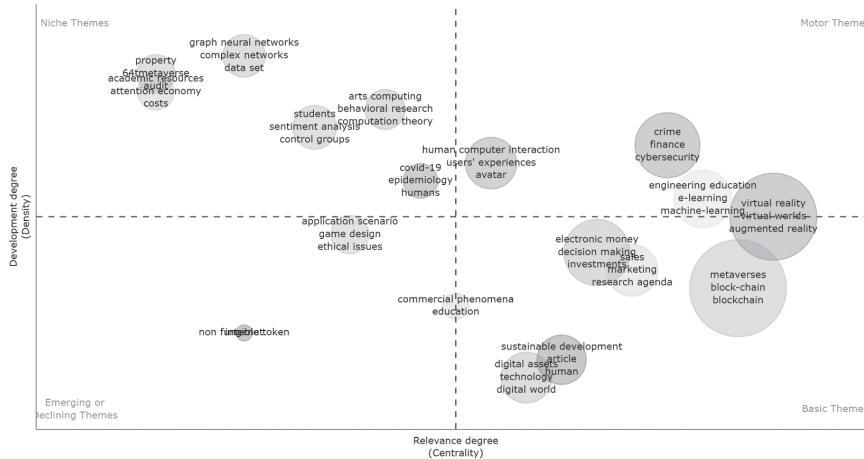
An alternative approach to examining the occurrence of terms within documents is creating a thematic map. In Figure 18, a strategic or thematic map is presented, where centrality indicates the significance of each theme, and density signifies the degree of development of the respective themes. The positioning of each theme within one of the four quadrants in Figure 18 categorizes them as basic, emerging, motor, or niche. Each bubble corresponds to a network cluster, and its size is proportionate to the frequency of the term's occurrence.

In this context, “metaverse” and “blockchain” are deemed as basic themes with potential for further expansion. At the same time “cybersecurity” and “avatar” are categorized as motor themes that have already received significant attention. On the other hand, “graph

Aysan, A. F., & Nanaeva, Z. (2024). Investigating virtual financial ecosystem: Ascent of Metaverse economics research. *Efil Journal of Economic Research*, 7(3), 10-39.

neural networks” and “data set” represent niche themes. Notably, “non-fungible tokens,” and particularly “game design” and “ethical issues,” emerge as pertinent topics that are currently gaining relevance within the research field.

Figure 18. Thematic map (keywords plus)



3.5 Co-authorship analysis

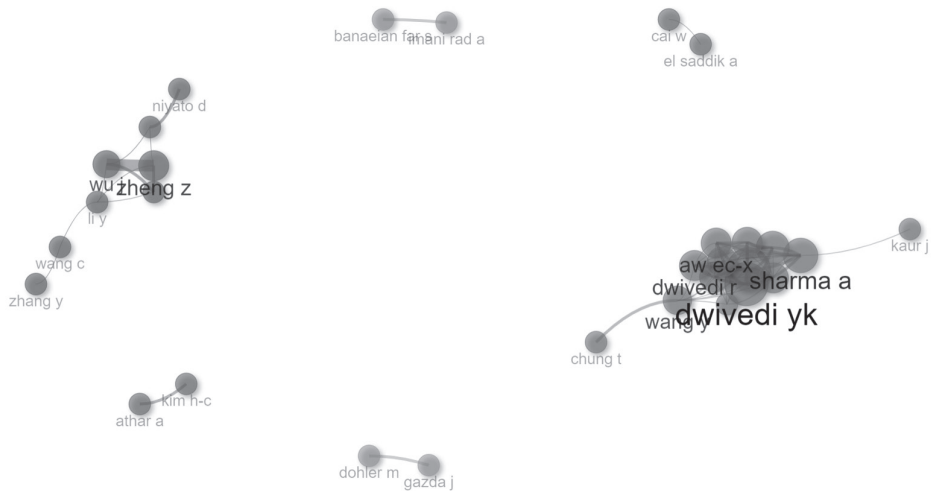
Presently solo authorship in publications has become increasingly rare. The progression of science and technology often necessitates a comprehensive range of expertise for efficient research. Collaborative efforts among scholars facilitate the generation of more comprehensive and robust research papers (Tahamtan et al., 2016, as cited in Donthu et al., 2021). Examining the allocation of social and academic associations among authors and their affiliations can prove valuable in comprehending ongoing developments and forecasting future trends.

