



Article

Advances in Metaverse Investigation: Streams of Research and Future Agenda

Mariapina Trunfio * and Simona Rossi

Department of Management and Quantitative Studies, Parthenope University of Naples, 80132 Naples, Italy

* Correspondence: trunfio@uniparthenope.it

Abstract: The metaverse has increasingly attracted the attention of academics and practitioners, who attempt to better understand its theoretical foundations and business application areas. This paper provides an overarching picture of what has already been studied and investigated in metaverse academic investigation. It adopts a systematic literature review and a bibliometric analysis. The study designs a thematic map of the metaverse research. It proposes four streams of research (metaverse technologies, metaverse areas of application, marketing and consumer behaviour and sustainability) for future investigation, which academics and practitioners should explore. It also contributes towards a systematic advancement of knowledge in the field, provides some preliminary theoretical contributions by shedding light on future research avenues, and offers insights for business.

Keywords: metaverse; virtual reality; immersive technologies; marketing; sustainability; Bibliometrix

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1. Introduction

The metaverse, like many innovations, is shrouded in mysticism and scepticism [1]. If many believe it will be revolutionary and fully transform how people work, shop, socialise, and play, others are sceptical, and see it as a fad. However, whether or not we think of the metaverse as a technological revolution, it is undeniable that the massive diffusion of this technology will impact on nearly all aspects of life and business in the next decade, allowing interaction in virtual and augmented spaces and a blend of both [2].

Companies in this industry are eager to explore ways to capitalise on the metaverse to create virtual experiences for their consumers. Consumers are increasingly opting for metaverse products and services, and participating in virtual worlds [3]. Tech giants such as Nvidia, Roblox, Decentraland, The Sandbox, the Chinese Baidu and the Korean Netmarble strive to create metaverse platforms as virtual worlds in which people interact, game, work and do business.

The metaverse challenge has even attracted the attention of policymakers. The European Commission, for example, 2020 introduced the Virtual and Augmented Reality Industrial Coalition, a platform for structured dialogue between the European VR/AR ecosystem and policymakers [4].

The metaverse has been defined as a three-dimensional space representation based on virtual and augmented reality, where people can use personal avatars to work, play and synchronously communicate with each other [5–7]. It is also increasingly attracting the interest of academics who have already tried to conceptualise the phenomenon by proposing frameworks and research agendas [3,8–10].

Although metaverse is a term that has been gaining interest in the academic world since 2021, the term was coined in 1992 by Neal Stephenson in his novel *Snow Crash*. In 2021, Facebook CEO Mark Zuckerberg announced the decision to rebrand the company, changing its name to “Meta”.

However, most of this primary research remains independent, and the academic community feels strongly the need for new theoretical frameworks that deepen the metaverse [3,11].

This paper aims to contribute to the metaverse debate systematically. It analyses, synthesises and discusses recent academic papers, and defines the metaverse investigation's main streams and future research agenda. A systematic literature review approach provides an overarching picture of what has already been investigated, and the existing gaps that need further research. It contributes toward a systematic advancement of knowledge in the field, and offers insights and guidance to practitioners on modelling and managing the metaverse [12].

The remainder of the paper is structured as follows. Section 2 presents the theoretical background of the study. Section 3 describes the methodology used for conducting the systematic literature review [12,13]. Section 4 presents the bibliometric analysis results, including the year in which research began, the journals that publish most research, and the most relevant authors with publications on the topic. Section 5 then classifies these studies in terms of different macro-themes and provides a critical discussion of the findings from the literature review, and highlights its key contributions. Lastly, Section 6 concludes the study by highlighting its limitations and proposing directions for future research.

2. Theoretical Background

Metaverse: The State of the Art

The literature has attempted to conceptualise and define the metaverse in several ways. Herrman and Browning define it as “a fully realised digital world that exists beyond the analogue one in which we live” [14]; Morgado explains it as “a plethora of interconnected world” [15]. Meta Platforms, Inc. Bosworth and Clegg (2021) describe it more simply: “The ‘metaverse’ is a set of virtual spaces where you can create and explore with other people who aren’t in the same physical space as you” [6].

Across the definitions, the term metaverse defines a collective, persistent, and interactive parallel reality created by synthesising virtual worlds where people can use personal avatars to work, play and communicate with each other. Virtual technologies enhance the perceived immersion with the character realness of the avatars and residents. Usually networked and situated with intelligent agents, they allow users to interact with virtual objects and intelligent agents freely, and to communicate with each other [16]. In multiple forms, these worlds can be experienced synchronously and persistently by an unlimited number of users [5,17,18].

The common attributes of the metaverse are multi-technology, sociality and hyper spatiotemporality [10]. It integrates various new technologies [19], including augmented reality (AR), virtual reality (VR), and mixed reality (MR), and constitutes an economic system based on blockchain (multi-technology). The metaverse embraces economic systems, cultural systems, and legal systems (sociality) in a virtual world; it allows the breaking of boundaries of time and space (hyper spatiotemporality) [10].

Changes in consumer and business behaviours are frequently associated with changes in the metaverse [3,20]. Academic investigation concerns customers’ journey, purchasing process, buying behaviour, perceived value and value propositions and consumption patterns [20]. Individuals can live through immersive experiences, interacting with the metaverse-scape. Hedonic motives drive consumers to undertake virtual experiences for enjoyment and pleasure, whereas utilitarian reasons drive consumers to satisfy their functional needs in the virtual world [3]. Escaping reality is another key driver of users’ participation in the metaverse experience [20]. ICTs, in particular virtual worlds, enhance escapism, helping people who want to ‘leave’ the real world in which they live, both cognitively and emotionally [21].

3. Methodology

The literature review is a research method which contributes towards a systematic advancement of new knowledge in the field [12]. It aims to map the relevant literature, identify streams of research, and design potential research gaps that need further investigation. This research is built upon the rigorous, transparent, and reproducible protocol of the

systematic literature review as a scientific and transparent process that reduces the selection bias, through an exhaustive literature search [12,13]. Building on recent studies [22–24] in addition to the systematic literature review, a bibliometric analysis was also performed, to provide greater comprehensions into the field’s current state and to highlight future research directions.

Quality journals are the basis for selecting quality publications for a literature review. Therefore, the database Scopus, run by Elsevier Publishing, was considered for the search for relevant literature, being the most significant abstract and citation source database used in recent reviews. The following research chain: “Metaverse”, searching under title, abstract, and keywords, was used.

The systematic literature review protocol (see Figure 1) was conducted on 3 July 2022, considered an open starting time to trace back to the origin of metaverse research. The initial search attempts identified 518 documents.

