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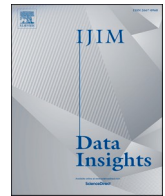
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Deciphering the evolution of metaverse - A techno-functional perspective in digital marketing

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ABSTRACT

The metaverse has disrupted the traditional marketing practices and it has potential to transform entire world of marketing activities with thrilling immersive experiences. This study provides an analysis of evolving field of metaverse marketing in the context of information systems using state of the art bibliometric and scientometric tools coupled with machine learning algorithms. Utilizing 257 documents from Scopus database that published between 1996 and 2024, this research maps and unveils the development of metaverse marketing from its inception and the role of information systems in its evolution. The analysis of literature resulted in five main emerging themes of the role of information systems in metaverse marketing research as User Experience, Customer engagement, Convergence of metaverse Technology, Design of virtual goods & experience and Global Social Interaction. The major sub-themes of the study are User Behaviors and Preferences, Branding on virtual environment, Virtual reality, Virtual wearables and Virtual Socialization. This study also reveals the emerging trends and gaps in literature that pave the ways for future research expansion in the information systems and metaverse marketing. Few of the important future research areas identified are understanding user experience, design of immersive customer engagement strategies, customer virtual presence and Security & privacy concerns of the users on metaverse platform.

1. Introduction

Dynamic information systems (IS) have caused technological advancement which has resulted in continuously disrupting and shaping the ways of business operations (Dwivedi et al., 2023). Almost every sector of business is witnessing a major shift in the way they engage and transact with their customers, as result of digital transformation within corporate IS. The marketing practices in the new era of virtualisation and immersiveness have too seen a substantial revolution. Metaverse is a new technological breakthrough that is created using virtual reality, augmented reality, artificial intelligence and internet which can offer real-time 3D avatars and virtual world to connect, communicate and engage with customers (Dahane et al., 2022). Integrated with the application of proper IS, metaverse marketing is made successful as IS enables strategic collection, storage and analysis of data generated with the metaverse itself (Reibestein & Iyengar, 2023). This may result in leading marketers across corporates to track through customer

behaviours, understanding their preferences, needs and wants, as well as relevant trends (Mehra et al., 2024). IS have paved room for advanced analytics execution which assists in enhancing accuracy, optimizing campaigns and personalizing marketing strategies (Wasiq et al., 2024; Nyagadza, 2022). Furthermore, to this, when metaverse is combined with marketing, it empowers marketers' innovative ways to virtually connect, engage, promote products and services and provide thrilling immersive experience in the virtual world. This shows that IS are key in improving metaverse marketing as real time feedback is generated (Hadi et al., 2023), and enhances user experience (UX), necessary in tailored customer experiences (CX).

The metaverse has given opportunity to organizations to attract and reach to the consumers in innovative way. The advancement in digital environment necessitated by IS provides the new approach to traditional organization to transform their business digitally (Wasiq et al., 2023). The emergence of metaverse because of dynamic and enhanced information system (IS) is one of the most lucrative marketing approaches to

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diversify the traditional marketing method. The metaverse is a virtual platform, which allow to organization to adopt new marketing activities to carried out the business. The smart organizations are always grabbing the opportunity to reach the target audience by use of metaverse marketing activity (Abu Bashar et al., 2022). Due to this, it clearly shows that dynamic IS have given room for consistent digital platforms integration within the metaverse, by synchronizing brand messaging, promotional activities, and digitalized campaigns (Lu & Mintz, 2023). IS are there to support and generate anthropomorphic chatbots, virtual assistants and interactive elements to improve service by creating instant responses and personalized recommendations for customers (Lu & Mintz, 2023; Nyagadza et al., 2022).

Metaverse is a virtual community place where individual can transect, relax, play, work and socialize (Rosário et al., 2023). It is revealed by the scholars that Metaverse will transform every business such as consumer product, healthcare, entertainment, payment solution and B2B technical solution that create the value for the organizations (Pantano & Servidio, 2012). Metaverse technology is providing a platform to marketers and individual to extend to connect and reach to potential customers and others. With the growth of metaverse, scalability and flexibility because of IS, corporates have managed to adapt to market conditions changes, and advancements of technology (Hadi et al., 2023). These scalable IS can deal and/or handle complex volumes of data with veracity and user interactions, while allowing new features integration and innovations (Hennig-Thurau et al., 2024).

Metaverse marketing applications leveraging dynamic information systems (IS), offer the marketers' brands to enhance their real-world positioning or reposition their products and brands in a new virtual environment. There are various industry introducing and implementing metaverse technology in their marketing strategies such as Balenciaga, Dolce & Gabbana, Nike and Jimmy choo. Some fashion brand Gucci launched their own virtual platform name as Gucci Garden and working together with gaming platform and Roblox; Dolce & Gabbana and Jimmy Choo are offering digital rare-only garment; whereas Nike introduced their Non-Fungible Token (NFT) (Katicic et al., 2015; Lee, 2020). Many luxury retail brands initiated offering their non-fungible token and virtual products to the potential customers through metaverse virtual environment to enhance their AVATAR in the metaverse (W-J. Lee, 2020). Global luxury retail witnessed the new revolution in metaverse marketing strategy where they offer virtually wearable products to customers through digital disruption and new trend in metaverse (Rather, 2023; Nyagadza et al., 2023). Adidas luxury brand associated with Bored Ape Yacht Club have to modified and customized virtually wearable clothing for AVATAR, offering to their consumers (Mehra et al., 2024). Due to this, IS are very essential to the development and deployment of VR and AR in the metaverse; where brands can display their products, do events hosting, and interact with customers with novelty in approaches (Reibstein & Iyengar, 2023). IS helps in strengthening and streamlining creation of content, management, and deployment across various digital virtual platforms, through automated processes in innovative metaverse marketing (Lu & Mintz, 2023).

The tremendous growth in Augmented Reality (AR)/Virtual Reality (VR) have accelerated implementation of metaverse in retail luxury brands, Luxury brands transformation from electronic commerce (e-commerce) to immersive commerce (i-commerce) to build consumer positive and strong interaction and communication in the new form of online shopping in the metaverse (Rosenberg, 2023). Metaverse marketing integrated with IS lead to the rise of secure transactions and privacy, data protection, which is very important for establishing and maintaining, trust and compliance with governance regulations (Hennig-Thurau et al., 2024). In doing so, IS facilitate transparency in trend analysis, market and marketing analysis for informed decision making in staying alert to competition in the industry (Dwivedi et al., 2023).

The research landscape of metaverse marketing is revolving around the subjects of creation of immersive experience (Nasr & El-Deeb, 2023),

virtual retailing (de Regt et al., 2021), customer engagement (Yung et al., 2021) and creation of digital assets(Liu et al., 2014; Walczak et al., 2019), through efficient dynamic IS. The opportunities and strategies of metaverse marketing such as micro customisation, gamification, virtual influencers, virtual collaborators and related tools and wearables have extensively been investigated. Similarly, the challenges and considerations like accessibility, data privacy, seamless IS, ethical marketing, and cultural and societal impact is studied extensively (Valaskova et al., 2022). Given the volume of research in the field of the metaverse marketing, and information systems (IS), it is needed to combine them together and present the most important aspects such as emerging trends, important topics, prominent keywords and overall intellectual structure.

As far as extant literature is concerned, there are review studies, which have been carried out on different subjects like information systems (IS), virtual reality (VR) in marketing, mixed reality (XR), virtual self, immersive technology research, etc.

The research on this subject is in its initial stage. There exist few systematic literature reviews (SLRs) research on the use of metaverse marketing to understand the significant importance and use of metaverse marketing strategies. Research studies exists on use of various immersive tools such as AR/VR, AVATAR, XR technology to attract their customers on metaverse (Mishra & Dharmavaram, 2023). As far as the review studies on the use of metaverse marketing enhanced by dynamic information systems (IS), is concerned it have been conducted in certain industry such as automobile (Nowak & Flotyński, 2018), banking (Karim et al., 2022), telecom (Cunha et al., 2022) and health industry (Dwivedi et al., 2022).

However, a comprehensive bibliometric analysis is not performed to present holistic past, present and future prospects of metaverse marketing. There exist one bibliometric study that too focused on conceptual modelling of metaverse in marketing (ÇELİK et al., 2022). Therefore, we employed systematic literature review (SLR) to understand the research trends in metaverse marketing, and information systems (IS) by answering the following research questions:

- RQ1 How do information systems contribute to marketing strategies within the metaverse?
- RQ2 What is the structure of metaverse marketing and how it has evolved over the years?
- RQ3 What are the main topics of metaverse marketing and its associated keywords?
- RQ4 What are the most prominent emerging themes and sub-themes of metaverse marketing?
- RQ5 What could be the probable areas of future research work based on emerging themes and sub-themes?

The rest of the study is organised as follows. The next section is describing the detailed data collection strategy and research methodology. Then results and discussion are presented, it is then followed by emerging trends, future research work, limitations and conclusion of this study.

