



Evolution and trends of the metaverse in business and management: A bibliometric analysis

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Abstract

The Metaverse is an immersive digital environment that enables users, through avatars, to create worlds, objects, and interact with each other for various purposes. Furthermore, its significance in Business and Management is increasingly evident. The objective of this research is to examine the evolution, trends, and research approaches related to the Metaverse in the field of Business and Management. This study presents a comprehensive contextualization and bibliometric analysis of the existing literature in this area. In the contextualization phase, publications per year, citations received per year, most cited publications, and languages used in publications were examined. These analyses provided an overview of the temporal evolution of research, influential publications, and language diversity in the field of Business and Management. Subsequently, a bibliometric analysis was conducted using Co-citation, Bibliographic coupling, and Co-occurrence of author keywords. These analyses helped identify relationships between scientific works, thematic connections, and collaborations among researchers in the studied field. The use of the Web of Science database ensured the quality and comprehensiveness of the collected data, while the Vosviewer tool facilitated efficient visualization and analysis of the results. The findings of this study provide a detailed understanding of the research landscape in Business and Management, revealing key areas of focus, significant contributions, and existing collaboration networks. These insights can be valuable for researchers, professionals, and regulators in the field of Business and Management.

Keywords Metaverse · Business · Management · Bibliometric · Digital transformation · Vosviewer

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1 Introduction

In recent years, the concept of the Metaverse has captured the attention of the scientific, business, and technological communities (Kim 2021; Weking et al. 2023). With the promise of a virtual and digitally immersive world, the Metaverse is emerging as a field of study and exploration in various disciplines (Ionut-Cristian and Dan-Marius 2021; Bansal et al. 2022; Lee et al. 2022). Particularly in the field of Business and Management, questions arise regarding the economic, organizational, and strategic implications of this new reality (Papagiannidis et al. 2008; Patrick 2009; Lee et al. 2011; Kraus et al. 2022; Queiroz et al. 2023).

Despite this recent interest, the term Metaverse first emerged in 1992 in the science fiction novel “Snow Crash” (Stephenson 1992). Metaverse is a combination of the prefix “meta” that meaning “beyond” – which implies transcending – and the suffix “-verse” that is a shorthand for “universe”, and which describes a parallel world to the physical one (Dionisio et al. 2013; Lee et al. 2021; Tlili et al. 2022).

As a relatively new term, various publications have manifested in the literature that have tried to establish a less holistic definition, revealing the lack in consensus regarding the term (Ritterbusch and Teichmann 2023). Ritterbusch and Teichmann (2023: p. 12373) carried out a systematic review of the literature to propose one of the most complete and recent definitions of the Metaverse, “Metaverse, a crossword of ‘meta’ (meaning transcendency) and ‘universe’, describes 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”.

The Metaverse has been the subject of research in various fields, such as healthcare (Bansal et al. 2022; Liu et al. 2022), engineering (Ionut-Cristian and Dan-Marius 2021; Wang 2022), education (Lee et al. 2022; Yilmaz et al. 2023), finance (Vidal-Tomás 2022; Zhang et al. 2022; Ghosh et al. 2023; Li et al. 2023; Qiao et al. 2023), marketing (Bourlakis et al. 2009; Buhalis et al. 2022; Dwivedi et al. 2022, 2023; Cheah and Shimul 2023) environment (Sébastien et al. 2009; Pamucar et al. 2022; Jaung 2022; Branca et al. 2023; Tlili et al. 2023) property (Papagiannidis et al. 2008; Zhou et al. 2018; Damodaran 2023), and even user behavior within the Metaverse (Lee et al. 2011; Verhagen et al. 2011; Chinie et al. 2022). Nevertheless, the field of Business and Management still requires significant contributions to establish a robust fundamental theory that serves researchers, regulators, and practitioners to be able to make informed decisions (Sauer and Seuring 2023; Kraus et al. 2024).

Similarly, bibliographic reviews or bibliometric methodologies have been conducted in different contexts, focusing both on general (Damar 2021; Abbate et al. 2022; Feng et al. 2022; Shen et al. 2023) and specific research fields, such as industrial services (Tlili et al. 2023), education (Tlili et al. 2022; Tas and Bolat 2022; Battal and Tasdelen 2023) or health care (Liu et al. 2022; Zhao et al. 2022). Nevertheless, there are no bibliometric analyses focused on the Business and Management research field. This emphasizes the need for carrying out a comprehensive study on this topic to try to establish the theoretical fundamentals in the research field.

The approach of the bibliometric study focuses on analyzing the scientific production related to the Metaverse in the field of Business and Management, in order to provide an overview of the prevailing research and trends to identify the status quo, the opportunities, and potential future research directions (Kraus et al. 2022; Sauer and Seuring 2023).

To accomplish this, the Web of Science (WoS) database has been used as the primary source of information, and a bibliometric analysis has been conducted after collecting and cleaning the data. Bibliometric analyses allow analysing co-citation, co-occurrence, and bibliographic coupling networks, enabling us to identify “invisible colleges”, the main thematic fields of research, and the relationships between authors (Lievrouw 1989; Zupic and Čater 2015).

The goal of this study is to make a valuable contribution to the expanding and robustness of knowledge based on the Metaverse and its potential implications for Business and Management. It stands as the pioneering endeavor to conduct a bibliometric review specifically focused on the Business and Management perspective owing to the limited amount of research conducted in this field and the novelty of the concept. Furthermore, this research marks a pivotal moment where researchers can explore novel research directions, regulators can identify fields requiring their involvement, and practitioners can observe the advancements made in the field. These insights can serve as a foundation for exploring new applications and harnessing the potential of the Metaverse.

2 Literature review

The Metaverse can be defined as an immersive virtual environment wherein users, through the utilization of immersive technology, are able to interact with each other through avatars for social, economic, or educational purposes, primarily (Dionisio et al. 2013; Meta 2021). The Metaverse has been a turning point in how people interact with technology, companies, and one another. As a result, numerous sectors have been impacted significantly (Bourlakis et al. 2009; Bansal et al. 2022; Damodaran 2023). It can be asserted that the Metaverse constitutes a new paradigm on which businesses are being developed (Hassouneh and Brengman 2011; Zhou et al. 2018) and it has significantly impacted numerous companies that have decided to expose themselves to this new reality (Aharon et al. 2022; Kraus et al. 2022; Ferrigno et al. 2023; Meta 2023). Besides, the Metaverse is forming its own “economy”, changing, for example, the customer-company interaction. Companies have had to adapt to this new reality to retain or capture new customers in accordance to their objectives of profitability.