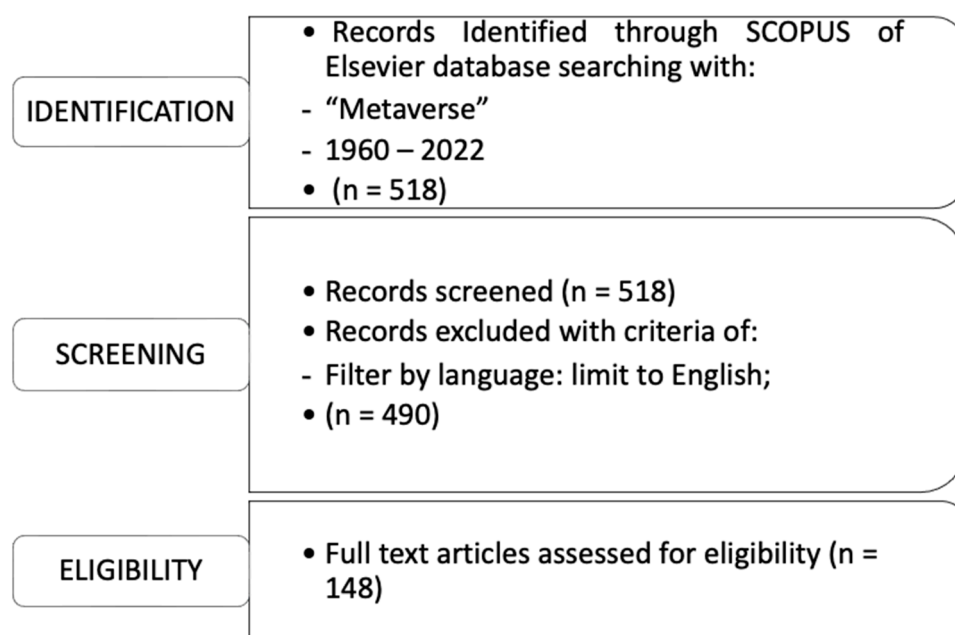


Figure 1. The protocol of the systematic quantitative literature review.

After the identification of the articles, the research adopted criteria for inclusion and exclusion. Firstly, the 518 articles were screened, considering English-language articles. Since it is an emerging topic, book reviews, editorials, and papers from conference proceedings were also included in the research. After the screening, a sample of 490 papers was obtained.

Afterwards, the full text of these papers was reviewed, to assess eligible articles. As a result, 342 articles were excluded because their subject matter was not closely related to the topic of the metaverse. In the end, 148 eligible documents were identified, having been published in 112 sources among journals, books, and conference proceedings.

The relevant data of the 148 documents in the final sample were saved and organised in a Microsoft Excel spreadsheet to include all the essential paper information such as paper title, author names, affiliations, abstract, keywords and references. Subsequently, adopting the bibliometrics analysis method [25], the R-Tool ‘Biblioshiny for Bibliometrix’ was used to perform a comprehensive bibliometric analysis. Bibliometrix is a recent R-package that facilitates a more complete bibliometric analysis, employing specific tools for both bibliometric and scientometric quantitative research [25].

The qualitative analysis of the above-identified 148 documents was implemented through a thematic analysis which assisted in identifying and discussing the themes in the

literature. Thematic analysis is an approach broadly used in bibliometrics to explore the conceptual structure of a research domain [26,27].

Using such an approach allows us to classify and organise documents by homogenous factors, so ideas and arguments can be clustered together to form a theme. A thematic map based on co-word network analysis and clustering was also generated to identify four topological regions, according to density and centrality dimensions. Density measures the strength of internal ties among all keywords describing the research theme and is a measure of the theme's development. Centrality measures the strength of external ties to other themes: it can be understood as a measure of the importance of a theme in the development of the entire research field analysed [28].

This result was obtained from a semi-automatic algorithm by reviewing the keywords of all references analysed in this study (apart from the author's keywords) to capture deeper variations [25].

4. Findings

The bibliometric analysis provided information on the 148 documents, allowing us to highlight the topic's significance (Table 1).

Table 1. The 148 documents analysed.

Authors	Title	Year	Source Title
Abbate S., Centobelli P., Cerchione R., Oropallo E., Riccio E.	A first bibliometric literature review on Metaverse [8]	2022	2022 IEEE Technology and Engineering Management Conference: Societal Challenges: Technology, Transitions and Resilience Virtual Conference, TEMSCON EUROPE 2022
Abeles T.P.	Education unbound [29]	2007	On the Horizon
Afshar S.V., Eshaghi S., Kim I.	Pattern Analysis of Virtual Landscape within Educational Games [30]	2022	Journal of Digital Landscape Architecture
Akour I.A., Al-Marouf R.S., Alfaisal R., Salloum S.A.	A conceptual framework for determining metaverse adoption in higher institutions of gulf area: An empirical study using hybrid SEM-ANN approach [31]	2022	Computers and Education: Artificial Intelligence
Alawadhi M., Alhumaid K., Almarzooqi S., Aljasmi S., Aburayya A., Salloum S.A., Almesmari W.	Factors Affecting Medical Students' Acceptance of the Metaverse System in Medical Training in the United Arab Emirates [32]	2022	South Eastern European Journal of Public Health
Alcantara A.C., Michalack D.L.	The Metaverse Narrative in the Matrix Resurrections: A Semiotic Analysis Through Costumes [33]	2023	Springer Series in Design and Innovation
Armitage J.	Rethinking haute couture: Julien Fournié in the virtual worlds of the Metaverse [34]	2022	French Cultural Studies
Ayiter E.	"Smooth space" for avatars: A proun in the Metaverse [35]	2015	Analysing Art, Culture, and Design in the Digital Age
Ayiter E.	Synthetic worlds, synthetic strategies: Attaining creativity in the Metaverse [36]	2010	Metaplasticity in Virtual Worlds: Aesthetics and Semantic Concepts
Ayiter E.	The avatars of alpha tribe [37]	2020	Modified: Living as a Cyborg
Baía Reis A., Ashmore M.	From video streaming to virtual reality worlds: an academic, reflective, and creative study on live theatre and performance in the Metaverse [38]	2022	International Journal of Performance Arts and Digital Media

Table 1. Cont.

Authors	Title	Year	Source Title
Batnasan G., Gochoo M., Otgonbold M.-E., Alnajjar F., Shih T.K.	ArSL21L: Arabic Sign Language Letter Dataset Benchmarking and an Educational Avatar for Metaverse Applications [39]	2022	IEEE Global Engineering Education Conference, EDUCON
Belei N., Noteborn G., De Ruyter K.	It's a brand new world: Teaching brand management in virtual environments [40]	2011	<i>Journal of Brand Management</i>
Bibri S.E., Allam Z.	The Metaverse as a Virtual Form of Data-Driven Smart Urbanism: On Post-Pandemic Governance through the Prism of the Logic of Surveillance Capitalism [41]	2022	<i>Smart Cities</i>
Binson B.	Editorial Metaverse and Crypto Art during the COVID-19 Pandemic [42]	2021	<i>Journal of Urban Culture Research</i>
Boche H., Pohl V.	On non-detectability of non-computability and the degree of non-computability of solutions of circuit and wave equations on digital computers [43]	2022	<i>IEEE Transactions on Information Theory</i>
Boulos M., Burden D.	Web GIS in practice V: 3-D interactive and real-time mapping in second life [44]	2007	<i>International Journal of Health Geographics</i>
Boulos M.N.K., Scotch M., Cheung K.-H., Burden D.	Web GIS in practice VI: A demo playlist of geo-mashups for public health neogeographers [45]	2008	<i>International Journal of Health Geographics</i>
Bousba Y., Arya V.	Let's connect in metaverse. Brand's new destination to increase consumers' affective brand engagement & their satisfaction and advocacy [46]	2022	<i>Journal of Content, Community and Communication</i>
Brennen B., dela Cerna E.	Journalism in second life [47]	2010	<i>Journalism Studies</i>
Brownsword R.	Law, authority, and respect: three waves of technological disruption [48]	2022	<i>Law, Innovation and Technology</i>
Cagnina M.R., Poian M.	Second life: A turning point for web 2.0 and E-business? [49]	2008	<i>Interdisciplinary Aspects of Information Systems Studies: The Italian Association for Information Systems</i>
Calongne C., Sheehy P., Stricker A.	Gemeinschaft identity in a gesellschaft metaverse [50]	2013	<i>The Immersive Internet: Reflections on the Entangling of the Virtual with Society, Politics and the Economy</i>
Cameron A.	Splendid isolation: 'Philosopher's islands' and the reimagination of space [51]	2012	<i>Geoforum</i>
Chadwick S.	Planning and Probity: Shirley Porter to the Metaverse [52]	2022	<i>Journal of Planning and Environment Law</i>
Chávez-Aguayo M.A.	Democratisation of creativity and cultural production in virtual worlds: A new challenge for regulation and cultural management [53]	2009	<i>Proceedings of the European Conference on Games-based Learning</i>
Chen C., Yao M.Z.	Strategic use of immersive media and narrative message in virtual marketing: Understanding the roles of telepresence and transportation [54]	2022	<i>Psychology and Marketing</i>