2. Information system as enabler of metaverse marketing strategies

Information systems play a pivotal role in facilitating metaverse marketing strategies by providing the essential infrastructure and tools needed to leverage this emerging platform. They enable businesses to create, manage, and optimize immersive virtual environments where marketing activities can blossom. Through advanced data analytics, information systems offer valuable insights into user behavior, preferences, and engagement, allowing for highly personalized marketing campaigns. The following are few important scenario of the role of information systems in facilitating marketing on metaverse.

2.1. Integration of information systems in metaverse marketing

The swift and steady transformation in technology has also transformed the marketing strategy, distribution, management, and production systems in firms (Baby et al., 2023). The internet technology and information system are moving in incremental directions (Maltseva et al., 2021). The fluctuation in technology is exceptional. Smart organizations are integrating the newest technologies such as Artificial intelligence (AI) (Lucchi, 2023), Machine learning (Ananthachari & Schutte, 2023; Rohizan et al., 2019), Internet of things (IoT) (Maksymyuk et al., 2023) and Metaverse to enhance their business. Metaverse technology is a collaborative information and communication platform connect virtual and physical world together (Ritterbusch et al., 2023). This information technology has disrupted the business management information system and business model of the firms by adding the metaverse technologies features such as virtual reality (VR), mixed reality (MR) and augmented reality (AR) (Mogaji et al., 2023). The authors identified that metaverse encourage the business to build the health relation with the customers and the way customer are connecting with business offerings (Henry, 2023). The authors also identified that metaverse application benefits the smart firms to established better relationship with customers and build virtual brand image (Punyatoya & Saini, 2023).

2.2. Data analytics and customer insights through information systems in the metaverse

Information system and technologies play pivotal role to organizing, acquiring, accessing, storing, interpreting, and analysing data to support the businesses (Chiang et al., 2018; Daşdemir, 2023). Metaverse virtual environment permit the business to collect the vast data through the various method and devices (AR, VR, XR etc.) (R. S. Jha et al., 2023). There are various analytical tools such as Oculus insight data, Adobe analytics and Landvault monetize that help the marketers to interpret the data get the hidden information about users and customers (Ritterbusch et al., 2023). By implementing these data analytical tool businesses uncovers data insight into user intent and engagement and preferences. The data analytics help business to predict result like customer engagement, likelihood to recurrence (Dineva, 2023). Integration of metaverse data collection environment such as AR, VR can define the personalized marketing such as user eye tracking, user movement and interaction with the consumers (Mok et al., 2023). Information system and newest technology in metaverse virtual environment such as Blockchain technology and AI-driven insight to enhance user experience in future (R. S. Jha et al., 2023).

2.3. Information systems for real-time interaction and engagement technologies

By integrating Information system into metaverse platform to allow real time interaction with users. Information system provide a platform to metaverse user to interact with each other in real time environment. Brands encourage their users to build the virtual community with help of advance information system to boost the brands in metaverse (Chafiq et al., 2023). Brands or company engage and encourage the target audience to talk about the brands (J. Wang et al., 2023) and interact with the others through virtual event to foster virtual community (Siu et al., 2023; Zheng et al., 2015). Metaverse become the new environment to various virtual community to permit the user to connect same characteristics of users and collect the latest information about the brands and community (Matute et al., 2019). The innovative development in the field of information system and metaverse technology are changing degree of marketing strategies for brands. Brands are using the metaverse technology such as AR, VR, MR and XR (extended reality) to expand and attract the attention of consumers towards brand awareness among online communities or audiences. By integrating the IS and

virtual reality, augmented reality consumer can engage with the brands instantly through various avatar that provide personalized feeling (Yaqoob et al., 2023). Virtual showroom brands like Gucci and Nike are providing virtual space to try product virtually (Hollensen et al., 2023; Ruan et al., 2023). Engaging customer through game that also increase the retention and experience (Munde & Kaur, 2023; Mohammad Wasiq et al., 2024). Business has integrated the IS to increase the sense of community to that enables the business to real time discussion and instant feedback about the products and services (Janet et al., 2023).

2.4. The role of information systems in ensuring privacy and security in the metaverse

Security and privacy are pressing concern for both brands and users in metaverse marketing (A. Jha, 2023). Brands or companies are developing attractive privacy and security policy for metaverse infrastructure and information system to attract large numbers of customers or users to ensure secure business transaction (Du et al., 2022), online games, virtual identity and attend online events (Park & Kim, 2022). Companies are incorporating information system, blockchain technology (Ryu et al., 2022), artificial intelligence (L.T. et al., 2022) and zero knowledge proof (Kim & Ryou, 2023) in their metaverse platform to enhance the security and privacy (Saboune, 2022). These technologies give the immense confidence to users to use the metaverse to secure their data, information, and foster trust in virtual brand experience (Seiler et al., 2022).

2.5. Information systems in shaping emerging trends in metaverse marketing

Integration of information system with the metaverse marketing can lead an unpredictable future. AI- power insight will boost the consumer experience whereas Blockchain will provide the data integrity and security to the user. Chatbots powered by AI will transform and enhance the virtual customer experience, offering immediate feedback, anticipate user's enquiry on previous trends and behaviors.

3. Data and methodology

This research is based on the bibliometric review analysis and topic modelling technique. Bibliometric technique helps in the identification of the trends in a specific area of research using numerical based descriptions (M. Kabir Hassan et al., 2023b; Naeem et al., 2022a).

As described in Fig. 1, the data were retrieved from the Scopus database using unique Boolean combinations of keywords for metaverse and marketing. Scopus database is considered as a large database of scholarly research in the field of business and economics, it is widely selected by the scholars for carrying out bibliometric research (Husnain et al., 2019; Singh & Bashar, 2023). The systematic review process and reporting of the results have been done as per the guidelines suggested in by Varsha et al. (2024b) in their paper that fantastically outlined the effective systematic review process.

Scopus indexes a wider range of journals, including those from emerging fields and regions, leading to a more comprehensive and diverse dataset (Vieira et al., 2009). Research by Falagas et al. (2008) demonstrated that Scopus covers a higher percentage of journals across various subject areas compared to WoS. Moreover, it provides more inclusive content coverage by indexing conference papers, book chapters etc. Web of Science prioritizes quality over quantity, whereas Scopus aims for a blend of both. Web of Science encompasses 16,200 journal titles across its four journal citation indexes (SCIE, SSCI, AHCI, ESCI), while Scopus includes 22,794 active titles and 13,583 inactive titles in its database. Recognized as the largest universally embraced and consistent database for scientific publications, Scopus holds significant prominence in the academic community (Bartol et al., 2014).

The data then subjected to certain criterion of exclusion and

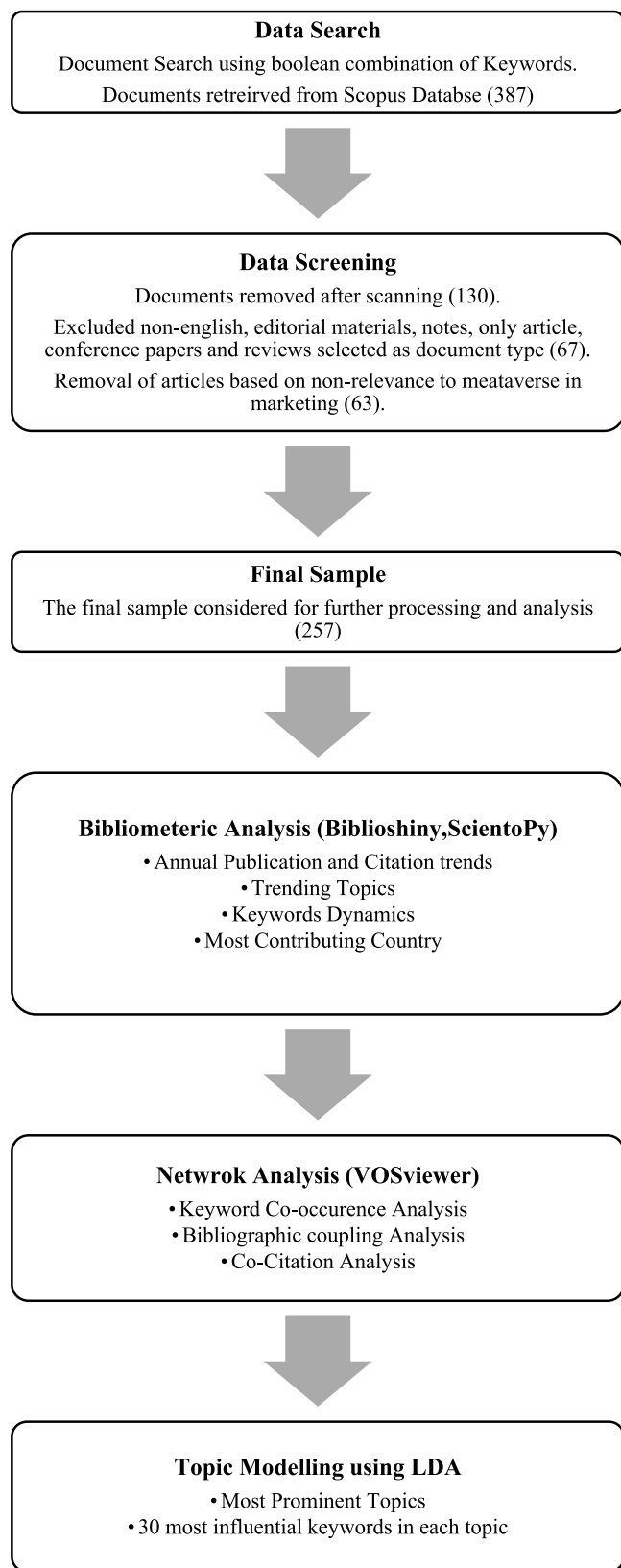


Fig. 1. Research Methodology.

inclusion. The articles that were not published in English language, article type other than reviews, conference papers & articles and articles having their central theme other than metaverse marketing were removed.