Figure 19 illustrates the collaborative network of authors within the domain of Finance in the Metaverse. The largest cluster centers around Dwivedi Y., which can be attributed to his production of several highly cited documents authored in collaboration with numerous co-authors. As such, Dwivedi Y.’s most cited work in the defined research field, titled “Shaping the Metaverse into Reality: A Holistic Multidisciplinary Understanding of Opportunities, Challenges, and Avenues for Future Investigation,” is co-authored by 12 researchers. Similarly, another important document by Dwivedi Y., “Exploring the Darkverse: A Multi-Perspective Analysis of the Negative Societal Impacts of the Metaverse,” also involves 12 co-authors. At the same time, smaller collaborative clusters are observed among highly cited documents. For instance, Dohler and Gazda co-authored “Blockchain-empowered service management for the decentralized metaverse of things,” accruing 17 citations according to Scopus (Maksymyuk et al., 2022). Thus, the findings depicted in

Aysan, A. F., & Nanaeva, Z. (2024). Investigating virtual financial ecosystem: Ascent of Metaverse economics research. *Efil Journal of Economic Research*, 7(3), 10-39.

Figure 19 support the notion that productive papers often necessitate diverse expertise and consequently involve a larger number of authors.

Figure 19. Collaboration network



As depicted in Figure 20, several countries, with a minimum of 5 documents per country as the threshold, including China, India, the United Kingdom, the United States, and the United Arab Emirates, exhibit substantial collaboration in co-authoring documents with other nations. The color legend utilized in the figure illustrates the evolving dynamics of co-authorship leadership over time. It becomes evident that the initial leadership in co-authorship transitions from the United States and the United Kingdom to China and India as time progresses.

Figure 20. Co-authorship of countries

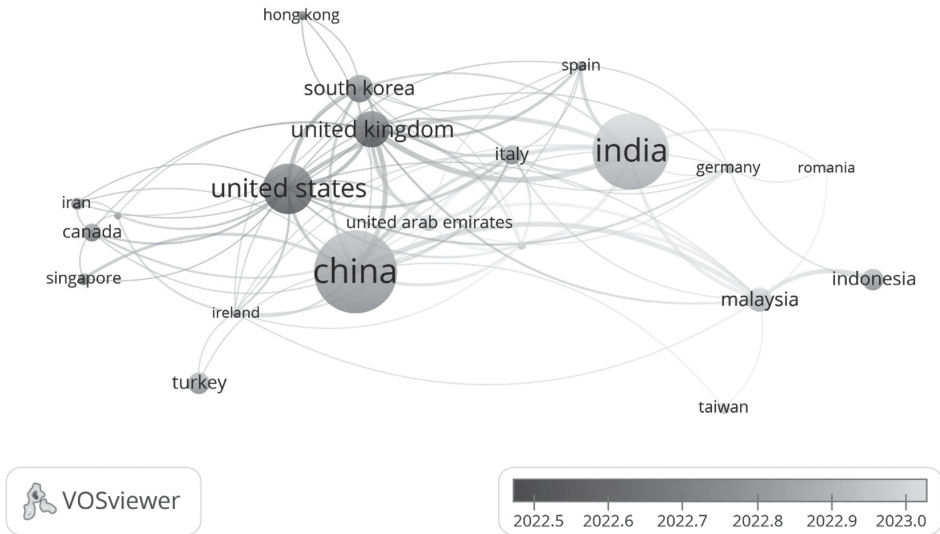
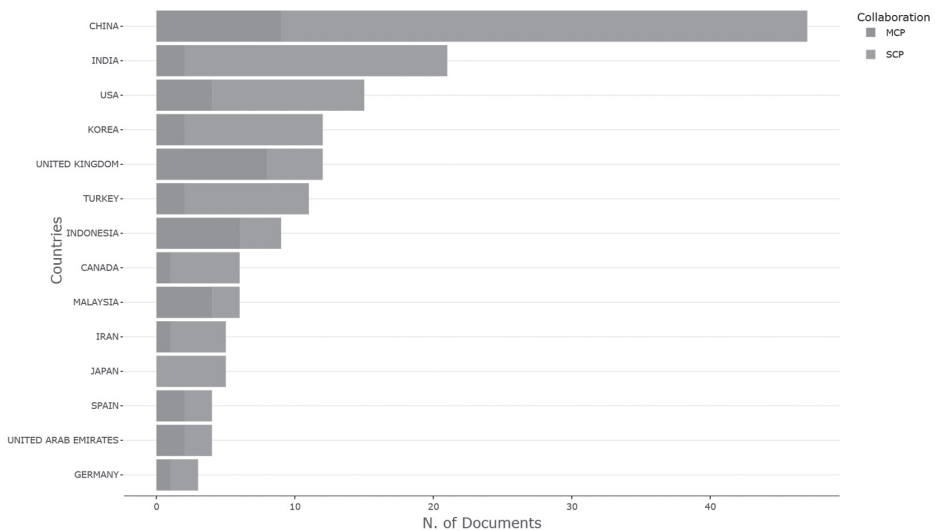