Table 1. Cont.

Authors	Title	Year	Source Title
Chia A.	The metaverse, but not the way you think: game engines and automation beyond game development [55]	2022	<i>Critical Studies in Media Communication</i>
Choi H.-S., Kim S.-H.	A content service deployment plan for metaverse museum exhibitions—Centering on the combination of beacons and HMDs [7]	2017	<i>International Journal of Information Management</i>
Choi H.-Y.	Working in the Metaverse: Does Telework in a Metaverse Office Have the Potential to Reduce Population Pressure in Megacities? Evidence from Young Adults in Seoul, South Korea [56]	2022	<i>Sustainability (Switzerland)</i>
Corballis T., Soar M.	Utopia of abstraction: Digital organisations and the promise of sovereignty [57]	2022	<i>Big Data and Society</i>
Dai E., Bal J.	Harmonising culture in co-operative business ventures: Using a simulation in a metaverse [58]	2009	<i>Proceedings of the European Conference on Games-based Learning</i>
Dai W.	Optimal policy computing for blockchain based smart contracts via federated learning [59]	2022	<i>Operational Research</i>
Darwish A., Hassanien A.E.	Fantasy Magical Life: Opportunities, Applications, and Challenges in Metaverses [60]	2022	<i>Journal of System and Management Sciences</i>
Dear K.	Beyond the ‘Geo’ in Geopolitics: The Digital Transformation of Power [61]	2022	<i>RUSI Journal</i>
Devisch O.	The metaverse as lab to experiment with problems of organised complexity [62]	2012	<i>Complexity and Planning: Systems, Assemblages and Simulations</i>
Díaz J.E.M.	Virtual World as a Complement to Hybrid and Mobile Learning [63]	2020	<i>International Journal of Emerging Technologies in Learning</i>
Díaz J.E.M., Saldaña C.A.M., Avila C.A.R.	Virtual world as a resource for hybrid education [64]	2020	<i>International Journal of Emerging Technologies in Learning</i>
Dincelli E., Yayla A.	Immersive virtual reality in the age of the Metaverse: A hybrid-narrative review based on the technology affordance perspective [65]	2022	<i>Journal of Strategic Information Systems</i>
Dominguez-Noriega S., Enrique Agudo J., Ferreira P., Rico M.	Language learning resources and developments in the Second Life metaverse [66]	2011	<i>International Journal of Technology Enhanced Learning</i>
Doyle D., Kim T.	Embodied narrative: The virtual nomad and the meta dreamer [67]	2007	<i>International Journal of Performance Arts and Digital Media</i>
Dozio N., Marcolin F., Scurati G.W., Ulrich L., Nonis F., Vezzetti E., Marsocci G., La Rosa A., Ferrise F.	A design methodology for affective Virtual Reality [68]	2022	<i>International Journal of Human Computer Studies</i>

Table 1. Cont.

Authors	Title	Year	Source Title
Dwivedi Y.K., Hughes L., Baabdullah A.M., Ribeiro-Navarrete S., Giannakis M., Al-Debei M.M., Dennehy 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., Wei-Han Tan G., Tiwari M.K., Viglia G., Wamba S.F.	Metaverse beyond the hype: Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy [9]	2022	<i>International Journal of Information Management</i>
Egliston B., Carter M.	Critical questions for Facebook's virtual reality: data, power and the Metaverse [69]	2021	<i>Internet Policy Review</i>
Estudiante A., Dietrich N.	Using Augmented Reality to Stimulate Students and Diffuse Escape Game Activities to Larger Audiences [70]	2020	<i>Journal of Chemical Education</i>
Falchuk B., Loeb S., Neff R.	The Social Metaverse: Battle for Privacy [71]	2018	<i>IEEE Technology and Society Magazine</i>
Fernandez P.	Facebook, Meta, the metaverse and libraries [72]	2022	<i>Library Hi Tech News</i>
Gadalla E., Keeling K., Abosag I.	Metaverse-retail service quality: A future framework for retail service quality in the 3D internet [73]	2013	<i>Journal of Marketing Management</i>
Gaggioli A., Chirico A.	Call for Special Issue Papers: Virtual Emotions: Understanding Affective Experiences in the Metaverse [74]	2022	<i>Cyberpsychology, behavior and social networking</i>
Garrido-Iñigo P., Rodríguez-Moreno F.	The reality of virtual worlds: pros and cons of their application to foreign language teaching [75]	2015	<i>Interactive Learning Environments</i>
Guo X., Hou L.	Key Technology Research of Digital Fashion Based on Virtual Technology [76]	2022	<i>Advances in Transdisciplinary Engineering</i>
Gursoy D., Malodia S., Dhir A.	The metaverse in the hospitality and tourism industry: An overview of current trends and future research directions [3]	2022	<i>Journal of Hospitality Marketing and Management</i>
Hadjistassou S.K.	Culturally afforded tensions in the second life metaverse: From sustainability initiatives in Europe to sustainability practices in the United States [77]	2016	<i>International Journal of Web-Based Learning and Teaching Technologies</i>
Harley D.	"This would be sweet in VR": On the discursive newness of virtual reality [78]	2022	<i>New Media and Society</i>
Hedrick E., Harper M., Oliver E., Hatch D.	Teaching & Learning in Virtual Reality: Metaverse Classroom Exploration [79]	2022	2022 Intermountain Engineering, Technology and Computing, IETC 2022
Hirsch P.B.	Adventures in the Metaverse [80]	2022	<i>Journal of Business Strategy</i>

Table 1. Cont.