In the first stage of the analyses, bibliometric analyses were performed. The bibliometric techniques offer a powerful set of tools for analyzing and understanding the dynamics of the research landscape in a specific research field, from identifying trends and benchmarking performance to mapping knowledge domains and informing strategic decision-making (Firmansyah & Umar 2023; Johri et al., 2024; Varsha et al., 2024a). By leveraging bibliometric analysis, researchers and practitioners can gain valuable insights that drive innovation and advance the field of metaverse marketing. The Biblioshiny application of R Package and ScientoPy is employed to conduct bibliometric analysis. Biblioshiny application is a graphical interface of the bibliometric package of R. Biblioshiny interface helps in the processing of data to obtain descriptive information like publication trend, best journals, prolific authors, best sources etc. This application is widely used in bibliometric analysis studies to reveal the pattern and trends in a particular area of research (M K Hassan et al., 2021; Srisusilawati et al., 2021). ScientoPy is a python based open source scientometric tool that helps in analysing bibliographic data of marketing landscape and presenting outputs in a comprehensive engaging graphics (Ruiz-Rosero et al., 2019).

In the next stage, network analyses were conducted, network analysis provides valuable insights into the complex interconnections and dynamics of research networks, empowering researchers and practitioners to understand relationships, identify key players, segment audiences, optimize strategies, and predict market trends (Kargaran et al., 2022; Sharma et al., 2021). The keywords co-occurrence analysis, bibliographic coupling analysis and co-citation analysis is performed to understand the clustering of dataset into various research themes of metaverse in marketing by uncovering & visualising patterns of interactions. VOSviewer is among the top software being selected by the scholars to conduct network visualisation to understand the underlying research streams (Bashar et al., 2022; Rabbani, 2021).

Then, a machine learning based topic modelling analysis was performed. A python based Latent Dirichlet Allocation (LDA) technique is employed. This is a non-supervised probabilistic method that provides automatically searching, organising, summarising and understanding of large set of data. It helps in the discovery of hidden theme in the dataset and segmenting them in those identified themes (Eom et al., 2021; Nilashi et al., 2019). For LDA modelling to be applied the dataset needed to be pre-processed. There are various steps to be followed, the raw data needed to be cleaned, tokenised, de-lemmatised, and stop words are removed. The processed final data set is then applied to LDA model.

The perplexity and coherence score are determined to test the fitness of the model. The perplexity is a measure explaining how successfully LDA model is predicting a topic. The lower the score the better the topic model. While, the coherence value measures the score of a single topic by measuring the score of semantic closeness in the topic. Score is calculated for each model, a score closed to 0.7 is considered to be a good fit. The data pre-processing, mining and the coding of current LDA model is done in Python.

4. Results and discussion

4.1. Data characteristics

The dataset contains the publications between 1996 and 2024 (Jan 20). The dataset is having a sample of 257 articles published by 200 different sources. These documents are authored by 789 authors, however, only 41 documents are single authored. The co-authors per document is 3.36 that shows a great collaboration among authors having collaboration index of 3.48.

It is evident from Fig. 2 that majority of the documents are articles followed by conference papers and review. 45 % of total articles and 30 % of conference papers are published between 2022 and 2023. This shows that research in the field of immersive marketing or marketing on the metaverse is thoroughly undertaken by the scholars at large.

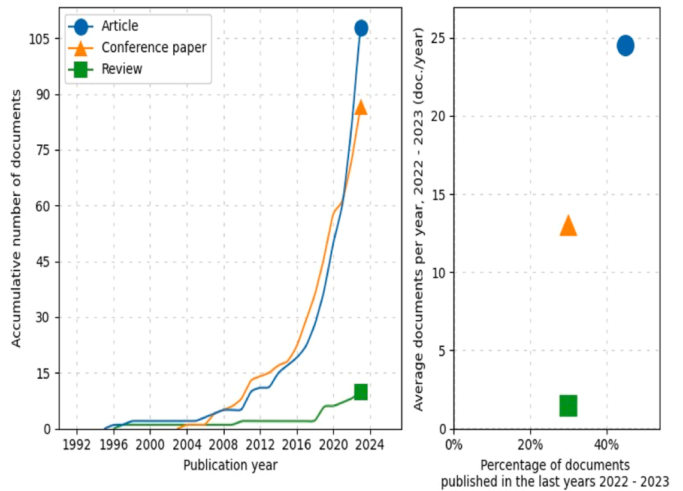
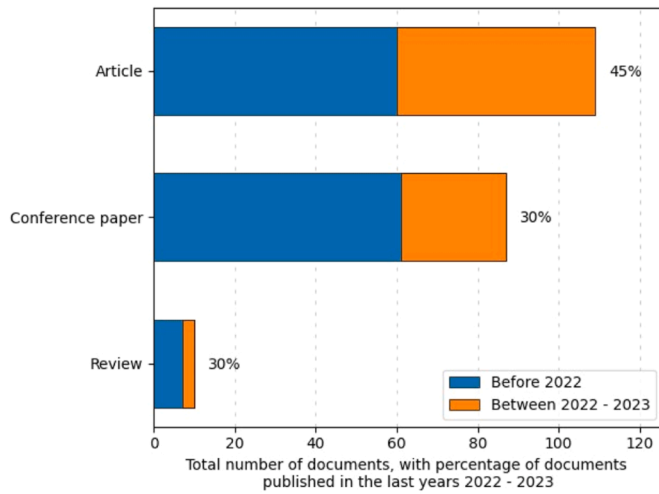


Fig. 2. Document Type & its Evolution.

4.2. Publication and citation

The above Fig. 3 shows the publication and citations trend over the period of time in the field of metaverse marketing. The first article was published in the year 1996 and steadily grow till the year 2010. From 2010 onwards, it saw a great jump in number of articles, it experienced exponential growth from 2017 onwards. The number of research publication has gone all time high in the year 2021 and the trend is continuing.

This is interesting to note that articles written on the marketing on metaverse has always attracted other scholars either in marketing domain or allied fields. This can be noticed from the citation's trends (Fig. 3). It also reflects the fact that marketers are looking positively toward the possibilities of adoption and application of metaverse in marketing processes supported by reliable dynamic information system.

4.3. Author's keywords evolution trend

The publications of author's, keywords used by the authors and its evolution trend is shown in Fig. 4. The keyword "virtual reality" was first found in 2006 and have seen almost exponential growth from then. Moreover, it can also be explicitly visualised that related technologies such as segmented reality, mixed reality all started getting attention during 2010 onwards. This is interesting to note that almost 15 articles are published between 2022 and 2023 having their central theme on virtual reality that is enabled by the information system & its robust structures.

4.4. Most productive country

The most productive countries based on the total number of publications are presented in Fig. 5. The most productive country is United States having published 43 articles, and 33 % of total publications on metaverse marketing has published during 2022–2023. This is evident from the evolution trend is united states is continuously contributing since the area has seen growth. The scholars have deliberated on the cutting-edge technologies & information systems to evolve metaverse applications and strategies to exploit its highest potential in marketing applications.

China is found second most contributing country with a total of 19 publications and 8 of their total articles are published only during 2022–2023. The development of knowledge in the subject of metaverse marketing & information system got substantial development support from the scholars of China. The industry is also getting positive momentum from the government initiatives and programs like "Three-Year Action Plan for Metaverse Industry Development" which in turns results in the demand of empirical understanding of the application of the metaverse technologies in the marketing application practices.