Figure 21 provides more insight into the co-authorship of countries. Despite being productive publishers, China, India, and the USA exhibit a larger proportion of papers authored within their own countries. Conversely, the United Kingdom, Indonesia, and Malaysia display more documents produced in collaboration with other nations. Notably, Japan stands out as the country with all its papers authored exclusively within its borders.

Figure 21. Corresponding authors' countries



4. Discussion and conclusion

Responding to the growing number of publications on the emerging field of the Metaverse and aiming to address the existing literature gap regarding a systematic literature review on the topic of Finance in the Metaverse, this study conducted a comprehensive bibliometric analysis and addressed several relevant research questions.

In addressing research question 1 (R1), a search within the Scopus database yielded 267 publications (following data cleaning) within the research field of Finance in the Metaverse. The observation that a significant portion of these documents were published in 2023, coupled with the prevalence of articles and conference papers, signifies the novelty and emerging nature of this research area. Furthermore, the sharp year-to-year growth in the number of publications, along with the fact that even after the January 3 cut-off date, an additional 12 documents were identified, underscores the highly promising and growing academic interest in this topic. The earliest document in this area, titled "Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges, and ethical implications in the metaverse," depicted the case of the earliest Metaverse prototype, the Second Life platform (Papagiannidis, Bourlakis & Li, 2008).

Like the literature on Fintech, the research topic of Finance in the Metaverse is deeply connected to technology, which accounts for the substantial presence of papers within the Computer Science and Engineering domains.

The citation analysis conducted in this study provided answers to research question 2 (R2) and highlighted several significant findings within the defined research field of Finance in the Metaverse. The document "The social metaverse: Battle for privacy" by Falchuk et al. (2018) emerged as the most cited publication in this domain. Regarding local citations, "Money, possessions, and ownership in the Metaverse: NFTs, cryptocurrencies, Web3, and Wild Markets" by Belk et al. (2022) received the highest number of references within the scope of this research.

Furthermore, the analysis revealed that Myriam Brouard, affiliated with the University of Ottawa (Canada), is the most cited author in the field. Brouard's co-authorship of the locally most cited document by Belk et al. (2022), published in the *Journal of Business Research*, contributed to her prominence. However, when assessing the local impact of authors, Zheng Zibin, a professor at Sun Yat-Sen University in China, earned the highest local h-index. Zheng's most cited paper, "Financial Crimes in Web3-Empowered Metaverse: Taxonomy, Countermeasures, and Opportunities," was published in *IEEE Open Journal of the Computer Society* in 2023.

Additionally, the study identified the most frequently cited sources of publication, with *IEEE Technology and Society Magazine*, *Technological Forecasting and Social Changes*, and *Finance Research Letters* ranking at the top. *Finance Research Letters* exhibited the highest local impact among these sources. Regarding affiliations, Sun Yat-Sen University emerged as the most productive institution, followed by Bina Nusantara University (Indonesia) and Manchester Metropolitan University (UK).

Answer to research question 3 (R3) identifies the most prevalent words and phrases employed in publications within the specified research area. The keyword analysis revealed that authors frequently used terms such as “metaverse,” “blockchain,” “NFT,” “cryptocurrency,” and “virtual reality” in documents related to Finance in the Metaverse. Interestingly, the authors’ choice of keywords aligns closely with the keywords plus, which include terms such as “metaverse,” “blockchain,” “block-chain,” “virtual reality,” and “non-fungible tokens” among the top five commonly used words and phrases. Additionally, several other frequently occurring terms include “web 3,” “smart contracts,” “decentralization,” “machine learning,” “digital assets,” “5G mobile communication,” and “electronic money.” These identified words and phrases demonstrate their relevance and significance within the field of Finance in the Metaverse.