Authors	Title	Year	Source Title
Hollensen S., Kotler P., Opresnik M.O.	Metaverse—the new marketing universe [18]	2022	<i>Journal of Business Strategy</i>
Hsieh Y.-L., Lee M.-F., Chen G.-S., Wang W.-J.	Application of Visitor Eye Movement Information to Museum Exhibit Analysis [81]	2022	<i>Sustainability (Switzerland)</i>
Hudson-smith A.	Incoming Metaverses: Digital Mirrors for Urban Planning [82]	2022	<i>Urban Planning</i>
Hudson-smith A., Shakeri M.	The Future's Not What It Used To Be: Urban Wormholes, Simulation, Participation, and Planning in the Metaverse [83]	2022	<i>Urban Planning</i>
Huh S.	Application of the computer-based testing in Korean medical licensing examination, the emergence of a metaverse in medical education, journal metrics and statistics, and appreciation to reviewers and volunteers [84]	2022	<i>Journal of Educational Evaluation for Health Professions</i>
Hutson J.	Social Virtual Reality: Neurodivergence and Inclusivity in the Metaverse [85]	2022	<i>Societies</i>
Huvila I.	Sorting out the metaverse and how the metaverse is sorting us out [86]	2013	<i>The Immersive Internet: Reflections on the Entangling of the Virtual with Society, Politics and the Economy</i>
Hwang G.-J., Chien S.-Y.	Definition, roles, and potential research issues of the metaverse in education: An artificial intelligence perspective [87]	2022	<i>Computers and Education: Artificial Intelligence</i>
Ilyina I.A., Eltikova E.A., Uvarova K.A., Chelysheva S.D.	Metaverse—Death to Offline Communication or Empowerment of Interaction? [88]	2022	<i>Proceedings of the 2022 Communication Strategies in Digital Society Seminar 2022, ComSDS 2022</i>
Jaffurs S.E.	SIMphonic Island: Exploring musical identity and learning in virtual space [89]	2011	<i>Learning, Teaching, and Musical Identity: Voices Across Cultures</i>
Jeon J.-E.	The Effects of User Experience-Based Design Innovativeness on User–Metaverse Platform Channel Relationships in South Korea [90]	2021	<i>Journal of Distribution Science</i>
Jeong J.-B., Lee S., Ryu E.-S.	DWS-BEAM: Decoder-Wise Subpicture Bitstream Extracting and Merging for MPEG Immersive Video [91]	2021	<i>2021 International Conference on Visual Communications and Image Processing, VCIP 2021—Proceedings</i>
Jeong Y., Choi S., Ryu J.	Design of LMS for the Shared Campus in Metaverse Learning Environment [92]	2022	<i>Proceedings of 2022 8th International Conference of the Immersive Learning Research Network, iLRN 2022</i>
Joy A., Zhu Y., Peña C., Brouard M.	Digital future of luxury brands: Metaverse, digital fashion, and non-fungible tokens [93]	2022	<i>Strategic Change</i>
Jungherr A., Schlarb D.B.	The Extended Reach of Game Engine Companies: How Companies Like Epic Games and Unity Technologies Provide Platforms for Extended Reality Applications and the Metaverse [94]	2022	<i>Social Media and Society</i>
Kappe F., Steurer M.	The open metaverse currency (OMC)—A micropayment framework for open 3D virtual worlds [95]	2010	<i>Lecture Notes in Business Information Processing</i>

Table 1. Cont.

Authors	Title	Year	Source Title
Kesselman M.A., Esquivel W.	Technology on the move, Consumer Electronics Show 2022: the evolving Metaverse and much more [96]	2022	<i>Library Hi Tech News</i>
Kim J.	Advertising in the Metaverse: Research Agenda [11]	2021	<i>Journal of Interactive Advertising</i>
Kim K.	Metaverse in journal publishing [97]	2022	<i>Science Editing</i>
Kim K., Yang E., Ryu J.	The Effect of Students' Perceptions on Intention to use Metaverse Learning Environment in Higher Education [98]	2022	<i>Proceedings of 2022 8th International Conference of the Immersive Learning Research Network, iLRN 2022</i>
Knox J.	The Metaverse, or the Serious Business of Tech Frontiers [99]	2022	<i>Postdigital Science and Education</i>
Koo H.	Training in lung cancer surgery through the metaverse, including extended reality, in the smart operating room of Seoul National University Bundang Hospital, Korea [100]	2021	<i>Journal of Educational Evaluation for Health Professions</i>
Korbel J.J., Siddiq U.H., Zarnekow R.	Towards Virtual 3D Asset Price Prediction Based on Machine Learning [101]	2022	<i>Journal of Theoretical and Applied Electronic Commerce Research</i>
Korkmaz S., Kim I.	The Optimal D:H Ratio Assessment for Sense of Enclosure in Virtual Landscapes [102]	2022	<i>Journal of Digital Landscape Architecture</i>
Kozinets R.V.	Immersive netnography: a novel method for service experience research in virtual reality, augmented reality and metaverse contexts [103]	2022	<i>Journal of Service Management</i>
Kraus S., Kanbach D.K., Krysta P.M., Steinhoff M.M., Tomini N.	Facebook and the creation of the metaverse: radical business model innovation or incremental transformation? [104]	2022	<i>International Journal of Entrepreneurial Behaviour and Research</i>
Kye B., Han N., Kim E., Park Y., Jo S.	Educational applications of Metaverse: Possibilities and limitations [105]	2021	<i>Journal of Educational Evaluation for Health Professions</i>
Lee H.J., Hwang Y.	Technology-Enhanced Education through VR-Making and Metaverse-Linking to Foster Teacher Readiness and Sustainable Learning [106]	2022	<i>Sustainability (Switzerland)</i>
Lee J.	The era of Omni-learning: Frameworks and practices of the expanded human resource development [107]	2022	<i>Organizational Dynamics</i>
Lee S.-E., Domina T., MacGillivray M.	Exploring consumers' flow experiences in virtual shopping: An exploratory study [108]	2011	<i>International Journal of Electronic Marketing and Retailing</i>
Lee S.-G., Trimi S., Byun W.K., Kang M.	Innovation and imitation effects in Metaverse service adoption [109]	2011	<i>Service Business</i>
Lee U.-K.	Tourism Using Virtual Reality: Media Richness and Information System Successes [110]	2022	<i>Sustainability (Switzerland)</i>
Lee U.-K., Kim H.	UTAUT in Metaverse: An "Ifland" Case [111]	2022	<i>Journal of Theoretical and Applied Electronic Commerce Research</i>
Leone M.	The semiotics of religious space in Second Life® [112]	2011	<i>Social Semiotics</i>

Table 1. Cont.