Australia is the third most contributing country with 18 publications and has seen tremendous growth in the last few years. The trend of research and application is quite promising in Australia, a research outcome shown that half of the population is interested in virtual shopping provided they are given proper equipment etc. The e-commerce companies are adopting metaverse at increasing rate that fuels the research and development in the challenges and opportunities of marketing in metaverse supported by information systems (Mabiletsa

Annual Publication and Citations Trend

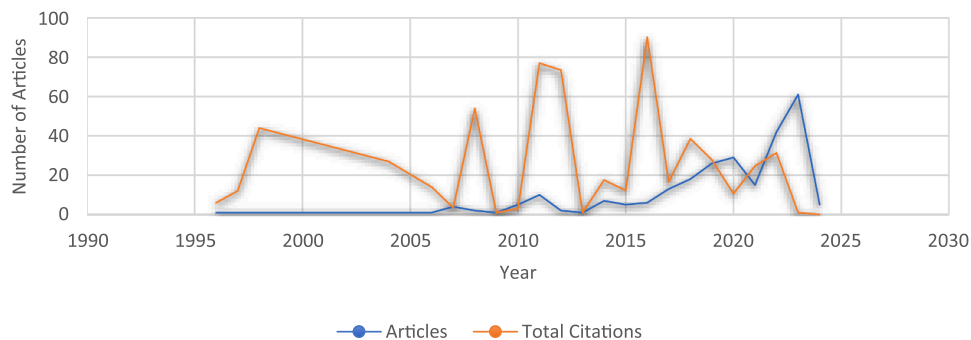


Fig. 3. Annual Publication and Citations Trend.

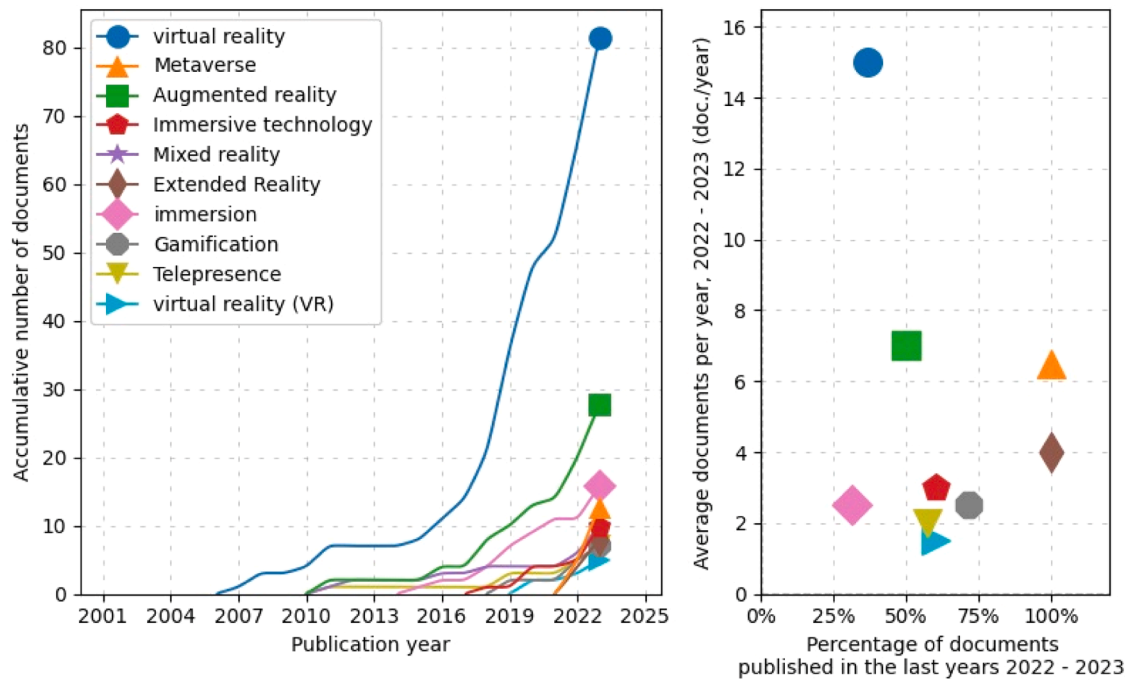


Fig. 4. Author's Publication & Keywords Evolution Trend.

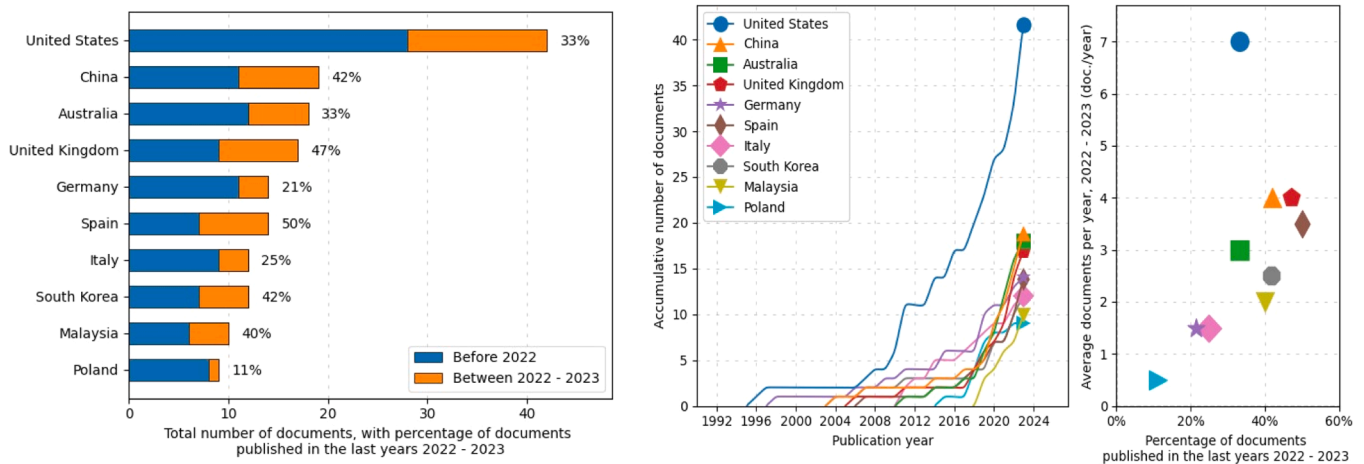


Fig. 5. Most Contributing Countries.

et al., 2020; Schnack et al., 2019).

5. Network analysis

Network analysis is a technique which results in a graphical relationship of the variables in a data set. It helps in understanding the complex nature of data set and estimate the probable relationship (M. Kabir Hassan et al., 2023a). This article has employed VOSviewer application for network analysis. Co-citation, bibliographic coupling and keywords co-occurrence network are made to understand underlying research landscape of metaverse marketing. We have followed the following methods to validate clusters of the networks (co-citations, Bibliographic coupling and keyword co-occurrence).

Visual inspections: Each cluster was visually inspected to ensure that the documents within it share common themes or topics. We also checked the closeness of the nodes and, importantly, the boundaries between clusters to ensure there was no overlapping, maintaining the distinctness of our clusters.

Qualitative Assessment: We assessed the titles, abstracts, and keywords of documents within each cluster to ensure they are topically similar or related. In addition, we checked for coherence in the content of documents to ascertain that they belong together in the same cluster and align with the themes or subthemes in the metaverse research domain.

5.1. Co-citation analysis

Co-citation analysis is a technique which helps in visualising similar research, two documents are said to be co-cited if they have been cited together in a third document (Naem et al., 2022b). Co-citation analysis provides valuable insights into the intellectual structure of a field, facilitates knowledge discovery and dissemination (Tiwary et al., 2021). The VOSviewer application is used to construct the co-citation network by keeping the minimum number of citations of an author at 20. Out of 16,527 authors only 87 met the threshold condition and resulted in the network with four distinct clusters as presented in Fig. 6.

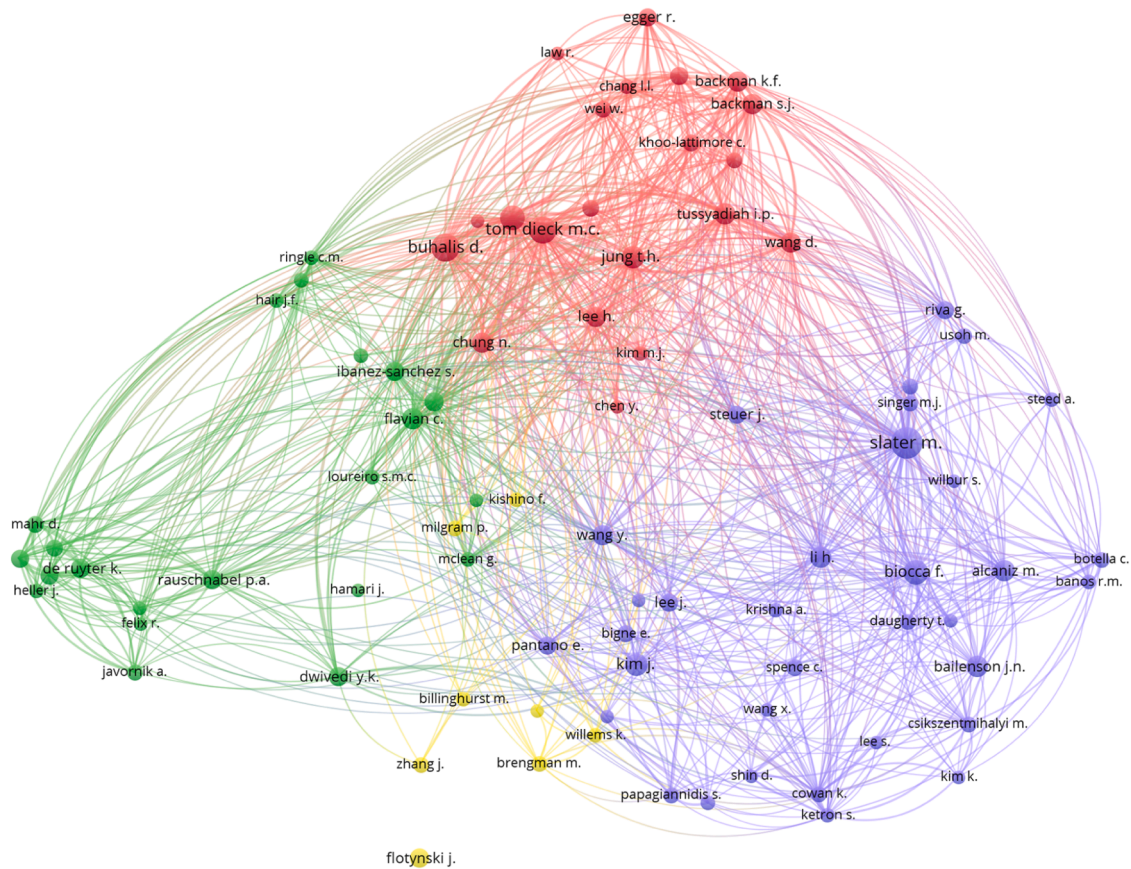


Fig. 6. Co-citation Analysis.