To address research question 4 (R4) and identify prevailing and emerging themes within the field of Finance in the Metaverse, a thematic map was constructed using the keywords plus. The thematic map revealed distinct categories of themes. Basic developed themes that are of current interest and have been presented by many publications are “Metaverse and “Blockchain”. Examples of basic themes requiring further exploration are “Digital Assets” and “Digital World”.

Themes that have already been produced in an extensive research documents, motor themes, are presented by “Avatar”, “Cybersecurity”, “Human-Computer Interaction”, “User’s Experience” phrases.

Niche themes that had substantial publications but are not closely related to the topic of Finance in the Metaverse are presented by such phrases as “Arts Computing”, “Behavioral Research”, “Graph Neural Networks”, “Sentiment Analysis” and “Computation Theory”.

The emerging themes, which are closely related to the defined field of research but have fewer publications, hold particular significance within the thematic map and offer valuable insights into potential areas for future research. Emerging themes are “Non-Fungible Tokens” (NFT), “Application Scenario”, “Game Design” and “Ethical Issues”.

Notably, the theme of “Ethical Issues” in the Metaverse is particularly important, considering the ethical discussions and moral considerations associated with creating financial services in virtual worlds. Researchers can explore this theme further by referring to papers authored by Dwivedi et al. (2023), Niu and Feng (2022), and Jin (2024).

The theme of “Application Scenario” holds relevance across various Metaverse research areas. For example, Li et al. (2023) discuss a blockchain collaborative network for the Metaverse, while Liu et al. (2022) utilize application scenarios with Kolmogorov entropy to describe the cryptocurrency market in the Metaverse.

The topic of “Non-Fungible Tokens” (NFTs) remains popular and emergent within Finance in the Metaverse field despite extensive existing literature. Researchers can initiate their exploration of NFTs and Finance in the Metaverse by referring to highly cited papers such as those authored by Belk et al. (2022), Vidal-Tomas (2022), and Dwivedi et al. (2023).

In addressing research question 5 (R5) and defining specific avenues for future investigation, a reference to Patel et al. (2022) is relevant. Their bibliometric analysis proposes a comprehensive array of prospective research inquiries, encompassing the examination of the impact of virtual financial intermediation, the role of technology in enhancing trust dynamics within financial contexts, exploration of initial coin offerings, and analysis of regulatory mechanisms relating to blockchain-based financial systems, among others.

Moreover, insights from Ooi et al. (2023) offer additional guidance for exploring the future landscape of banking within the Metaverse. Their suggestions include the examination of corporate decision-making processes regarding the integration of banking services into virtual environments, strategies for cultivating customer-bank relationships in virtual reality settings, mechanisms for safeguarding consumer interests within the Metaverse, factors influencing consumer perceptions of this digital realm, and implications of Metaverse adoption on employment dynamics within the banking sector.

Finally, Kunar et al. (2023) contribute further dimensions to the discourse by highlighting prospective research domains. These encompass the identification of key financial sector innovations for seamless Metaverse integration, exploitation of smart contract functionalities to bolster financial service provision within virtual environments, initiatives aimed at enhancing technological and financial literacy within virtual reality contexts, and clarification of challenges and barriers of financial services integration in the Metaverse.

In conclusion, exploring Finance within the Metaverse presents an expanding avenue for prospective scholarly analysis, necessitating interdisciplinary collaboration among specialists across diverse research domains to address its multifaceted dimensions comprehensively.

References:

- Abbate, S., Centobelli, P., Cerchione, R., Oropallo, E., & Riccio, E. (2022, April). A first bibliometric literature review on Metaverse. In *2022 IEEE Technology and Engineering Management Conference (TEMSCON EUROPE)* (pp. 254-260). IEEE.
- Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of informetrics*, 11(4), 959-975.
- Aydin, Ö. (2023). Google Bard generated literature review: Metaverse. *Journal of AI*, 7(1), 1-14.
- Aysan, A. F., & Nanaeva, Z. (2022). Fintech as a financial disruptor: A bibliometric analysis. *FinTech*, 1(4), 412-433.
- Aysan, A. F., & Unal, I. M. (2023). Challenges in Islamic Fintech and Digitalization: An Extensive Literature Review. *World Scientific Annual Review of Islamic Finance*, 1, 41-52.
- Belk, R., Humayun, M., & Brouard, M. (2022). Money, possessions, and ownership in the Metaverse: NFTs, cryptocurrencies, Web3 and Wild Markets. *Journal of Business Research*, 153, 198-205.
- Biancone, P., Saiti, B., Petricean, D., Chmet, F. The bibliometric analysis of Islamic banking and Finance. *Journal of Islamic Accounting and Business Research*. 2020;11(9).
- Chen, C., Zhang, L., Li, Y., Liao, T., Zhao, S., Zheng, Z., ... & Wu, J. (2022). When digital economy meets web 3.0: Applications and challenges. *IEEE Open Journal of the Computer Society*.

- Aysan, A. F., & Nanaeva, Z. (2024). Investigating virtual financial ecosystem: Ascent of Metaverse economics research. *Efil Journal of Economic Research*, 7(3), 10-39.
- Citi (2022). Metaverse and money. Decrypting the future. Citi GPS: Global Perspectives and Solutions. https://www.citifirst.com.hk/home/upload/citi_research/AZRC7.pdf
- Davis, A., Murphy, J., Owens, D., Khazanchi, D., & Zigurs, I. (2009). Avatars, People, and Virtual Worlds: Foundations for Research in Metaverses. *Journal of the Association for Information Systems*, 10 (2), 1.
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of business research*, 133, 285-296.
- Dosso, M., & Aysan, A. F. (2022). The technological impact in finance: a bibliometric study of fintech research. In *Eurasian Business and Economics Perspectives: Proceedings of the 35th Eurasia Business and Economics Society Conference* (pp. 193-209). Cham: Springer International Publishing.
- Dwivedi, Y. K., Kshetri, N., Hughes, L., Rana, N. P., Baabdullah, A. M., Kar, A. K., ... & Yan, M. (2023). Exploring the Darkverse: A Multi-Perspective Analysis of the Negative Societal Impacts of the Metaverse. *Information Systems Frontiers*, 1-44.
- Falchuk, B., Loeb, S., & Neff, R. (2018). The social Metaverse: Battle for privacy. *IEEE Technology and Society Magazine*, 37(2), 52-61.
- Firmansyah, E. A., & Umar, U. H. (2023). Metaverse in business research: a systematic literature review. *Cogent Business & Management*, 10(2), 2222499.
- Hill, A. (2021). How Business Can Make the Most of the Metaverse. *Financial Times*, November 8, 2021, <https://www.ft.com/content/61ce8588-5233-44d0-aa12-ce9ed60fb314>
- IBM, 2024. Boolean combinations. Available at: <https://www.ibm.com/docs/pt/qsip/7.4?topic=queries-boolean-combinations>
- Janik A, Ryszko A, Szafraniec M. Scientific landscape of smart and sustainable cities literature: A bibliometric analysis. *Sustainability* (Switzerland). 2020;12(3).
- Jin, S. V. (2024). "In the Metaverse We (Mis) trust?" Third-Level Digital (In) equality, Social Phobia, Neo-Luddism, and Blockchain/Cryptocurrency Transparency in the Artificial Intelligence-Powered Metaverse. *Cyberpsychology, Behavior, and Social Networking*, 27(1), 64-75.
- Johri, A., Joshi, P., Kumar, S., & Joshi, G. (2024). Metaverse for Sustainable Development in a bibliometric analysis and systematic literature review. *Journal of Cleaner Production*, 140610.
- Joy, A., Zhu, Y., Peña, C., & Brouard, M. (2022). Digital future of luxury brands: Metaverse, digital fashion, and non-fungible tokens. *Strategic change*, 31(3), 337-343.
- Koohang, A., Nord, J. H., Ooi, K. B., Tan, G. W. H., Al-Emran, M., Aw, E. C. X., ... & Wong, L. W. (2023). Shaping the Metaverse into reality: a holistic multidisciplinary understanding of opportunities, challenges, and avenues for future investigation. *Journal of Computer Information Systems*, 63(3), 735-765.
- Kumar, S., Sureka, R., Lucey, B. M., Dowling, M., Vigne, S., & Lim, W. M. (2023). MetaMoney: Exploring the intersection of financial systems and virtual worlds. *Research in International Business and Finance*, 102195.
- Lee, J., & Kwon, K. H. (2022). Sustainable and Safe Consumer Experience NFTs and Raffles in the Cosmetics Market after COVID-19. *Sustainability*, 14(23), 15718.
- Li, Q., Kong, L., Min, X., & Zhang, B. (2023). DareChain: A Blockchain-Based Trusted Collaborative Network Infrastructure for Metaverse. *International Journal of Crowd Science*, 7(4), 168-179.
- Linnenluecke, M. K., Marrone, M., & Singh, A. K. (2020). Conducting systematic literature reviews and bibliometric analyses. *Australian Journal of Management*, 45(2), 175-194.