To make the Metaverse a reality, technology is an unquestionable prerequisite. From a general point of view, technology is divided into hardware and software. Hardware enables users to interact with the Metaverse through different technological tools, such as phones, tablets, or glasses (Meta 2021). Currently, the main focus for user interaction with the Metaverse is based on glasses due to the quick access they offer to Augmented Reality (AR) or Virtual Reality (VR). While VR fully immerses

the user, enabling the creation of a completely separate environment from reality, AR interacts, complements or replaces the user's environment (Kozinets 2023).

Software comprises the computer code enabling user interaction within the Metaverse. Depending on the information system and metadata availability, the generated virtual worlds can significantly vary. They can range from an initial model with a singular, simple and generic vision to a more advanced model that incorporates a simulation engine capable of analyzing the data established by the programmer and fostering immersive interactions within the Metaverse (Sébastien et al. 2009). Achieving the highest level of immersion requires metadata from all non-human participants (NHP) within the Metaverse through three approaches: textual description, visual representation, and formalized rules that define the behaviors of NHP present in the Metaverse. Textual descriptions involve delineating the ethological behavior of NHP by detailing their actions in forms. In the visual representation, these descriptions from the forms are compiled and graphically represented in three-dimensional formats. In the formalized rules, specifications are outlined detailing how NHP interact within their environment (Bourlakis 2009; Sébastien et al. 2009; Patrick 2009; Jaung 2022; Meta 2021).

Nevertheless, the technology underlying the metaverse is still in its infancy. Substantial development is needed in audio, hand tracking, eye tracking, sensors, graphics, computer vision, and artificial intelligence to achieve the optimal development of the Metaverse (Meta 2021) and the fruitful results derived from its use.

As previously indicated, the Metaverse has facilitated the emergence of a new form of "economy". Platforms have developed their own "currencies or tokens" (Syuhada et al. 2023), typically linked to a fiat exchange rate. This can be observed through currencies such as "Linden dollars" in Second Life, "Mana" in Decentraland, and "Sand" in Sandbox (Scarle et al. 2012; Nakavachara and Saengchote 2022; Li et al. 2023). Furthermore, these currencies or tokens are a relatively new concept, which is why research has focused on their efficiency, behavior, and associated risks (Zhang et al. 2022; Ghosh et al. 2023; Li et al. 2023; Qiao et al. 2023; Syuhada et al. 2023). The transition of certain tokens, such as Mana, has been observed to go from a period of market inefficiency in their early years to market efficiency; nevertheless, not all the tokens examined have produced identical outcomes (Zhang et al. 2022). Likewise, the hedging relationship between altcoins associated with the Metaverse and Bitcoin or other cryptocurrencies changes over time (Li et al. 2023; Qiao et al. 2023). According to Li et al. (2023), under normal market conditions, Metaverse's coins show a positive correlation with Bitcoin, which hinders risk hedging. Nevertheless, during times of market turbulence and abrupt movements of Bitcoin, these coins can serve as hedge assets, reducing the risk of an investment portfolio. This conclusion aligns with the findings of Syuhada et al. (2023), who concludes that a portfolio consisting of Metaverse coins carries more risk compared to a portfolio consisting of both Metaverse coins and Bitcoin. On the other hand, Qiao et al. (2023), instead of focusing on the market state (turbulent or calm), delves more into specific time periods. Qiao et al. (2023) suggests that in the short term, there is indeed higher risk for Metaverse non fungible tokens (NFTs), but in the long term, that risk is reduced. In fact, they indicate that Metaverse NFTs can be a good hedging instrument as they do not contribute to risk spillover to other altcoins (Quiao et al. 2023). This notion

of coverage discussed is consistent with Vidal-Tomás's (2022) perspective, who also suggests that Metaverse NFTs can serve as a hedge against play-to-earn platform coins.

The emergence of this new reality has brought new opportunities for businesses and entrepreneurs. On one hand, companies reap the benefits of internationalization by utilizing VR to conduct product testing before venturing into new markets or cultures (Papagiannidis et al. 2008). On the other hand, the issue of ownership poses a dilemma. Entrepreneurs have the potential to develop and evaluate products within Metaverses (Zhou et al. 2018; Meta 2021; Damodaran 2023), but they face the risk of losing ownership to the virtual ecosystem in which they operate (Zhou et al. 2018). Second Life was among the pioneering platforms that introduced the transfer of ownership rights for user-developed products (Zhou et al. 2018). Presently, the concept of ownership extends to the creators, enabling them to monetize their creations (Meta 2021).

Shifting the perspective to marketing, the Metaverse has been analyzed from various perspectives. Examples of this include how advertising campaigns, their environments, and their packaging have been adapted to this immersive new reality. For instance, within the tourism sector (Gursoy et al. 2022), analyses have focused on how companies in the industry can leverage virtual tours to enhance their ensuing real sales (Ampountolas et al. 2023), giving the customer first-hand immersion before buying (Bourlakis et al. 2009). In a broad sense, beyond any specific sector, considerable attention has been devoted to how marketing campaigns should be tailored for the Metaverse (Buhalis et al. 2022; Dwivedi et al. 2022, 2023; Cheah and Shimul 2023), to achieve customer retention or acquisition. Furthermore, research has been conducted on store environments (Hassouneh and Brengman 2015) and even the unboxing experience (Chen and Yao 2022; Branca et al. 2023), examining how these aspects should be optimized to provide users with a positive and satisfying experience. Additionally, researchers have also studied whether the consumer's perception of counterfeiting has shifted (Plangger and Campbell 2022). This can be attributed to the fact that the possession of digital assets could change consumers' outlook regarding the importance of product authenticity.

Currently, a topic that has captured the attention of the scientific community is the environment (Sébastien et al. 2009; Pamucar et al. 2022; Jaung 2022; Branca et al. 2023; Tlili et al. 2023). Sébastien et al. (2009) have studied how to develop biodiversity in the Metaverse to improve the user experience. On the other hand, Jaung (2022) has conducted research on the demand for forest recreation, reaching the conclusion that virtual experiences were preferred over real experiences in nature. Furthermore, the Metaverse has the potential to enhance the environment by minimizing the production of physical goods and instead focusing on digital creations. This approach can result in reduced pollution, lowered risk of contamination, and the prevention of harmful waste generation that negatively impacts the environment (Branca et al. 2023; Tlili et al. 2023).

In addition, to achieve all these profitability and environmental objectives, it is imperative to understand how consumers perceive and engage with the Metaverse (Lee et al. 2011; Verhagen et al. 2011; Chinie et al. 2022). It is crucial for them to comprehend the types of businesses they can establish (Papagiannidis et al. 2008;

Zhou et al. 2018), how they can communicate within each platform (Sharma et al. 2011), or to whom belong the property of the products generated (Zhou et al. 2018; Damodaran 2023). These aspects are very important to know if consumers are going to be interested in interacting and generating content within these platforms.