The largest cluster is presented with blue colour and contains 34 authors. This cluster enumerates the technological tools and the overall information systems used in the virtual marketing world for creating immersive marketing environment. **Mel Salter** is the most prominent author of this cluster and has authored “A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments”, “From presence to consciousness through virtual reality”, “Depth of presence in virtual environments” etc. these research are focussed on the self-personalisation on virtual world i.e. on metaverse. Similarly, **Frank A Biocca**, has authored articles which have pinned the important aspects of designing virtual environments such as 3D presence, designing advertisements and promotions on virtual environments, visual touch in virtual environments, virtual product experience etc. (Sestino et al., 2023; Tom Dieck & Han, 2022). One of another important authors in this cluster is **Mariano Alcañiz Raya**, who have published important articles on the development of virtualisation tools and its application in marketing. Augmented reality experience, immersion vs emotion, emotion recognition using wearable sensors, virtual presence etc. are few of his remarkable work (Idrees et al., 2023; Rosário et al., 2023). This cluster is reflecting upon the availability of information system that enables the expansion of virtualisation technologies and its implementation in marketing practices.

The second most prominent cluster is made of 24 authors and represented by green colour. The central theme of this cluster is about customer experience on metaverse and immersive digital environment. The customer experience is tailored based on the state of the art information system that observe record and process vital customer information. The documents of the authors that makes substantial contribution to this cluster are authored by **Dimitrios Buhalis**, **Hyunae Lee**, **Timothy Jung** etc. They have published articles such as “Exploring Consumer Behavior in Virtual Reality Tourism Using an Extended Stimulus-Organism-Response Model.”, “Augmented Reality, Virtual

Reality and 3D Printing for the Co-Creation of Value for the Visitor Experience at Cultural Heritage Places”, “Experiencing immersive virtual reality in museums”, “Metaverse marketing: How the metaverse will shape the future of consumer research and practice” and “Shaping the metaverse into reality: Multidisciplinary perspectives on opportunities, challenges, and future research” (Cuomo et al., 2015; Wiederhold et al., 2014b; Zeng & Richardson, 2017).

The smallest cluster of this network is made of 9 authors and presented by yellow colour. It enumerates the importance of information system in gauging consumer behaviour and providing real-time behavioural intelligence based on the analytics tools to offer personalised solutions. This cluster is centred around consumer behaviour on virtual immersive environments. The authors prominently contributed their documents in this cluster are **Jakub Flotyński**, **Jie Zhang** and **Malaika Brengman**. The research stream in this cluster is revolving around the titles such as “Virtual and augmented reality: Advancing research in consumer marketing”, “When brands come to life: experimental research on the vividness effect of Virtual Reality in transformational marketing communications”, “Can’t touch this: the impact of augmented reality versus touch and non-touch interfaces on perceived ownership”, “Touching the void: exploring consumer perspectives on touch-enabling technologies in online retailing” etc. (Badri et al., 2017; de Regt et al., 2020; Yung et al., 2021).

5.2. Bibliographic coupling analysis

Bibliographic coupling is a method of analysing documents based on their relatedness of bibliographies i.e. two documents are considered to be bibliographically coupled if a same document is referred in both documents, this method is helpful in measuring research impact and exploring structure of intellectual landscape (Sousa et al., 2022). With the help of the results of bibliographic coupling, researchers can identify

related works, explore research networks, discover emerging trends, evaluate research impact, and identify research gaps (Stocchi et al., 2022).

VOSviewer application is used for creation of bibliographic coupling network, the minimum number of citations of a document was kept 10, out of 257, 74 met the threshold criteria, the network thus obtained is having three clusters and presented in Fig. 7.

The largest cluster of this network is presented in blue colour and contains 31 authors, the influential document in this cluster are based on the investigation of the importance of information system in virtualisation. The results of this analysis are consistent with the co-citations analysis in terms of the themes of the clusters. The most prominent documents of this cluster are “Immersive virtual reality technology in a three-dimensional virtual simulated store: Investigating telepresence and usability”, “Virtual reality in tourism: a state-of-the-art review”, “Virtual reality and tourism marketing: Conceptualizing a framework on presence, emotion, and intention”. Therefore, this cluster emphasises on the reliable information systems that in metaverse marketing and examine technology as a driver of metaverse, shaping the overall structures, consumer interaction & experiences (Beck et al., 2019; Yung et al., 2021). The second largest cluster of this network is made of 24 items and presented in green colour. This cluster is explaining the various immersive experiences a customer can have on the virtual platforms and environments. Few of the major research areas in this cluster are social networking platforms, intuitive user interfaces, mega customisation, virtual transactions etc. These virtual platforms can only be achieved when it is being strongly supported by required information system.

The most substantial research articles that have been bibliographically coupled in this cluster are “Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy”, “Augmented reality: Designing immersive experiences that maximize consumer engagement”, and “Solving the crisis of immediacy: How digital technology can transform the customer experience” etc. emphasising upon the importance of accessibility, engagement and overall experience on the metaverse (Dwivedi et al., 2022; Hofmann et al., 2021; Scholz & Smith, 2016).

The third cluster of the network is the smallest cluster represented by pink colour and contains 19 documents. The main theme of this cluster is engagement of the customer in the virtual environment and focussed on important aspects of customer engagement such as social interactions, virtual communities, contents generated by users, Para social interactions (Boletsis & Karahasanovic, 2020; Daoud et al., 2023; de Regt & Barnes, 2019) etc. For successful virtualisation of marketing activities, the firm must focus on creating dynamic, vibrant and engaging communities and group where customers can engage with other customer and discuss about their thought about a given brand. The super-immersive and engaging virtual communities can be designed and implemented with the help of information systems that assure high availability in terms of speed and data reliability.

5.3. Keywords co-occurrence analysis

keyword co-occurrence provides important aspects of data such as their semantic similarities and thematic structure that helps in topic