- Aysan, A. F., & Nanaeva, Z. (2024). Investigating virtual financial ecosystem: Ascent of Metaverse economics research. *Efil Journal of Economic Research*, 7(3), 10-39.
- Liu, F., Fan, H. Y., & Qi, J. Y. (2022a). Blockchain technology, cryptocurrency: entropy-based perspective. *Entropy*, 24(4), 557.
- Liu, Z., Ren, L., Xiao, C., Zhang, K., & Demian, P. (2022b). Virtual reality aided therapy towards health 4.0: A two-decade bibliometric analysis. *International journal of environmental research and public health*, 19(3), 1525.
- Mackenzie, S. (2022). Criminology towards the metaverse: Cryptocurrency scams, grey economy and technosocial. *The British Journal of Criminology*, 62(6), 1537-1552.
- Maksymyuk, T., Gazda, J., Bugár, G., Gazda, V., Liyanage, M., & Dohler, M. (2022). Blockchain-empowered service management for the decentralized Metaverse of things. *IEEE Access*, 10, 99025-99037.
- Niu, X., & Feng, W. (2022, June). Immersive Entertainment Environments-from theme parks to Metaverse. In *International Conference on Human-Computer Interaction* (pp. 392-403). Cham: Springer International Publishing.
- Papagiannidis, S., Bourlakis, M., & Li, F. (2008). Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses. *Technological Forecasting and Social Change*, 75(5), 610-622.
- Park, S.M., & Kim, Y.G. (2022). A Metaverse: Taxonomy, Components, Applications, and Open Challenges. *IEEE Access*, 10, 4209-4251.
- Patel, R., Migliavacca, M., & Oriani, M. E. (2022). Blockchain in banking and Finance: A bibliometric review. *Research in International Business and Finance*, 62, 101718.
- Ooi, K. B., Tan, G. W. H., Aw, E. C. X., Cham, T. H., Dwivedi, Y. K., Dwivedi, R., ... & Sharma, A. (2023). Banking in the Metaverse: a new frontier for financial institutions. *International Journal of Bank Marketing*, 41(7), 1829-1846.
- Ritterbusch, G. D., & Teichmann, M. R. (2023). Defining the Metaverse: A systematic literature review. *IEEE Access*.
- Riva, G., & Wiederhold, B. K. (2022). What the Metaverse is (really) and why we need to know about it. *Cyberpsychology, behavior, and social networking*, 25(6), 355-359.
- science mapping analysis. *Journal of Informetrics*, 11(4), 959-975.
- Tlili, A., Huang, R., Shehata, B., Liu, D., Zhao, J., Metwally, A. H. S., ... & Burgos, D. (2022). Is Metaverse in education a blessing or a curse: a combined content and bibliometric analysis. *Smart Learning Environments*, 9(1), 1-31.
- Tlili, A., Huang, R., Shehata, B., Liu, D., Zhao, J., Metwally, A. H. S., ... & Burgos, D. (2022). Is Metaverse in education a blessing or a curse: a combined content and bibliometric analysis. *Smart Learning Environments*, 9(1), 1-31.
- Van Eck, N., & Waltman, L. (2010). Software survey: VOSviewer, a computer program for bibliometric mapping. *scientometrics*, 84(2), 523-538.
- Vidal-Tomás, D. (2022). The new crypto niche: NFTs, play-to-earn, and metaverse tokens. *Finance research letters*, 47, 102742.
- Wu, J., Lin, K., Lin, D., Zheng, Z., Huang, H., & Zheng, Z. (2023). Financial Crimes in Web3-empowered Metaverse: Taxonomy, Countermeasures, and Opportunities. *IEEE Open Journal of the Computer Society*, 4, 37-49.