Authors	Title	Year	Source Title
Liu F., Zhang Y., Zhao L., Dai Q., Liu X., Shi X.	A Metaverse-based Student's Spatiotemporal Digital Profile for Representing Learning Situation [113]	2022	<i>Proceedings of 2022 8th International Conference of the Immersive Learning Research Network, iLRN 2022</i>
Lukava T., Morgado Ramirez D.Z., Barbareschi G.	Two sides of the same coin: accessibility practices and neurodivergent users' experience of extended reality [114]	2022	<i>Journal of Enabling Technologies</i>
Mandolfo M., Baisi F., Lamberti L.	How did you feel during the navigation? Influence of emotions on browsing time and interaction frequency in immersive virtual environments [115]	2022	<i>Behaviour and Information Technology</i>
Marmaridis I., Griffith S.	Metaverse services: Extensible learning with mediated teleporting into 3D environments [116]	2009	<i>Lecture Notes in Business Information Processing</i>
Masferrer J.Á.R., Sánchez F.E., Hernández D.F.-O.	Experiences complementing classroom teaching with distance seminars in metaverses and videos [117]	2014	<i>Journal of Cases on Information Technology</i>
Mura G.	Analysing art, culture, and design in the digital age [118]	2015	<i>Analysing Art, Culture, and Design in the Digital Age</i>
Murray J.H.	Virtual/reality: how to tell the difference [119]	2020	<i>Journal of Visual Culture</i>
Nurhidayah N.N., Halim N., Basri M.	Analysing Student's Learning Outcome Using Systemic Approach [120]	2020	<i>Asian EFL Journal</i>
Otake K., Okamoto S., Akiyama Y., Yamada Y.	Magnitude estimation of self-speed under different visual cue conditions in virtual space [121]	2022	<i>LifeTech 2022—2022 IEEE 4th Global Conference on Life Sciences and Technologies</i>
Owens D., Mitchell A., Khazanchi D., Zigurs I.	An Empirical Investigation of Virtual World Projects and Metaverse Technology Capabilities [122]	2011	<i>Data Base for Advances in Information Systems</i>
Pamucar D., Deveci M., Gokasar I., Tavana M., Köppen M.	A metaverse assessment model for sustainable transportation using ordinal priority approach and Aczel-Alsina norms [123]	2022	<i>Technological Forecasting and Social Change</i>
Papagiannidis S., Bourlakis M., Li F.	Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses [124]	2008	<i>Technological Forecasting and Social Change</i>
Park S., Kim S.	Identifying World Types to Deliver Gameful Experiences for Sustainable Learning in the Metaverse [125]	2022	<i>Sustainability (Switzerland)</i>
Park S., Min K., Kim S.	Differences in learning motivation among Bartle's player types and measures for the delivery of sustainable gameful experiences [126]	2021	<i>Sustainability (Switzerland)</i>
Pham V.C., Luu Q.K., Nguyen T.T., Nguyen N.H., Tan Y., Ho V.A.	Web of Tactile Things: Towards an Open and Standardised Platform for Tactile Things via the W3C Web of Things [127]	2022	<i>Lecture Notes in Business Information Processing</i>
Pigultong M.	Cognitive Impacts of Using a Metaverse embedded on Learning Management System for Students with Unequal Access to Learning Resources [128]	2022	<i>2022 10th International Conference on Information and Education Technology, ICIET 2022</i>

Table 1. Cont.

Authors	Title	Year	Source Title
Power D., Teigland R.	Postcards from the Metaverse: An introduction to the immersive internet [129]	2013	<i>The Immersive Internet: Reflections on the Entangling of the Virtual with Society, Politics and the Economy</i>
Rapanotti L., Hall J.G.	Lessons learned in developing a second life educational environment [130]	2010	<i>CSEDU 2010—2nd International Conference on Computer Supported Education, Proceedings</i>
Rauschnabel P.A., Babin B.J., tom Dieck M.C., Krey N., Jung T.	What is augmented reality marketing? Its definition, complexity, and future [131]	2022	<i>Journal of Business Research</i>
Riar M., Xi N., Korbel J.J., Zarnekow R., Hamari J.	Using augmented reality for shopping: a framework for AR induced consumer behavior, literature review and future agenda [132]	2022	<i>Internet Research</i>
Riva G., Villani D., Wiederhold B.K.	Call for Special Issue Papers: HUMANE METAVERSE: Opportunities and Challenges Towards the Development of a Humane-Centered Metaverse [133]	2022	<i>Cyberpsychology, behavior and social networking</i>
Riva G., Wiederhold B.K.	What the Metaverse Is (Really) and Why We Need to Know about It [134]	2022	<i>Cyberpsychology, Behavior, and Social Networking</i>
Ronzani D.	IT Law: Will Law Transcend Metaverse? (Part 2) [135]	2022	<i>Jusletter IT</i>
Ronzani D.	Will Law Transcend into Metaverse? (Part 1) [136]	2021	<i>Jusletter IT</i>
Rospigliosi P.A.	Metaverse or Simulacra? Roblox, Minecraft, Meta and the turn to virtual reality for education, socialisation and work [137]	2022	<i>Interactive Learning Environments</i>
Sartamorn S., Oe H.	Metaverse Marketing for Community Development: Revitalisation of Traditional Industrial Sectors in Thailand [138]	2022	<i>Springer Proceedings in Business and Economics</i>
Sayem A.S.M.	Digital fashion innovations for the real world and Metaverse [139]	2022	<i>International Journal of Fashion Design, Technology and Education</i>
Schaf F.M., Paladini S., Pereira C.E.	3D AutoSysLab prototype: A social, immersive and mixed reality approach for collaborative learning environments [140]	2012	<i>IEEE Global Engineering Education Conference, EDUCON</i>
Schafer S.B.	Optimising cognitive coherence, learning, and psychological healing with drama-based video games [141]	2012	<i>Video Game Play and Consciousness</i>
Schlemmer E., Backes L.	Learning in metaverses: Co-existing in real virtuality [142]	2014	<i>Learning in Metaverses: Co-Existing in Real Virtuality</i>
Smaili N., de Rancourt-Raymond A.	Metaverse: welcome to the new fraud marketplace [143]	2022	<i>Journal of Financial Crime</i>
Smith P.	Black immigrants in the United States: Transraciolinguistic justice for imagined futures in a global metaverse [144]	2022	<i>Annual Review of Applied Linguistics</i>
Sofianidis A.	Why Do Students Prefer Augmented Reality: A Mixed-Method Study on Preschool Teacher Students' Perceptions on Self-Assessment AR Quizzes in Science Education [145]	2022	<i>Education Sciences</i>

Table 1. Cont.

Authors	Title	Year	Source Title
Solomon M.R., Wood N.T.	Introduction: Virtual social identity: Welcome to the Metaverse [146]	2014	<i>Virtual social identity and consumer behavior</i>
Spanò R., Massaro M., Ferri L., Dumay J., Schmitz J.	Blockchain in accounting, accountability and assurance: an overview [147]	2022	<i>Accounting, Auditing and Accountability Journal</i>
Spence C.	From the fairground sensorium to the digitalisation of bodily entertainment: commercialising multisensory entertainments involving the bodily senses [148]	2022	<i>Senses and Society</i>
Spivey W.A., Munson J.M.	Mot: Technology entrepreneurs in second life [149]	2009	<i>PICMET: Portland International Center for Management of Engineering and Technology, Proceedings</i>
Suh W., Ahn S.	Utilising the Metaverse for Learner-Centered Constructivist Education in the Post-Pandemic Era: An Analysis of Elementary School Students [150]	2022	<i>Journal of Intelligence</i>
Swilley E.	Moving Virtual Retail into Reality: Examining Metaverse and Augmented Reality in the Online Shopping Experience [151]	2016	<i>Developments in Marketing Science: Proceedings of the Academy of Marketing Science</i>
Tan T.M., Makkonen H., Kaur P., Salo J.	How do ethical consumers utilise sharing economy platforms as part of their sustainable resale behavior? The role of consumers' green consumption values [152]	2022	<i>Technological Forecasting and Social Change</i>
Tan T.M., Salo J.	Ethical Marketing in the Blockchain-Based Sharing Economy: Theoretical Integration and Guiding Insights [153]	2021	<i>Journal of Business Ethics</i>
Tan T.M., Saraniemi S.	Trust in blockchain-enabled exchanges: Future directions in blockchain marketing [154]	2022	<i>Journal of the Academy of Marketing Science</i>
Tarouco L., Gorziza B., Correa Y., Amaral E.M.H., Muller T.	Virtual laboratory for teaching Calculus: An immersive experience [155]	2013	IEEE Global Engineering Education Conference, EDUCON
Taylor C.R.	Research on advertising in the metaverse: a call to action [156]	2022	<i>International Journal of Advertising</i>
Tlili A., Huang R., Shehata B., Liu D., Zhao J., Metwally A.H.S., Wang H., Denden M., Bozkurt A., Lee L.-H., Beyoglu D., Altinay F., Sharma R.C., Altinay Z., Li Z., Liu J., Ahmad F., Hu Y., Salha S., Abed M., Burgos D.	Is metaverse in education a blessing or a curse: a combined content and bibliometric analysis [157]	2022	<i>Smart Learning Environments</i>
Uspenski I., Guga J.	Embodying metaverse as artificial life: at the intersection of media and 4E cognition theories [158]	2022	<i>Filozofija i Društvo</i>
Vázquez-Herrero J., Sirkkunen E.	Back to Fukushima: Perceptions and effects of an immersive journalism story [Regreso a Fukushima: Percepciones y efectos de una historia de periodismo inmersivo [159]	2022	<i>Profesional de la Informacion</i>