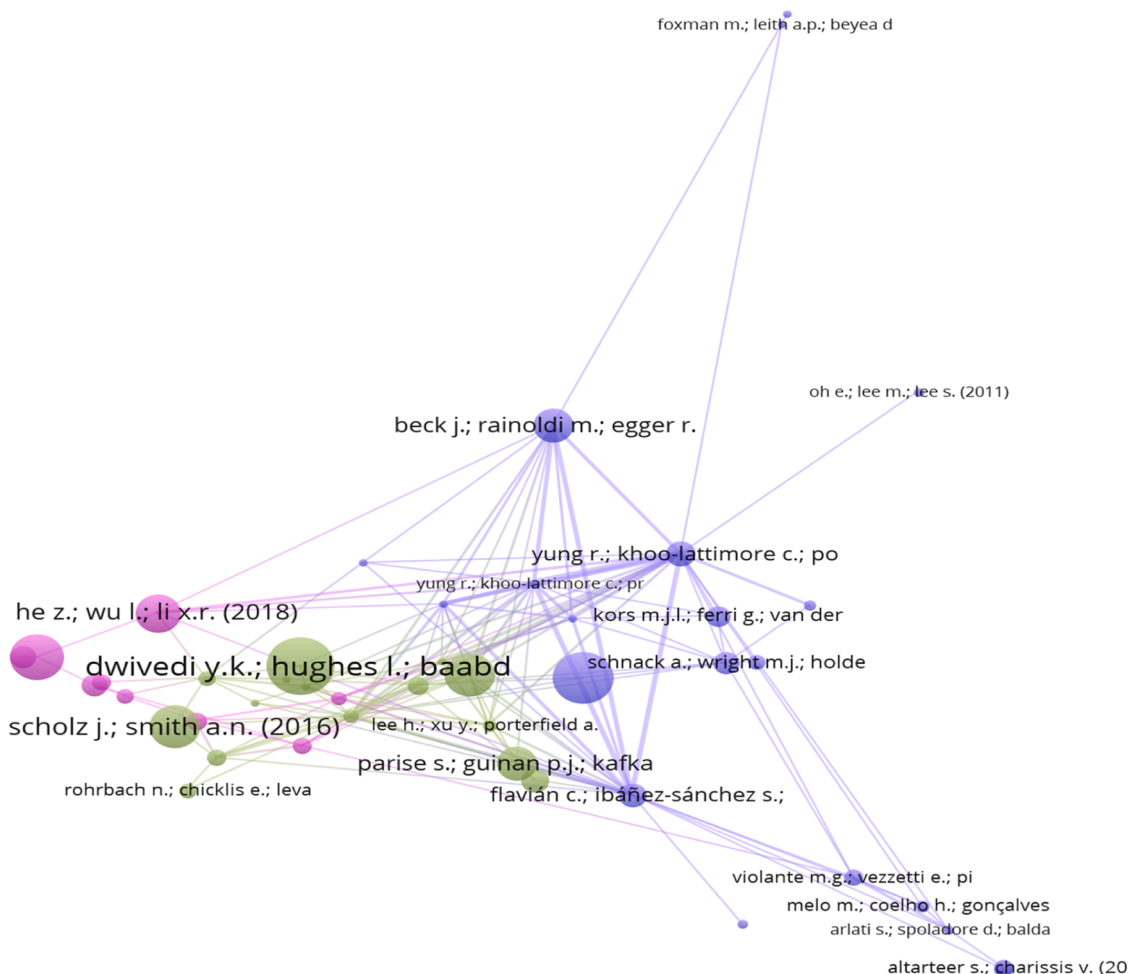


Fig. 7. Bibliographic Coupling Analysis.

modelling and insights into new streams of research (Abu Bashar et al., 2023). The co-occurrence of keywords, researchers can identify research themes, map knowledge networks, discover relationships between concepts, identify key concepts, and visualize research trends (Jenkins, 2022). The keyword co-occurrence analysis is performed using VOSviewer application, by keeping minimum number of occurrences of a keyword 5; only 54 keywords met the criteria out of 1688 keywords. The network resulted in three distinct clusters as shown in the Fig. 8.

The cluster presented by red colour is the largest cluster and made up of 23 keywords. The main theme of this cluster is technological advancement and designs for metaverse marketing activities. The most prominent keywords in this cluster is virtual reality that is in the core of metaverse concepts and its applications in businesses areas in general and marketing in particular. The information systems is crucial in the overall virtualisation process, it helps immensely in information management, critical analysis and utilisation of insights, which ultimately helps in virtual collaborations. Other important words in this cluster are design, presence, user interface, user experience, computer aided design, product design, immersive virtual reality etc. (Prabhakaran et al., 2020; Scholz & Smith, 2016; Yang & Zhang, 2023). It can be noted that for innovative marketing in the virtual world the marketing organisations should leverage on technology and design super immersive advertisement, attractive brand engagement and superb customer experience. For doing this a firm need to be ready to implement technologies such as spatial computing, blockchain, cryptocurrencies and NFTs, artificial intelligence, machine learning techniques, interactive content & gamification etc. (Albahri & AlAmoodi, 2023). The technological advancement and its adoption are key for an organisation to be able to leverage it by designing and attracting their target customers for better engagement and business outcome (de Regt et al., 2020).

The second largest cluster of this network contains 17 keywords and represented by green colour. This cluster signifies the tools & technologies being employed to virtualise the marketing environments. The information systems provides required infrastructure (cloud or On-premise servers), software tools like Customer Relationship Management (CRM), 3D modelling tools (Laser based scanners etc.), data analytics tools, content management systems, digital assets management to ascertain the design and development of super-immersive virtual environments on metaverse. The important keywords contributing substantially to this cluster are human computer interactions, immersive, virtual reality technologies, gamification, innovations etc. The most prominent keyword in this cluster is marketing, i.e. virtualising marketing practices using best available tools (Dahane et al., 2022). While the cluster discussed earlier is signifying the use of technologies for excellent marketing communication and customer experience in metaverse. The virtualisation along with immersive visualisation is only possible with the use of highly sophisticated visual tools for the creation of highly interactive and engaging customer environments (Mishra & Dharmavaram, 2023; Tom Dieck & Han, 2022).

The third and smallest cluster is made up of 14 items and presented using blue colour. This cluster consists of the keywords like electronic commerce, telepresence, augmented reality, extended reality, mixed reality, digital marketing, artificial intelligence and virtual worlds that make the base of the reliable information systems. This cluster again emphasise on the technological advancement and innovation the world of immersive virtual environment is taking place on a continuous basis (de Regt et al., 2021). The use of artificial intelligence techniques along with highly sophisticated machine language algorithms have given wings to metaverse to able to do real-time behavioural intelligence that makes customer delight and made it more popular & acceptable among

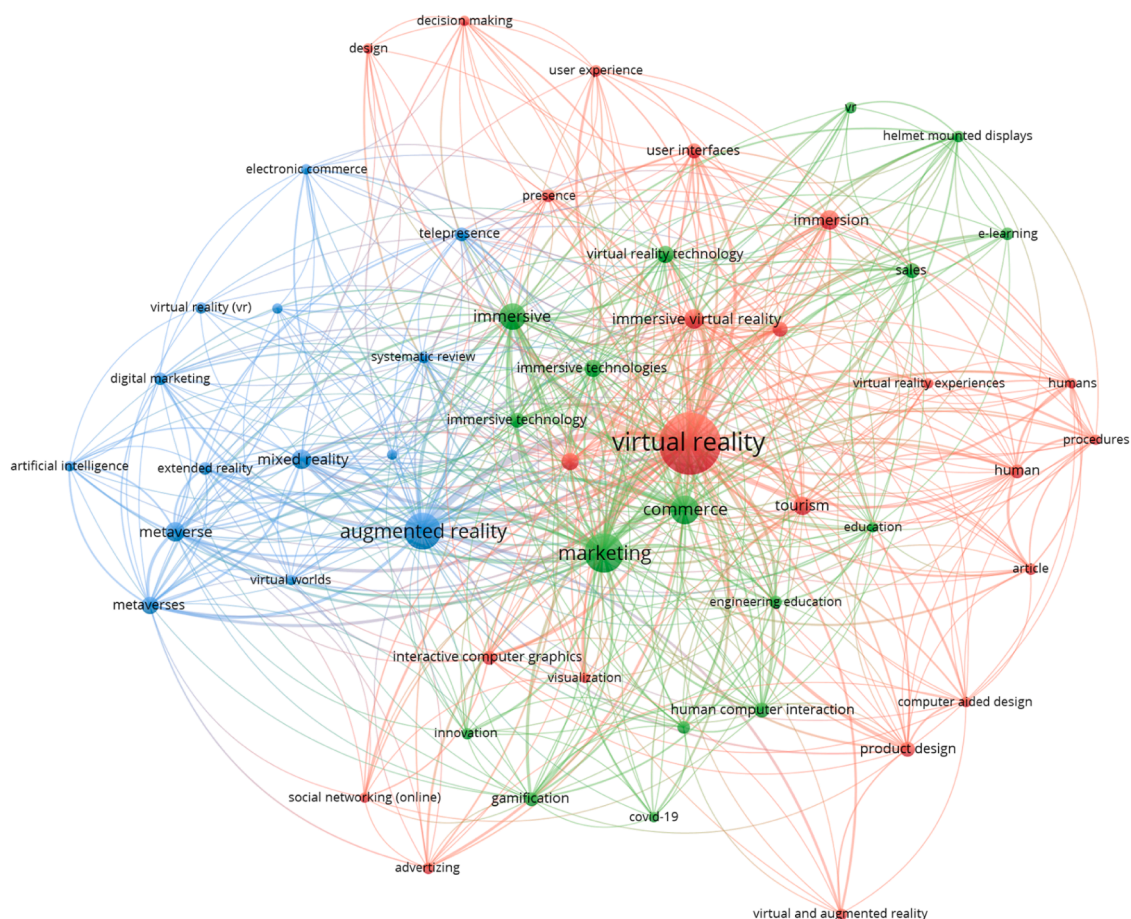


Fig. 8. Keywords Co-occurrence Analysis.

customers (Queiroz et al., 2018).

5.4. Topic modelling using LDA (Latent Dirichlet allocation)

Latent Dirichlet Allocation (LDA) is a widely used popular topic modelling techniques using machine learning algorithms that helps to unveils the hidden thematic structure in a given set of documents (Brzustewicz & Singh, 2021). This technique incredibly helps the researchers and the marketers in understanding consumer preferences, segmenting and targeting audiences, optimizing content strategy, conducting competitive analysis, gathering market intelligence, or managing brand reputation based on the topics yielded by the analysis. The output of this model gives the topics along with probable keywords in each topic.