In light of the recent boom in the field of Business and Management within the Metaverse research field, and due to the lack of foundational theories, this research carries out a bibliometric study in which the hidden relationships in the data are shown in order to see the lines of research and in this way help stakeholders in their decision-making process.

3 Method

This research has used the WoS core collection database to explore the latest advances surrounding the Metaverse. At the moment, WoS is the most common, popular and reputed source for raw data for literature and bibliometric analysis (Zupic and Čater 2015; Zhang et al. 2016; Birkle et al. 2020). The use of a single database as WoS allows the authors to manage all the publications in a consistent and standardized manner (Piñeiro-Chousa et al. 2020). WoS is categorized into specific areas, providing a useful mechanism to filter and identify relevant publications. Moreover, WoS offers very complete bibliographical information about publications: title, type, authors, institutional affiliations, keywords, abstract, citation counts, journal detail, publication year, volume, issue, and the list of references cited (Zupic and Čater 2015). WoS search used the string *Metaverse** and included data from January, 1 2008 until April, 30 2023. The search fields were limited to the categories of Business, Business Finance, Economics and Management. As a first result, 85 publications were obtained. Afterwards, the recommendations of Zupic and Čater (2015) through Microsoft Excel and plain text file were applied to clean the data. The research has been conducted to ensure reproducibility and thereby enhance the reliability of the authors' findings, effectively eliminating the potential for subjective bias (Kraus et al. 2020).

After cleaning the data, the publications were read and discarded if they were not related with Business and Management within Metaverse research field. Likewise, those publications that could not be accessed have been excluded. After this cleaning, the sample was composed of 67 publications.

Firstly, an analysis was conducted to examine (i) the number of publications published per year, (ii) the citations received per year, (iii) the most frequently cited publication, and (iv) the languages utilized. Secondly, bibliometric analyzes were carried out using the Vosviewer software (Version 1.6.18), allowing for a graphical representation of bibliometric maps that facilitates its interpretation (Van Eck and Waltman, 2010) effectively revealing hidden structures and dynamics in the data (Zupic and Čater 2015). Three additional analyses were carried out: (i) co-citation analysis, (ii) bibliographic coupling analysis, and (iii) author keywords co-occurrence analysis. Co-citation is the most used and validated bibliometric indicator (Boyack and Klavans 2010; Zupic and Čater 2015). Co-citation analysis allows to compare the frequency with which two publications have been mentioned together by a third document (Small 1973; Üsdiken and Pasadeos 1995). The more times said publica-

tions have been cited together, the more likely it is that they deal with similar topics, enabling the observation of “invisible colleges” detecting a common interest or objective (Lievrouw 1989; Zupic and Čater 2015). Through bibliographic coupling, associations can be established among publications that share a similar research approach (Peters et al. 1995; Jarneving 2007). In contrast to co-citation analysis, bibliographic coupling examines the extent of overlap in the authors’ bibliographies (Zupic and Čater 2015; Kovács et al. 2015). In addition, these two analyses are complementary (Jarneving 2007), in such a way, that the co-citation allows mapping the research bases and the bibliographic coupling indicates the current and future trends of the Metaverse (Zupic and Čater 2015; Kovács et al. 2015; López-Cabarcos et al. 2020). The author keywords co-occurrence analysis offers a glimpse into the associated topics that have been predominantly explored in relation to the Metaverse and the evolution of these words over time (Callon et al. 1983; Su and Lee 2010; Zupic and Čater 2015). Author keywords have been utilized for the co-occurrence analysis due to their precise nature regarding the content of each publication, providing valuable insights into research trends (Li et al. 2009; Zhang et al. 2016).

4 Results and discussion

4.1 Sample description

The initial description of the sample leads to the conclusion that there have been three distinct periods of publication about Metaverse. Figure 1 shows that the first period spans from 2008 to 2013, the second period encompasses 2014 to 2020 while the third period covers from 2021 to 2023. The publications of 2008 arose because of the development of the VR Second Life. The interest in Second Life may have been driven by its impressive growth figures and the high returns generated around it (Scarle et al. 2012). Due to this newfound success, companies from all over the world, such as Adidas, Dell or IBM (Papagiannidis et al. 2008; Bourlakis et al. 2009;

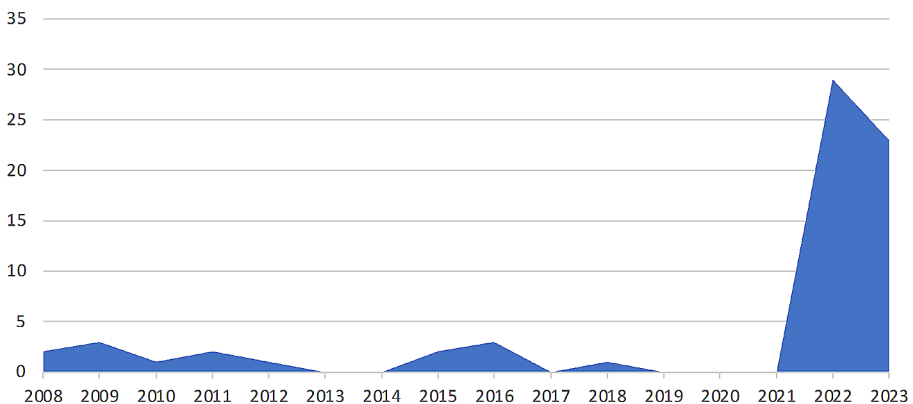


Fig. 1 Number of publications per year

Note: Figure 1 shows the number of publications related to Metaverse from 2008 to 2023

Verhagen et al. 2011) had their representation in this reality. Nevertheless, Second Life experienced a decline in user retention due to technical limitations, the targeted user profile, and a complicated user interface that hindered interaction within the diverse worlds created by other users (Zyda 2022; Ritterbusch and Teichmann 2023).

The rebound evident in 2015 may have been due to the acquisition of Oculus by Facebook in 2014 for \$ 2 billion. Oculus was a company that developed devices to be able to have an immersive experience in VR (Kraus et al. 2022). This was the first impulse that Facebook gave so that the participants of the Metaverse could experience it in a different way (Velazco 2021). On the other hand, the white paper of Decentraland was unveiled in 2015 (Ordano et al. 2015) which was essentially the first virtual world launched that utilized blockchain technology (Guidi and Michienzi 2022). Decentraland uses ERC-20, that it is the Ethereum blockchain network (Santana and Albareda 2022). These two reasons could have encouraged research on the Metaverse in that period.

Finally, a notable resurgence in Metaverse research can be observed in 2022. This is due, above all, to the change of name of the company Facebook (Ferrigno et al. 2023). Facebook was renamed Meta in October 2021. The intention behind the name change is to emphasize the transition from 2D interactions to immersive experiences facilitated by VR (Meta 2023). Indeed, Meta is making a considerable effort to make this new mode of interaction accessible to the general public (Kraus et al. 2022), incurring an operating loss of \$3,992 billions thus far (Meta 2023).