Table 1. Cont.

Authors	Title	Year	Source Title
Vernaza A., Armuelles V.I., Ruiz I.	Towards to an open and interoperable virtual learning enviroment using Metaverse at University of Panama [160]	2012	<i>Proceedings—2012 Technologies Applied to Electronics Teaching, TAE 2012</i>
Wagner R., Piovesan S.D., Passerino L.M., De Lima J.V.	Using 3D virtual learning environments in new perspective of education [161]	2013	<i>2013 12th International Conference on Information Technology Based Higher Education and Training, ITHET 2013</i>
Wallace M.	Virtual worlds, virtual lives [162]	2006	<i>PC World (San Francisco, CA)</i>
Wang F.-Y., Qin R., Wang X., Hu B.	MetaSocieties in Metaverse: MetaEconomics and MetaManagement for MetaEnterprises and MetaCities [163]	2022	<i>IEEE Transactions on Computational Social Systems</i>
Wang T., Okada S.	Human Relationship Advice System in Metaverse World: Application Propose of CTUP Model in Future Communication [164]	2022	<i>LifeTech 2022—2022 IEEE 4th Global Conference on Life Sciences and Technologies</i>
Wei D.	Gemiverse: The blockchain-based professional certification and tourism platform with its own ecosystem in the Metaverse [165]	2022	<i>International Journal of Geoheritage and Parks</i>
Wiederhold B.K.	Metaverse Games: Game Changer for Healthcare? [166]	2022	<i>Cyberpsychology, Behavior, and Social Networking</i>
Wiederhold B.K.	Ready (or Not) Player One: Initial Musings on the Metaverse [167]	2022	<i>Cyberpsychology, Behavior, and Social Networking</i>
Yong Y.J., Lee J.H., Kim Y.S.	A study on the possibility of a change in culture and arts education curriculum by shooting “METACLASSROOM” in the COIVD19 pandemic era [168]	2022	<i>Cypriot Journal of Educational Sciences</i>
Zaman U., Koo I., Abbasi S., Raza S.H., Qureshi M.G.	Meet Your Digital Twin in Space? Profiling International Expat’s Readiness for Metaverse Space Travel, Tech-Savviness, COVID-19 Travel Anxiety, and Travel Fear of Missing Out [169]	2022	<i>Sustainability (Switzerland)</i>
Zhou M., Leenders M.A.A.M., Cong L.M.	Ownership in the virtual world and the implications for long-term user innovation success [170]	2018	<i>Technovation</i>

4.1. Publication Trend

The research on the metaverse has been increasing since 2019, as shown in Figure 2. Although the first relevant paper was published in early 2007, it is only since 2019 that publications have begun to increase significantly, with a peak in 2021, which is also the year in which Mark Zuckerberg announced the change of name from Facebook to Meta. Publication trend renders the metaverse a young research field.

4.2. Most Relevant Sources

When looking at the sources overview, the analysis revealed 112 sources among journals, books, and conference proceedings, covering different fields, including marketing, management, economics, tourism and hospitality, engineering, communication, and technology.

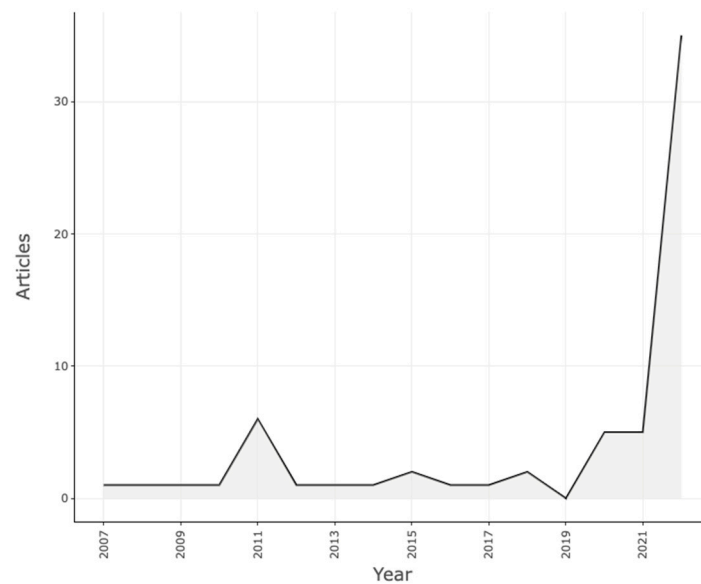


Figure 2. Timeline of the studies.

Figure 3 shows the sources that have published most documents on the topic. With seven documents published, the journal *Sustainability* published more research than any other journal. The series of conference proceedings *Lecture notes in business information processing* ranks second with four publications, followed by the *proceedings of 2022 8th International Conference of the immersive learning research network*, with four publications.

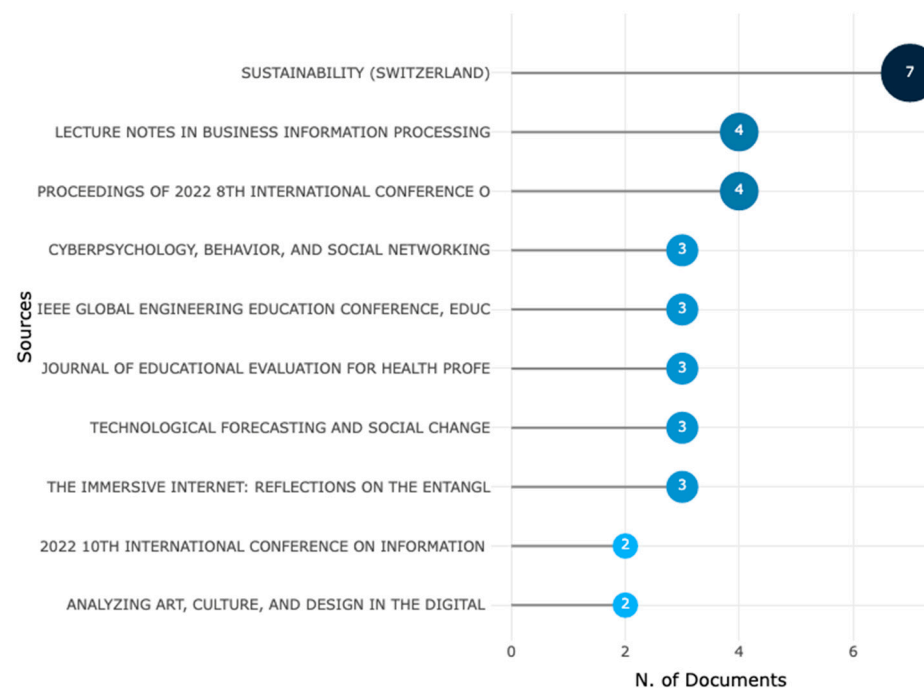


Figure 3. Most relevant sources.