The codes for the algorithm for LDA model have been written in python and run using jupyter notebook of Anaconda explorer. The data was pre-processed by removing unnecessary fields, stop words and tokenising each topic (the detailed process is outlined in the research methodology section). First, the model is run by specifying 3–30 topics and calculating coherence value for each iterations of the model. The highest value close to 0.7 i.e. 0.56 as indicated in Fig. 9 is accepted that specifies that there shall be five topics.

The output of the model with five topics and their corresponding most frequent keywords are depicted in the Fig. 10.

The topic modelling analysis of metaverse marketing is depicted in Fig. 11. It is a two-dimensional inter-topic distance map resulted from the LDA modelling. The left side of the output shows the topics, the size of the topic’s bubble specifies the weight of that particular topic in the overall model. A good model will have non-overlapping divergent circles across instead of overlapping ones. While the right side of the out shows 30 most important keywords for each topic.

This visual representation of the topics and keywords enables to discover the emerging trend and intellectual structure of metaverse marketing research. Each topic of the model is specifying underlying structure of metaverse marketing and its corresponding themes & sub-themes. A careful investigation of each topic reveals that these topics are pointing towards research in metaverse marketing with an emphasis on user experience, Customer Engagement, Convergence of Metaverse Technologies, Design of Virtual Goods & Experience, Global Social Interaction. These topics have been described with their subthemes in the subsequent section.

5.5. Emerging trends in metaverse marketing

As the topic of metaverse is in its evolving stage, the scholars are researching to understand the opportunities and challenges for its application in marketing. Based on the network analysis and topic modelling it is found that there are five emerging trends in the research landscape of information systems & metaverse marketing. Each trend is having its main theme and subsequent sub-themes. The following table is showing each research streams along with its theme and subthemes.

The above table 1 shows the emerging themes in the metaverse

marketing research. The main themes are pointing towards the current deliberations of the scholar regarding the implications of metaverse in marketing applications. The synthesis of these themes and sub-themes provides a comprehensive understanding of the information systems & metaverse ecosystem and its implications for businesses. Here’s an interpretation along with forward-looking perspectives:

a) User Experience (UX) and Customer Engagement:

Understanding user behavior, preferences, and navigation patterns is fundamental for creating immersive experiences that drive brand engagement and satisfaction. As the metaverse evolves, businesses should focus on assuring information systems that helps in enhancing user immersion and satisfaction through personalized interactions, compelling storytelling, and seamless navigation, ultimately fostering deeper connections and brand loyalty.

b) Convergence of Metaverse Technologies:

The convergence of information system tools such as VR, AR, blockchain, and spatial computing offers unprecedented opportunities for businesses to innovate and create immersive experiences. Businesses should explore the potential of emerging technologies such as the metaverse to pioneer new ways of engagement, leveraging blockchain for virtual asset ownership, and spatial computing for seamless integration of virtual and physical spaces.

c) Design of Virtual Goods & Experience:

A robust information system supported by sophisticated tools & platform is required to design virtual wearables, experiences, and customized offerings enhances user satisfaction and personalization. With the rise of virtual economies, businesses should prioritize user-centric design and digital twinning capabilities to deliver hyper-realistic virtual experiences, while also considering the environmental and ethical implications of virtual consumption.

d) Global Social Interaction:

Virtual socialization, collaborations, and shared communities facilitate global connections and collective experiences. Businesses should leverage on their information systems and digital assets to design and create virtual social platforms to foster inclusive communities, facilitate cross-cultural interactions, and bridge the gap between the physical and virtual worlds, while also addressing issues of digital inclusion and accessibility.

The metaverse represents a paradigm shift in how businesses engage with customers and stakeholders, offering unparalleled opportunities for innovation, collaboration, and creativity.

To thrive in the metaverse, businesses must invest in creating information system and adopt a user-centric approach, embrace emerging technologies, prioritize ethical and sustainable practices, and cultivate meaningful relationships with users and communities, ultimately shaping a more inclusive and immersive digital future.

In summary, the synthesis and interpretation of these themes and sub-themes underscore the transformative potential of the information system & metaverse, offering insights and perspectives to guide businesses in navigating this evolving landscape and unlocking new opportunities for growth and engagement in the digital age.

6. Future research direction

The article thoroughly examines the evolution and current landscape of the information system & metaverse marketing. As the metaverse continues to evolve, the integration of information systems in marketing strategies will play a crucial role in shaping its development. Future research in this area should focus on several key areas to address emerging challenges and leverage new opportunities. To deepen our understanding, future research could explore the intricate details of user experience within the metaverse. This includes delving into concepts like immersion, interaction design, usability, and personalization, and conducting studies on various aspects such as interface design, virtual

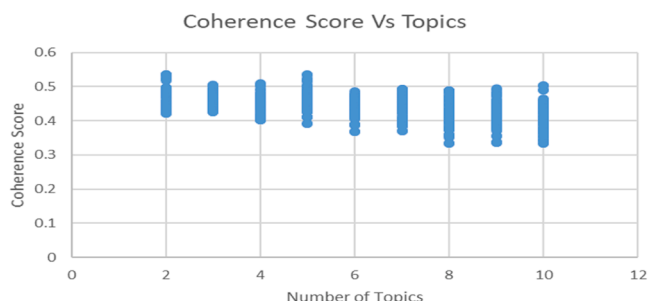


Fig. 9. Coherence Score Vs Topic.