Figure 2 shows the total number of citations, which has greatly varied throughout the years. Similar to the number of publications, citations have reached their peak in the most recent research period (2021 to 2023). This analysis reflects the average number of citations per year and examines the citations received by the most cited

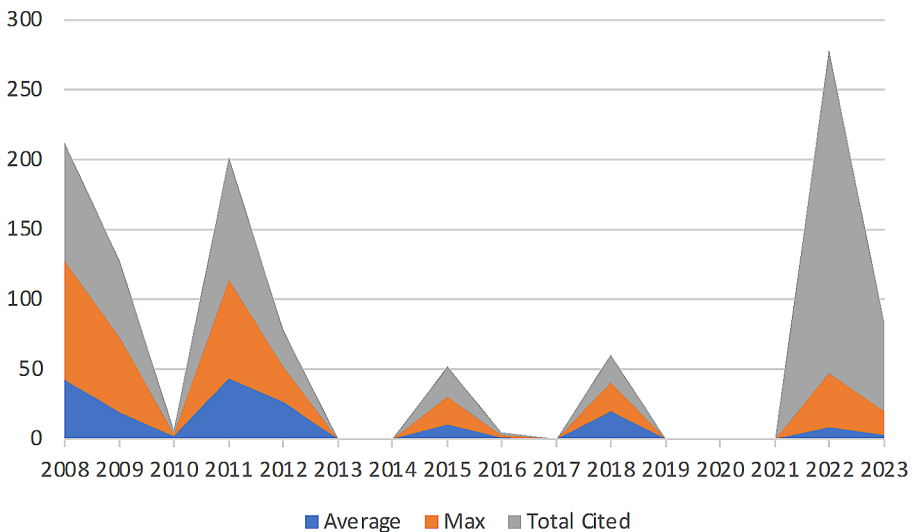


Fig. 2 Citations per year

Note: Figure 2 presents the total number of citations, the annual average citation count, and the citations received by the most highly cited publications

publication. The goal is to analyze if any publication has distorted the average or if, on the contrary, all the publications have received a similar number of citations. The last period (2021 to 2023) shows how the average of citations drop, due to the large number of publications that have been published and the short period of time they have had to be cited.

The most cited publication, as seen in Table 1, is a paper. This paper corresponds to the first publication period, this is because it has had more time to be reviewed and influence subsequent publications. This paper discussed the business opportunities and challenges that existed in virtual worlds, with a focus on Second Life's Metaverse (Papagiannidis et al. 2008).

Regarding the language used, all the publications are written in English except one that is written in Portuguese (1,49% of the sample). This publication is "Meta-verso, deepfake e infocapipse a opinião pública não existe" and it is a paper written in Portuguese. This is not a surprise given the increasing significance of English as a lingua franca for writing, publishing, and achieving international visibility (Duszak and Lewkowicz 2008; Flowerdew and Li 2009; López-Navarro et al. 2015).

Table 1 Most cited publications (all of them are papers)

Publication Title	Authors	Publication Year	Citations
Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses	Papagiannidis S., Bourlakis M., Li F.	2008	85
Satisfaction with virtual worlds: An integrated model of experiential value	Verhagen T., Feldberg F., van den Hooff B., Meents S., Merikivi J.	2011	71
Retail spatial evolution: Paving the way from traditional to metaverse retailing	Bourlakis M., Papagiannidis S., Li F.	2009	54
What is augmented reality marketing? Its definition, complexity, and future	Rauschnabel P.A., Babin B.J., Dieck M.C.T., Krey N., Jung T.	2022	39
The metaverse in the hospitality and tourism industry: An overview of current trends and future research directions	Gursoy D., Malodia S., Dhir A.	2022	30
Facebook and the creation of the metaverse: Radical business model innovation or incremental transformation?	Kraus S., Kanbach D.K., Krysta P.M., Steinhoff M.M., Tomini N.	2022	29
E-commerce transactions in a virtual environment: virtual transactions	Scarle S., Arnab S., Dunwell I., Petridis P., Protopsaltis A., de Freitas S.	2012	26
Ownership in the virtual world and the implications for long-term user innovation success	Zhou M., Leenders M.A.A.M., Cong L.M.	2018	20
Retailing in social virtual worlds: Developing a typology of virtual store atmospherics	Hassouneh D., Brengman M.	2015	20
A metaverse assessment model for sustainable transportation using ordinal priority approach and Aczel-Alsina norms	Pamucar D., Deveci M., Gokasar I., Tavana M., Koppen M.	2022	18

4.2 Mapping analysis

Three bibliometric indicators have been utilized to discover structures, detect invisible colleges, and analyze research trends: (i) Co-citation, (ii) Bibliographic coupling and (iii) Co-occurrence of author keywords.

4.2.1 Co-citation analysis

By employing co-citation analysis, researchers can compare the frequency at which two publications have been referenced together (Small 1973; Üsdiken and Pasadeos 1995). The greater the number of times these publications have been co-cited, the higher the likelihood that they address similar subjects, enabling the identification of invisible colleges and the recognition of shared interests or objectives (Lievrouw 1989; Zupic and Čater 2015). Simultaneously, co-citation analysis unveils the foundation upon which the publications are being written (López-Cabarcos et al. 2020).

Figure 3 displays the top ten references obtained from the reference co-citation analysis. The criterion for this analysis involved a minimum threshold of six cited references for inclusion, established according to citation counts. Each reference is represented by a label, with the size indicating the number of times the publication is referenced. Thus, the larger the size, the more frequently the reference is cited. The distance between two references denotes the probability of those references being cited together. Therefore, the shorter the distance, the higher the likelihood of them being cited together. The strongest co-citation links between references are also represented by lines. The colors depict the different clusters of cited references included in the analysis. References within a cluster are more likely to be cited along with other references from the same cluster (van Eck and Waltman 2022). Three clusters can be distinguished:

- Cluster I (green) is named “Foundations of the Metaverse”. It is composed by three publications about the pillars or fundamental parts upon which the Metaverse should be built.
- Cluster II (blue) is named “Metaverse applicability”. It is comprised of three publications. These publications explore the potential of Metaverse by examining its advantages and disadvantages in a real environment.