4.3. Seminal Papers

Interesting findings emerged considering the most globally cited documents that allow us to identify the seminal articles according to the timeliness, utility, and quality expressed by the scientific community'. Figure 4 shows the number of author citations for each article, identifying seminal works. Two of the most popular bibliometric indicators used to determine an article's quality are the number of citations and the studies cited in an article. With

84 global citations, the article ‘Making real money in virtual worlds: MMORPGs and emerging business opportunities, challenges and ethical implications in metaverses’ [124] is the most cited, followed by ‘A content service deployment plan for metaverse museum exhibitions—Centering on the combination of beacons and HMDs’ [7] with 49 citations and ‘Web GIS in practice V: 3-D interactive and real-time mapping in Second Life’ [44], with 40 citations.

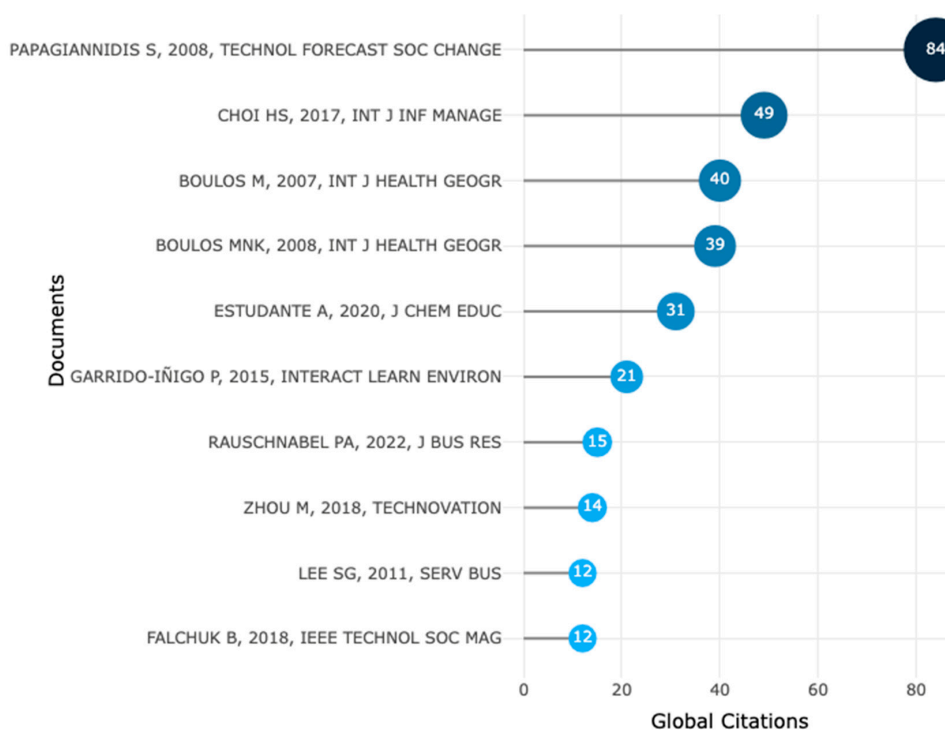


Figure 4. Most-cited articles [7,44,45,70,71,75,109,124,131,170].

Concerning the country’s scientific production, Figure 5 shows that publications on the topic in the USA amount to 44. The UK ranks second, with 36 publications, followed by South Korea with 29 documents and Italy with 19. The countries in blue on the map have published research on the topic. The more intense the colour, the greater the scientific production.

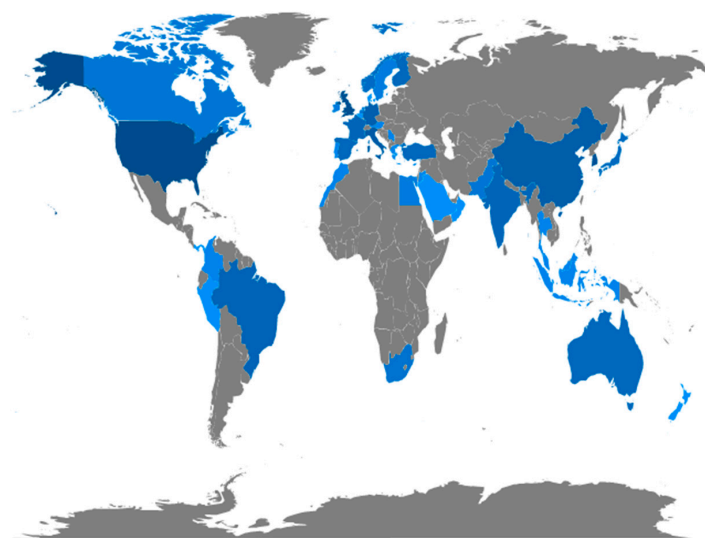


Figure 5. Country scientific production.

4.4. Themes and Streams of Research

Results can be summarised in various research themes, mapped in two-dimensional spaces: relevance degree (centrality) and development degree (density). The map classified the metaverse themes of research into four groups: motor themes, niche themes, emerging themes and basic themes (Figure 6). Motor themes and emerging themes were the most extensively populated areas.