The output of the model with five topics and their corresponding most frequent keywords are depicted in the fig 10.

```

Topic: 0
Words: vr|reality|virtual|marketing|immersive|tourism|research|technologies|experience|technology|study|new|paper|augmented|digital|consumer|based|system|ar|using|consumers|experiences|industry|design|real

Topic: 1
Words: virtual|vr|marketing|reality|immersive|study|research|technology|metaverse|experience|design|ar|product|new|consumer|development|technologies|interactive|tourism|users|environment|also|experiences|based|findings

Topic: 2
Words: virtual|reality|marketing|vr|immersive|study|research|experience|metaverse|technology|experiences|new|user|consumer|design|augmented|ar|users|paper|real|used|using|based|consumers|technologies

Topic: 3
Words: virtual|vr|reality|immersive|marketing|design|study|technology|experience|research|user|used|technologies|users|ar|social|world|real|consumer|using|based|environment|also|advertising|paper

Topic: 4
Words: virtual|reality|marketing|vr|research|immersive|experience|study|technologies|environment|tourism|design|technology|using|consumers|digital|ar|new|real|experiences|brand|product|users|based|paper
    
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Fig. 10. Most Frequent Words in each Topics.

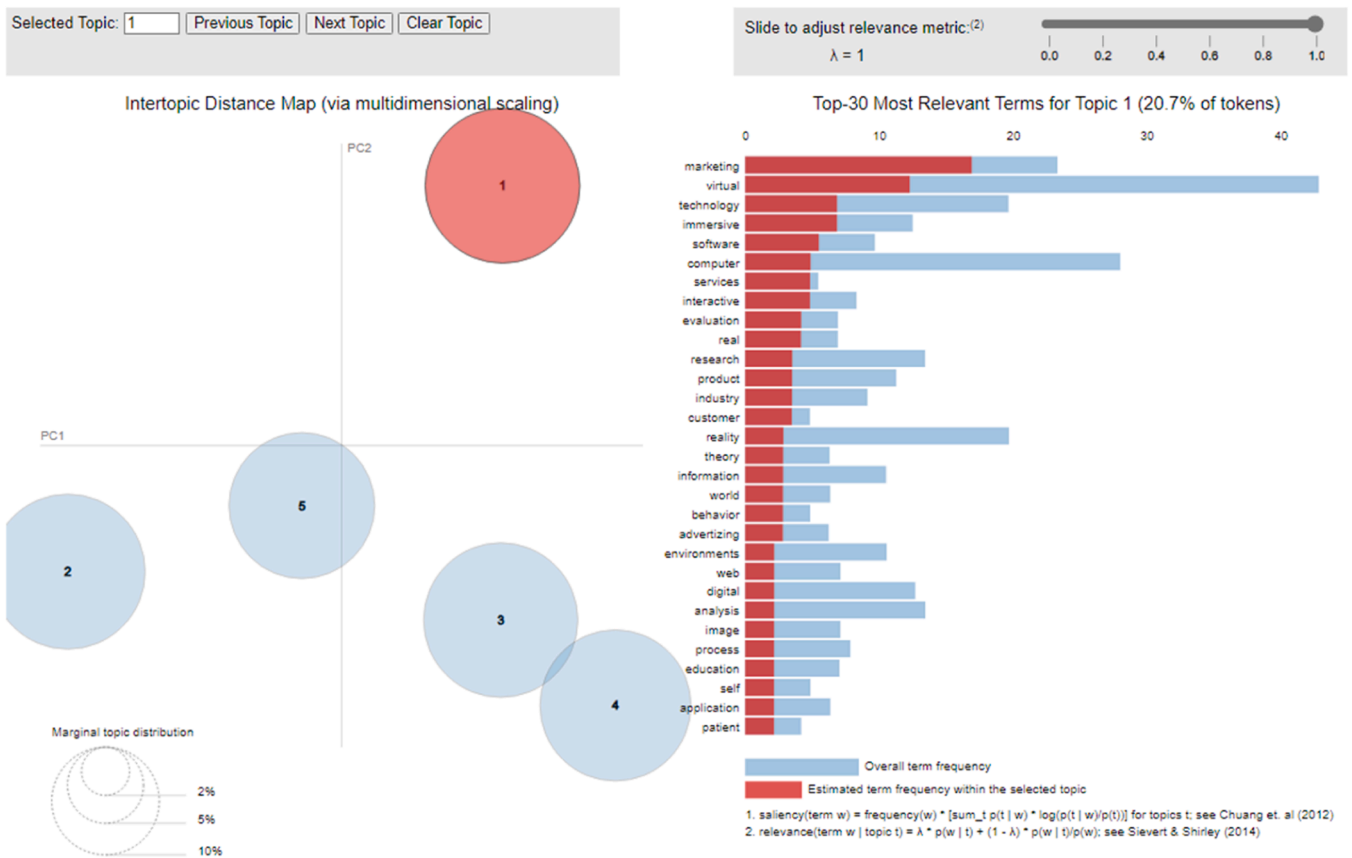


Fig. 11. Topic Modelling Analysis for Metaverse Marketing using LDA Model.

environment navigation, and the psychological factors influencing user engagement. How can information systems be designed to ensure interoperability between diverse virtual environments? What standards

and protocols are necessary for integration? This will help in designing cohesive marketing strategies across virtual platforms.

Moving forward, it would be beneficial to focus on developing

Table 1
Themes and Sub-themes of Metaverse Marketing.

Research Theme	Sub Themes	Reference(s)
User Experience (UX)	User Behaviour & Preferences	(Feng et al., 2019; Gopakumar & Dananjayan, 2023; Melancon, 2011)
	Interaction on metaverse environments	(Javornik et al., 2021; Katicic et al., 2015; Violante et al., 2019)
	Virtual Navigation Pattern	(Herranz De La Casa et al., 2019; Ouerghemmi et al., 2023; Qiu et al., 2020)
	Brand Engagement	(Alshurideh et al., 2023; Cowan et al., 2020; Zhang et al., 2008)
	Immersion on virtual platform	(Flotyński et al., 2018; Gopakumar & Dananjayan, 2023; Lee, 2020)
	Satisfaction on metaverse	(Lalić et al., 2020; Mabiletsa et al., 2020)
	Overall Virtual Experience	(Frechette et al., 2023; Prabhakaran et al., 2020)
Customer Engagement	Branding on virtual environment	(Flotyński et al., 2018; Lee, 2020; Neves et al., 2024)
	Brand Storytelling	(Silvestri, 2022; Song & Wu, 2023)
	Marketing using Avtar	(Gopakumar & Dananjayan, 2023; Melo et al., 2022)
	Placement of virtual product	(Neves et al., 2024; Pantano & Servidio, 2012)
	Brand Engagement	(Herranz De La Casa et al., 2019; Ouerghemmi et al., 2023)
	Virtual Brand Experience	(Calisto & Sarkar, 2024; Nowak & Flotyński, 2018)
Convergence of Metaverse Technologies	Virtual Reality (VR)	(Frechette et al., 2023; Prabhakaran et al., 2020)
	Augmented Reality (AR)	(Flotyński & Sobocinski, 2018; Q. Li et al., 2017)
	Blockchain & Cryptography	(M Wasiq et al., 2023; Mehra et al., 2024)
	Spatial computing	(Ibrahim & Juhari, 2019; Wiederhold et al., 2014b)
	Extended Reality	(Henriques & Winkler, 2021; Ibrahim & Juhari, 2019)
	Human Computer Interaction	(Flotyński et al., 2018; Pantano & Servidio, 2012)
Design of Virtual Goods & Experience	Virtual wearables (clothing, real estate, furniture, vehicles and other digital assets).	(Mehra et al., 2024; Wiederhold et al., 2014a)
	Design of virtual experiences, simulations.	(Flotyński et al., 2018; Ibrahim & Juhari, 2019)
	User Centric Customised Designs	(Flotyński et al., 2018; Henriques & Winkler, 2021)
	Digital Twinning Capabilities	(Correia & Simões-Marques, 2023; K. Li et al., 2023)
	Intimating Virtual Game Design	(Herranz De La Casa et al., 2019; R. Wang & Wang, 2010)
Global Social Interaction	Virtual Socialisation	(Barba et al., 2010; Nowak & Flotyński, 2018)
	Virtual Collaborations	(Nowak & Flotyński, 2018; Ramos-Galarza et al., 2024; Yung et al., 2021)
	Shared Virtual Communities	(Nasr & El-Deeb, 2023; Trisna Jaya & Jaw, 2023; Walczak et al., 2019)
	Real-Virtual World Bridge	(Chen et al., 2023; de Regt et al., 2020)
	Collective Virtual Presence	(Gopakumar & Dananjayan, 2023; Mabiletsa et al., 2020)

information systems that enable the design of effective strategies for engaging customers within the metaverse. This could involve investigating gamification techniques, social interaction models, and incentivization mechanisms aimed at fostering active participation and building loyalty among users.

In the realm of consumer behavior, the creation and customization of avatars play a significant role. Further research could investigate how consumers choose to represent themselves virtually, express their identities through avatars, and the subsequent impact of avatar customization on consumer behavior.

Social interactions are a cornerstone of the metaverse, influencing consumer behavior in multifaceted ways. Exploratory research could examine how virtual social networks and communities within virtual environments shape purchasing decisions, affect brand perception, and influence consumer preferences.

Privacy and security are paramount concerns in any online environment, including the metaverse. Therefore, it's essential to explore how consumers perceive privacy risks within virtual environments, their behaviors regarding sharing personal information, and the subsequent impact of privacy concerns on consumer trust and engagement with entire information system.

Lastly, there's a need for further investigation into the broader societal and cultural implications of metaverse marketing. Understanding how virtual communities from diverse cultural backgrounds will engage and interact within the metaverse can provide valuable insights into its impact on societies and cultures worldwide.

7. Limitations

This study has some limitations, and the results shall be looked accordingly. Firstly, the study is based on Scopus database, there may exist some good publications that might be missed if they are not listed in Scopus database that may lead to selection bias, it does not cover all literature published in metaverse marketing domain.

Secondly, the collection of 275 articles may not be fully representative of the complete body of metaverse marketing research, and a greater number of articles might generate more refined outcome.

Thirdly, topic modelling algorithms require the tuning of hyper-parameters, such as the number of topics or the choice of algorithm, results can vary significantly based on these parameter settings, making it challenging to obtain stable and reliable outcome.

Finally, bibliometric & network analysis have their advantages, these research methods unable to discover the complexity and depth of metaverse marketing qualitatively. Moreover, there are analyses which have been carried out based on total citations, h-indices etc., few good articles with great knowledge and deliberations might be missed because of less citations.

8. Conclusion

This study provided a detailed network analysis and topic modelling of the research trends in the information system & metaverse marketing. This study delves deeper to uncover the major topics, structures, and merging directions in the research of information system & metaverse marketing. The metaverse technologies have disrupted the marketing world and firms need to adopt and apply metaverse to be in the game. The virtual world along with amazing intuitive platform that gives thrilling customer experience is on rise and will be a major shift in the way the marketing programmes were carried out.

A sample of 257 articles published between 1996 and 2024 were selected based on the systematic literature review from Scopus database. This sample is then processed using Biblioshiny app of R studio for bibliometric analysis, network analysis was performed using VOSviewer application and topic modelling was done using machine learning LDA model. The research found five emerging trends in the research landscape of information systems & metaverse marketing. The research

streams are described below.

User Experience in metaverse marketing is the overall quality of interaction and engagement that users have with marketing content, products, or services within virtual environments.

Customer engagement in the metaverse refers to the process of actively involving and interacting with customers within virtual environments to foster meaningful relationships, drive brand loyalty, and achieve business objectives.

The **convergence of metaverse technologies** refers to the integration and combination of various emerging technologies to create interconnected, immersive virtual environments where users can interact, communicate, and engage with digital content and experiences.

The **design of virtual goods and experiences** in the metaverse involves creating and shaping digital assets, environments, and interactions that enhance user engagement, satisfaction, and immersion within virtual environments.

Global social interaction in the metaverse allow their potential users to perform various activity such as conferences, virtual concerts, parties and even wedding. These virtual occasions make a sense of presence and allow to users to engage with others as well as content in real time.

The current trend shows that research in information systems and the metaverse marketing will see a rapid growth to gauge & understand the consumer behaviour, ethical considerations, accessibility & infrastructure, privacy concerns and various challenges in the adoption & application. This research adds to the understanding of the research structure of metaverse marketing and contribute to the extant literature.

CRediT authorship contribution statement

Mohammad Wasiq: Formal analysis, Conceptualization. **Abu Bashar:** Resources, Investigation, Funding acquisition, Formal analysis. **Brighton Nyagadza:** Writing – original draft, Supervision. **Amar Johri:** Visualization, Project administration, Investigation, Data curation.

Declaration of competing interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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