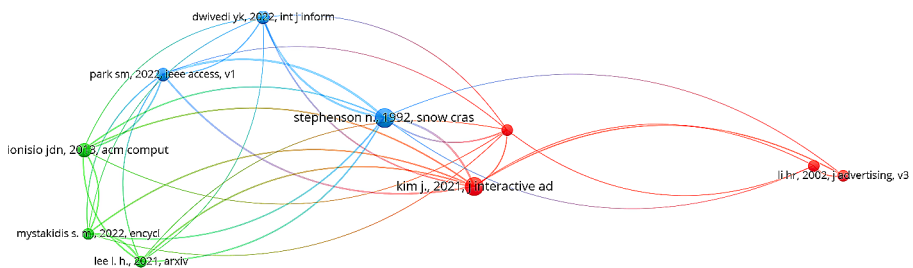


Fig. 3 Reference co-citation

Note: Figure 3 exhibits the top ten references derived from the reference co-citation analysis

- Cluster III (red) is named “User Experience”. It is composed of four publications. In one way or another, these publications focus on the user’s perception in the Metaverse.

Table 2 presents the references that have received the highest number of citations among the reviewed publications. It is worth mentioning that all of the publications, with the exception of “Snow Crash”, are papers. Notably, Stephenson’s novel “Snow Crash” (1992) emerges as the most frequently cited reference among all authors in the sample, accumulating a total of seventeen citations. This observation highlights the significant impact and relevance of Stephenson’s publication within the field. Indeed, this outcome is not unexpected, considering that it was the pioneering publication that introduced the term “Metaverse”.

“Advertising in the Metaverse: Research agenda”, by Kim (2021), with fifteen citations. This paper emphasizes the necessity of examining advertising in the Metaverse and indicates some of the questions that need to be answered, as well as the ways in which they need to be addressed.

“3D Virtual worlds and the Metaverse: Current status and future possibilities”, by Dionisio, William and Gilbert (2013), with nine citations. It tracks the evolution of Metaverses and how they have gone from virtual worlds in an initial stage (1970) to a stage of Metaverses with high graphic quality and with open-source contributions (2007). They search about how the conception of the Metaverse has been changing and the need for interconnection between them for acceptance by users. They propose four fundamental pillars for success: psychological realism, omnipresence (ubiquity), interoperability and experience in environments by users. For each area, the authors describe the current state and the developments needed to achieve a functional Metaverse.

“Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy”, by Dwivedi, Hughes, Baadbullah, Ribeiro-Navarrete, Giannakis, Al-Debei et al. (2022), with eight citations. This paper develops a set of twenty contributions from experts, who delved into the potentials and challenges facing the Metaverse from different points of view.

“A Metaverse: Taxonomy, Components, Applications, and Open Challenges”, by Park and Kim (2022), with eight citations. This paper studies the necessary components to build the Metaverse (hardware, software and contents well organized to maintain the experience) and investigates its limitations and potential issues. Subsequently, they analyze different Metaverse approaches from three perspectives: user interactions, implementations, and applications. They then turn to the last phase which analyzes three study cases (the Metaverse-related movie “Ready Player One”, the game Roblox, and papers published by Facebook’s research lab).

“Metaverse-retail service quality: A future framework for retail service quality in the 3D internet”, by Gadalla et al. (2013), with six citations. Through the methodology of focus group – with users of Second Life store – and critical incident techniques, the authors analyzed the value of the quality perceived by the consumer in a 2D sale – Internet store – and a 3D sale – store in Second Life Metaverse.

Table 2 Reference co-citation

Publication	Author	Publication Year	Citations	Link Strength
Snow Crash	Stephenson N.	1992	17	30
Advertising in the Metaverse: Research agenda	Kim J.	2021	15	26
3D Virtual worlds and the metaverse: Current status and future possibilities	Dionisio J.D.N., Burns III W.G., Gilbert R.	2013	9	17
Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	Dwivedi Y.K., Hughes L., Baabullah A.M., Rubeiro-Navarrete S., Giannakis M., Al-Debei M.M., Demnehly D., Metri B., Buhalis D., Cheung C.M.K., Conboy K., Doyle R., Dubey R., Dutot V., Felix R., Goyal D.P., Gustafsson A., Hinsch C., Jebabli I., Janssen M., Kim Y.G., Kim J., Koos S., Kreps D., Kshetri N., Kumar V., Ooi K.B., Papagiannidis S., Pappas I.O., Polyviou A., Park S.M., Pandey N., Queiroz M.M., Raman R., Rauschnabel P.A., Shirish A., Sigala M., Spanaki K., Tan G.W.H., Tiwari M.K., Viglia G., Wamba S.F. Park S.M., Kim Y.G.	2022	8	14
A Metaverse: Taxonomy, components, applications, and open challenges	Gadalla E., Keeling K., Abosag I.	2013	6	11
Metaverse-retail service quality: A future framework for retail service quality in the 3D internet	Lee L.H., Braud T., Zhou P., Wang L., Xu D., Lin Z., Kumar A., Bermejo C., Hui P.	2021	6	17
All one needs to know about Metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda	Li H., Daugherty T., Biocca F.	2002	6	5
Impact of 3-D Advertising on product knowledge, brand attitude, and purchase intention: The mediating role of presence	Mystakidis S.	2022	6	17
Metaverse	Steuer J.	1992	6	5
Defining virtual reality: Dimensions determining telepresence				

“All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, Virtual Ecosystem, and Research Agenda”, by Lee, Braud, Zhou, Wang, Xu, Lin et al. (2021), with six citations. The authors suggest fourteen pillars upon which the Metaverse must be developed. These pillars are separated into two groups: (i) eight pillars belong to technology enablers (Extended reality, User interactivity, Internet of thinking, Blockchain, Computer vision, Artificial intelligence, Edge cloud, and Network), and (ii) six pillars belong to the Metaverse ecosystem (Avatar, Content creation, Virtual economy, Social acceptability, Security & privacy, and Trust and accountability). They develop the current state of each of the pillars as well as the challenges and opportunities that arise in order to successfully develop the Metaverse.

“Impact of 3D Advertising on Product Knowledge, Brand Attitude, and Purchase Intention: The Mediating Role of Presence”, by Li et al. (2002), with six citations. They have explored the properties of 3D advertising and their impact on consumers, focusing on the sense of presence. In addition, to validate their theory, they have carried out two tests through different focus groups.

“Metaverse”, by Mystakidis (2022), with six citations. This paper holds forth the crucial parts of the Metaverse – immersive technologies – to propose their applicability in education.

“Defining Virtual Reality: Dimensions Determining Telepresence”, by Steuer (1992), with six citations. This paper explores the concept of VR and identifies key dimensions that contribute to the sense of telepresence within virtual environments.

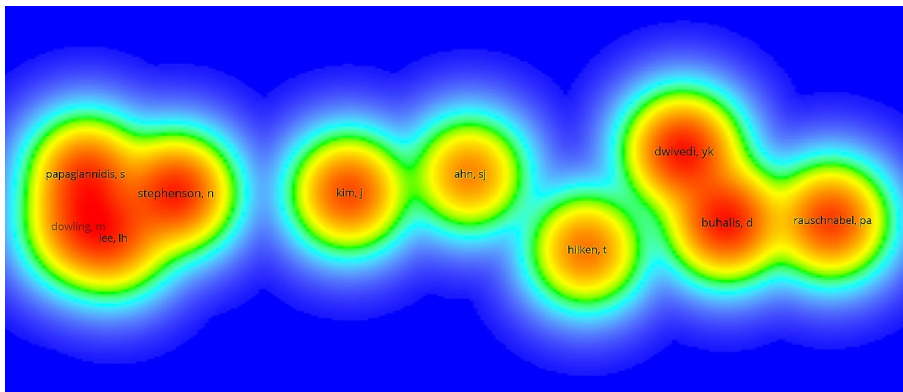
It has also been analyzed the link strength of each publication. Link strength indicates the total strength of the links of an item with other items (van Eck and Waltman 2022). Following this measure, there are different results. Park and Kim (2022) have a better link strength (link strength=20) than Dionisio et al. (2013) (link strength=17) and Dwivedi, Hughes, Baabdullah, Ribeiro-Navarrete, Giannakis, Al-Debei et al. (2022) (link strength=14). Lee, Braud, Zhou, Wang, Xu, Lin et al. (2021) (link strength=17) and Mystakidis (2022) (link strength=17) have the same link strength than Dionisio, William and Gilbert (2013) (link strength=17). The strongest link strength is held by Stephenson 1992.

Table 3 portrays the results of author co-citation, revealing the most frequently cited authors. Observation reveals that many of the authors listed in the table have contributed to the creation or co-authorship of the most cited publications. Among them, Buhalis emerges as the author with the highest link strength (148), indicating a strong association with other authors in terms of co-citations.

Figure 4 provides a detailed examination of the probability of authors being cited together in the same document. The colors represent the importance (in terms of citation count) for a given author, ranging from red (authors with the most citations) to green (authors with the fewest citations). The proximity or distance between authors proportionally indicates the likelihood of those authors appearing together. Hence, it can be asserted that there are significant possibilities of Papagiannidis, Stephenson, Dowling and Lee appearing together, just as there are high chances of Dwivedi, Buhalis, and Rauschnabel being cited together in the same text.

Table 3 Author co-citation

Author	Citations	Link Strength
Buhalis D.	18	148
Dwivedi Y.K.	18	132
Stephenson N.	17	57
Rauschnabel P.A.	15	109
Kim J.	14	66
Papagiannidis S.	14	13
Hilken T.	11	73
Lee L.H.	11	13
Ahn S.J.	10	52
Dowling M.	10	11

**Fig. 4** Density map of author co-citation analysis

Note: Figure 4 provides a comprehensive analysis of the co-citation probability among authors, where proximity indicates the likelihood of those authors appearing together

4.2.2 Bibliographic coupling

Bibliographic coupling enables the association of documents with similar research approaches (Peters et al. 1995; Jarneving 2007). Unlike co-citation, which focuses on the number of times two documents have been cited together, bibliographic coupling analyzes the overlap in bibliographies (Zupic and Čater 2015; Kovács et al. 2015). Moreover, these two analyses are complementary (Jarneving 2007). Co-citation helps in mapping the research foundations, while bibliographic coupling reveals current and future trends in the Metaverse (Zupic and Čater 2015; Kovács et al. 2015; López-Cabarcos et al. 2020).

Table 4 presents the journals, books or conferences that have contributed the most to the subject, the citations received and the link strength. The journal with more publications was “Finance Research Letters”, with five papers, followed by “Journal of Business Research”, “Psychology & Marketing” and “Technological Forecasting and Social Change”, with three papers each. This table shows the great dispersion in terms of publication sites. Upon analyzing the citations, the journals that have had the highest number of citations have been “Technological Forecasting and Social

Table 4 Documents and citations per source

Source	Documents	Citations	Link Strength
Finance Research Letters	5	18	10
Journal of Business Research	3	46	62
Psychology & Marketing	3	23	56
Technological Forecasting and Social Change	3	97	39
Business Horizons	2	6	22
Electronic Commerce Research	2	73	18
Handbook on 3D3C Platforms: Applications and Tools for Three Dimensional	2	0	1
International Journal of Advertising	2	9	9
Internet Research	2	5	45
Journal of the Academy of Marketing Science	2	11	32
Journal of Theoretical and Applied Electronic Commerce Research	2	9	33
Sosyoekonomi	2	0	3
Technovation	2	17	4

Change”, with 97 citations, “Electronic Commerce Research”, with 73 citations and “Journal of Business Research” with 46 citations. These three journals account for 68.8% of the citations among the most prolific publications.

Given that the field of research on the Metaverse is still in its early stages and considering the substantial impact it can have on social change, it is not surprising that the journal “Technological Forecasting and Social Change” is the most cited. The three works published in this journal have discussed the possibilities of the Metaverse from different perspectives: (i) the demand for forest recreation, in which it was concluded that the digital experience was preferred over the real one (Jaung 2022), (ii) the opportunities and business challenges in the Metaverse focusing on corporate responsibility (Papagiannidis et al. 2008), and (iii) the application of the Metaverse in auto-driving (for training autonomous driving), public transportation operation and safety, traffic operation, and sharing economy applications to obtain sustainable transportation (Pamucar et al. 2022). Indeed, through these papers, it becomes evident the importance of the potential implications that the Metaverse could have for society.

“Electronic Commerce Research” has published two papers on the retailing consumers. One of these papers explores the evolution of retail, starting from traditional methods and progressing to digital platforms, as well as its further progression into Metaverse retail (Bourlakis et al. 2009); the other paper proposes a typology of virtual store environment based on an in-depth investigation of 27 stores within Second Life (Hassounh and Brengman 2015). Thus, they study the prevailing status quo and try to draw conclusions that indicate a general success.

4.2.3 Author keywords co-occurrence

The author keywords co-occurrence analysis provides insights into the associated topics that have been mainly dealt with in the Metaverse, as well as the evolution of

these terms over time (Callon et al. 1983; Su and Lee 2010; Zupic and Čater 2015). For the co-occurrence analysis, author keywords have been utilized due to their specificity in describing the content of each publication, offering valuable information about the research trend (Li et al. 2009; Zhang et al. 2016).

Figure 5 presents the co-occurrence of the most often used author keywords. Similarly to Fig. 3, the labels in Fig. 5 represent keywords. The size indicates the frequency of their usage. Larger labels indicate keywords that have been used more frequently, while smaller labels represent less commonly used keywords. The proximity of the labels reflects the probability that they will be selected together. Shorter distance indicates a higher probability of co-occurrence, while greater distance indicates a lower probability of co-occurrence. In the same way, colors represent groups of keywords, with the same color indicating a bigger probability of being cited together (van Eck and Waltman 2022). At the core of the graph, the word “Metaverse” stands prominently, surrounded by other significant terms such as “Virtual Reality” and “Virtual World”, which exhibit relative levels of importance. Upon further exploration of the analysis results, it is evident the presence of six distinct clusters:

- Cluster I (red) is named “Second Life analysis”. It has the words: virtual world, Second Life, Metaverse retailing, ownership, and knowledge management. This cluster is focused on understanding the Metaverse through different perspectives

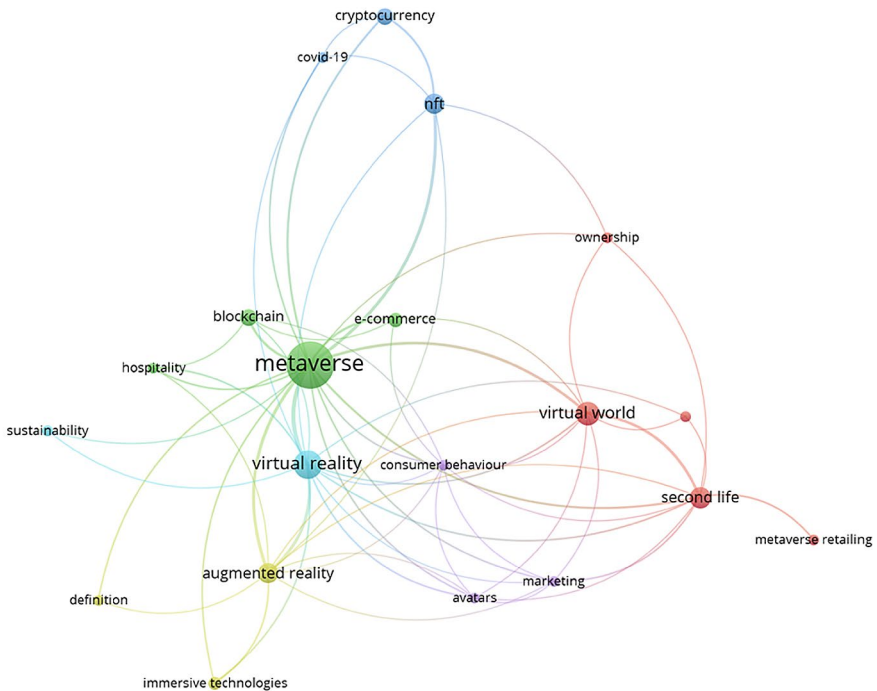


Fig. 5 Author keywords co-occurrence

Note: Figure 5 shows the results of the author keywords co-occurrence analysis

and focusing on analysis in Second Life, since it was a promising platform to establish this new reality.

- Cluster II (purple) is named “Changes in the consumer experience”. It is made up of avatars, consumer behavior, and marketing. It is focused on the consumer experience through user interaction and how the Metaverse can change the interactions between different sectors or brands with respect to the consumer. It is worth noting that all consumer interactions within the Metaverse are conducted through avatars, thus explaining the frequent presence and co-occurrence of the word avatars.
- Cluster III (yellow) is named “Metaverse technologies”. It is made up of Augmented Reality, immersive technologies, and definition. They are publications about how the new technologies that make up the Metaverse will affect the interaction with people.
- Cluster IV (light blue) is named “Sustainability in the Metaverse”. It is made up of Virtual Reality and sustainability. The publications within this cluster are focused on the investigation of the environmental impact of the Metaverse.
- Cluster V (green) is named “Paradigm shift”. It is made up of Metaverse, blockchain, e-commerce, and hospitality. It is called paradigm shift because publications start to incorporate blockchain and focus on how it can affect the tourism sector by Metaverse.
- Cluster VI (dark blue) is named “new economy”. It is made up of NFT, cryptocurrency, and covid-19. Focused on the new applications of cryptocurrencies and their effects on society and economy, as well as the possibility of democratizing ownership through the fragmentation of ownership through NFTs.

Figure 6 provides significant insights into the temporal evolution of author keywords co-occurrence, revealing a discernible shift in research focus. Initially, scholars directed their efforts towards analyzing Second Life as a means to comprehend this new reality and explore associated opportunities and threats. Over time, with the emergence of technologies such as blockchain, their attention gradually turned to other domains. These included the examination of cryptocurrencies and their profound societal and economic impact, the technological aspects themselves, emphasizing user acceptance and adoption of the technology and the reality, and the potential implications of the Metaverse for advancing environmentally conscious objectives. These findings further strengthen the outcomes derived from the previous analyses.

Delving deeper into the results obtained in Figs. 5 and 6; Table 5 provides a breakdown of the frequency of occurrence for each word. As previously indicated, the term “Metaverse” emerges as the most frequently used with thirty-nine occurrences. Likewise, the emergence of new topics such as blockchain (with five occurrences) or cryptocurrencies (with five occurrences) is evident. This lower occurrence it can be attributed to the novelty of these terms. These findings are consistent with the results observed in Figs. 5 and 6.

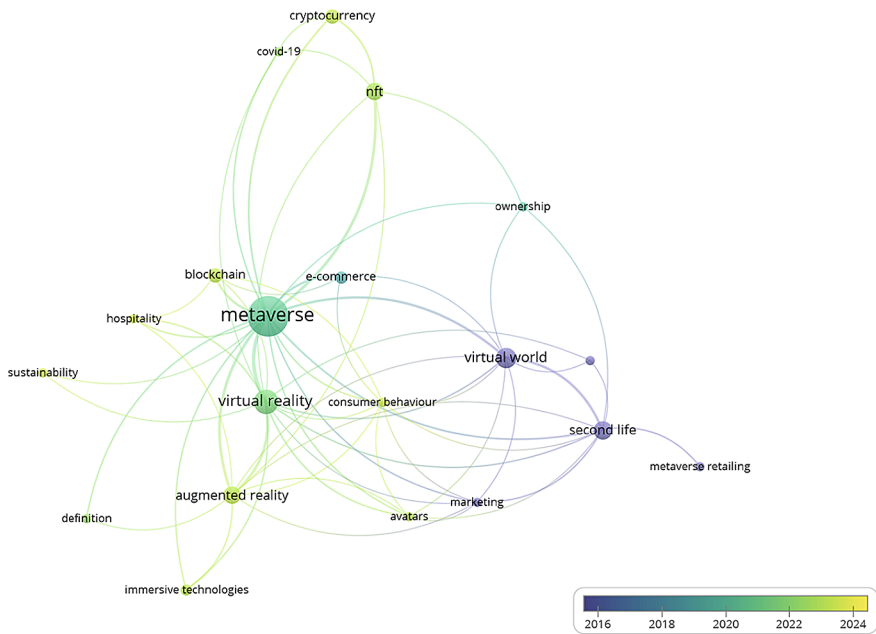


Fig. 6 Author keywords co-occurrence over time

Note: Figure 6 shows the results of the author keywords co-occurrence analysis over time

Table 5 Co-occurrence of author keywords

Keyword	Occurrences	Link Strength
Metaverse	39	57
Virtual Reality	14	33
Virtual World	10	19
Second Life	8	19
Augmented Reality	7	22
NFT	7	13
Blockchain	5	8
Cryptocurrency	5	7
E-commerce	4	7
Immersive technologies	3	6
Avatars	2	9
Consumer behaviour	2	10
Covid-19	2	5
Definition	2	3
Hospitality	2	6
Knowledge management	2	3
Marketing	2	9
Metaverse retailing	2	2
Ownership	2	4
Sustainability	2	2

5 Practical implications and conclusions

5.1 Practical implications

Although the concrete manifestation of the Metaverse remains unrealized due to its conceptual novelty, its future prospects are promising (Meta 2021). This study represents a pioneering effort in conducting a bibliometric review about The Metaverse, focusing specifically on Business and Management perspective. The bibliometric analysis has uncovered previously hidden structures and dynamics within the data (Zupic and Čater 2015). Hence, this study makes a substantial contribution to the expansion and consolidation of knowledge about the Metaverse and its potential implications for the Business and Management research field.

On the one hand, a preliminary description of the sample has been conducted, which allows concluding the growing interest that the study of the Metaverse has generated over the years (mainly from 2021). On the other hand, the study has encompassed several bibliographic analyses that allow concluding the fundamental development pillars around the Metaverse, considering very relevant aspects such as the Metaverse's real-world advantages and disadvantages, the user perception within the Metaverse, the main sources of top publications related to Metaverse, or the predominantly addressed topics when studying the Metaverse.

All this, is very important for researchers that can identify both the theoretical foundations of the topic and predict future trends to which research on the Metaverse is evolving; for example, how business should adapt to the Metaverse, how the interaction between the avatar and digital environment can influence the consumer behavior, what technological advancements should be carried out to achieve optimal results in the Metaverse, how to carry out financial operations throughout blockchain and cryptocurrencies in the Metaverse, or the real relationship between sustainable strategies and the functioning of the Metaverse. In addition to researchers, other stakeholders can also benefit from the results and conclusions of this study. Practitioners gain the possibility of being able to assess the feasibility of new businesses or test existing ones, and regulators gain the ability to find specialized advisors who can guide them on where regulations are most needed.

In summary, researchers can delve deeper into the theoretical foundations on the Metaverse, establishing new collaborations and/or identifying gaps in research to advance knowledge in the field of study. Professionals can identify what has been built, assess the viability of existing businesses, or explore potential business or management opportunities in that context. Regulators can develop the ability to find specialized advisors to establish regulations or laws with the aim of helping and protecting all participants in the Metaverse. In this way, thanks to this paper, researchers, practitioners, or regulators can draw valuable conclusions about the Metaverse, providing a very valuable contribution through strengthening knowledge derived from the growing societal interest around the Metaverse.

5.2 Conclusions, limitations, and future lines of research

This paper has carried out the first bibliometric analysis focused on the Metaverse from a Business and Management perspective. The aim has been to identify potential business opportunities and achieve a comprehensive understanding of the ongoing research and trends, with the intention of recognizing the current status, possibilities, and future research directions (Kraus et al. 2024). The analytical focus has facilitated a comprehensive examination of the sample, encompassing both a descriptive perspective, which involves defining its components, and a more in-depth approach utilizing bibliographic tools. This multi-dimensional analysis has provided a thorough understanding of the sample, enabling a nuanced exploration of its characteristics and insights at various levels.

In order to conduct the bibliometric analysis, three indicators were utilized: co-citation analysis, bibliographic coupling, and author keywords co-occurrence analysis. Through co-citation analysis of references and authors, it was observed that “Snow Crash” emerged as the most frequently cited publication with the highest link strength, indicating its significance compared to other works. This can be attributed to the fact that it was the first to coin the term “Metaverse”. In terms of the co-citation of authors, Buhalis and Dwivedi were the authors who were co-cited the most.

Furthermore, the bibliographic coupling analysis revealed that “Finance Research Letters” contributed significantly to the field, while “Technological Forecasting and Social Change” garnered most of the citations despite publishing relatively few articles.

Lastly, to identify the main research topics, author keywords co-occurrence analysis was conducted, revealing a sustained evolution in research themes. These topics encompassed a range of subjects including: cryptocurrencies, environment, and technology applicable to the Metaverse.

This research shows certain limitations. The main one is that this study is based on a single database, which may have resulted in the exclusion of relevant information from other databases like Scopus or Google Scholar. Moreover, the author co-citation analysis conducted – using the WoS core collection – only focuses on the first author (Zupic and Čater 2015). To address this limitation, an additional step was taken to manually locate the referenced publications and include all the authors involved in those publications. On the other hand, it is important to note that for a pair of publications to be included in a co-citation network, they need to be cited with a certain frequency before being included in a co-citation network (Üsdiken and Pasadeos 1995). As a result, some of the newer publications may not have been considered in the analysis.

The need for further research within the Business and Management field is underscored by the fact that the sample of the study included only 67 publications. This limited sample size highlights the opportunity for additional investigations and studies to expand our understanding of the subject area. Future lines of research could relate to aspects as the new payment methods that could be used on different Metaverse platforms, investigating whether it is more convenient to create own currencies for each platform or if it is better to use established digital or fiat currencies. It should also be analyzed the impact of the Metaverse economy in relation to the real econ-

omy, considering aspects as the level of consumer acceptance of 3D purchases compared to 2D purchases or how consumers perceive payment when using Metaverse platforms. Future studies should also analyze the advantages and disadvantages of using tokenization or NFTs as recognition of ownership. Deeper knowledge about the necessary legislative considerations to safeguard consumer and creator rights should also be addressed. Regarding sustainability, the environmental impact of implementing the Metaverse could be deeply studied in comparison to traditional production models. In addition, other bibliometric studies focused on different perspective of the Metaverse such as technology, sustainability, consumers behavior or financial aspects should be carried out.

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Author contributions All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by all authors. The first draft and previous versions of the manuscript was written and commented by all authors. All authors read and approved the final manuscript.

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Data availability The data supporting the results presented in this study are accessible through the WoS database. The data generated in this study is summarized in the various figures and tables presented throughout the paper. The initial results shown in Figs. 1 and 2; Table 1, provide a contextualization of the state of the art, highlighting the most impactful publications over time. Subsequent results, shown in Figs. 3, 4, 5 and 6; Tables 2, 3, 4 and 5, offer an in-depth bibliometric analysis of the Metaverse.

Declarations

Conflict of interest The authors have no financial or proprietary interests in any material discusses in this article.

No potential conflict of interest was reported by the authors.

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