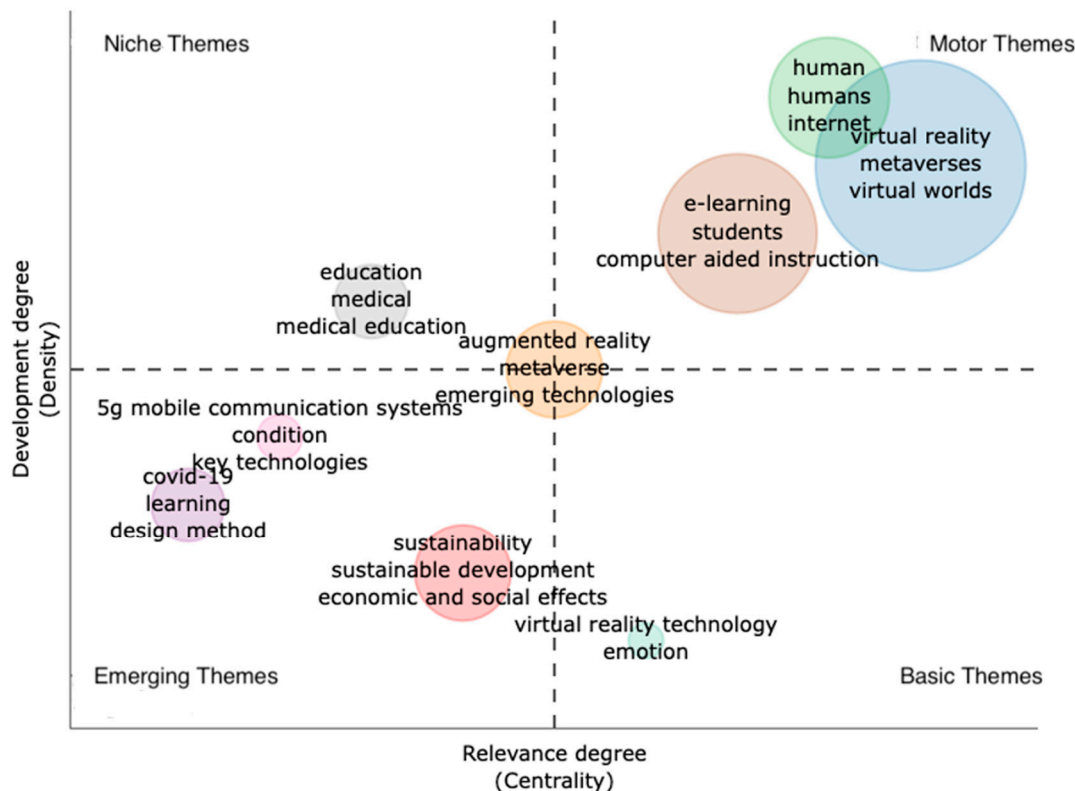


Figure 6. Thematic map of the metaverse research.

Motor themes (upper-right quadrant, strong centrality and high density) identify well-developed and relevant areas of academic investigation that can drive future research. As the study's main result, metaverses have been investigated as “virtual reality” and “virtual worlds”. The importance of adopting the metaverse as a virtual world useful for “e-learning”, “computer-aided instruction” and “human” perspective, represents another relevant aspect of the academic analysis.

Basic themes (lower-right quadrant, low centrality, high density) cover topics relevant to the research, but general. They, nonetheless, are potential areas of rapid development through further studies to address existing research gaps and to provide more comprehensive insights. They include “virtual reality technology” (as in the precedent quadrant) and “emotion” as a synthesis of marketing and consumer behaviour.

Emerging themes (lower-left quadrant, low density and low centrality), mainly representing themes such as “COVID-19”, and “key technology” such as “5g mobile communication system”; in addition, “sustainability”, “sustainable development” and “economic and social effects” have been reported in this area.

Niche themes (upper-left quadrant, high centrality, low density) contain very specialised topics that could be important for future research, such as “education”, “medical” and “medical education”.

Last but not least, the metaverse can be realised by exploiting augmented reality and other emerging technologies, as the intersection of the two axes shows.

Table 2 summarises the research themes and the corresponding number of documents.

Table 2. Themes and numbers of documents.

Research Themes	Number of Documents
virtual reality, metaverse, virtual worlds	29
e-learning, students, computer-aided instruction	25
sustainability, sustainable development, economic and social effects	17
augmented reality, metaverse, emerging technology	17
human, humans, internet	20
education, medical, medical education	10
COVID-19, learning, design method	10
5g mobile communication, condition, key technologies	8
virtual reality technology, emotion	6

Looking at the similarities, and combining convergent relevant themes, the analysis of the findings offers four relevant streams as a lens for interpreting the academic metaverse investigations (Table 3): key technologies, metaverse applications, marketing and consumer behaviour, and sustainable development.

Table 3. Streams and themes of the metaverse research.

Streams	Themes	Number of Documents
Metaverse technologies	<ul style="list-style-type: none"> - virtual reality, metaverse, virtual worlds - augmented reality, metaverse, emerging technology - 5g mobile communication systems, condition, key technology - virtual reality technology - internet 	54
Metaverse areas of applications	<ul style="list-style-type: none"> - e-learning, students, computer-aided instruction - education, medical, medical education - COVID-19, learning, design method 	45
Marketing and consumer behaviours	<ul style="list-style-type: none"> - emotion - human, humans 	26
Sustainable development	<ul style="list-style-type: none"> - sustainability, - sustainable development - economic and social effects 	17

5. Discussion

5.1. Metaverse Technologies

The paper underlines the metaverse as a combination of different technologies [10] identified in the detected literature [11,16,106,171]. If, on the one hand, the literature has focused on existing and consolidated technologies such as virtual reality and virtual worlds that make up “motor themes” and represent the condition for the existence of the metaverse, on the other hand, authors are beginning to explore new and emerging technologies such as 5g mobile communication, blockchain, digital twins, and the internet of things that make up “emerging themes”, and represent the conditions for the future development of the metaverse.

The metaverse world can exploit several opportunities in the coming years. The access point for the metaverse requires multisensory interactions with several technologies: virtual environments, digital objects and people immersive technologies, virtual reality (VR), augmented reality (AR), mixed reality (MR) and extended reality (XR) [172]. These technologies support the creation of the metaverse and facilitate immersive experiences in the digital world. Virtual reality technology provides users with a connected experience in the metaverse. On the other hand, augmented reality expands the use of virtual reality by overlaying digital information onto the physical environment. XR is an extended reality, a term used to include VR, AR, and MR. XR is used for virtual commerce or v-commerce to create computer-mediated indirect experiences [125].

Blockchain technology plays a crucial role, and provides a decentralised infrastructure for the metaverse, which develops robust use cases for its ecosystem [173]. It ensures data quality, privacy and security in the metaverse, and provides a complete economic system, allowing virtual goods to become physical objects [90].

Artificial intelligence (AI) plays different roles in automating the metaverse ecosystem, from traditional machine learning algorithms to advanced deep learning networks. By merging with other key technologies, AI works behind the scenes to create secure, scalable, and realistic virtual worlds on a reliable and always-on platform, guaranteeing the reliability of infrastructure, facilitating user interaction and supporting the content creation process [174].

The internet of things (IoT) is a technology that acts as a medium connecting the real world with the internet via computing devices for sensing and communication. They allow the sharing and receiving of information replicating the physical world in the metaverse more efficiently. The combination of immersive technologies and internet-of-things is described as XR-IoT (XRI). XRI creates a hyper-connected environment and improves the relationships between humans and objects and human-to-human relationships [175].

Lastly, digital twins—which establish a virtual twin of a real-world object by utilising real-world data to predict the expected behaviour of the real-world object [176]—are used in the metaverse to mirror the real world onto the virtual world [172]. The essence of this process is to enable the collection of data that help create simulations to model how a given product, process, or service would perform in the real world, providing trial solutions to unsolved issues.

5.2. Metaverse Areas of Application

The immersive characteristics of the metaverse play a key role in triggering companies in various fields to innovate their business model [104,177]. Due to the integration of different technologies, the possible applications of the metaverse range from the industrial field to several areas. Consumer goods, healthcare, hospitality, education and retail, gaming, and other forms of entertainment (including art shows and concerts), represent other significant groups of metaverse applications. Scholars have investigated in depth the different areas of application of the metaverse. Some fields already constitute consolidated research topics (e.g., e-learning), while others are still emerging (e.g., tourism) or are reducing their relevance (e.g., COVID-19).

As a ‘motor theme’, many authors emphasise the potential of the metaverse for technology-enhanced education and learning, due to the possibilities of the immersion experience, collaboration, and interaction [73,71]. Among the first application areas there are laboratory simulations (e.g., safety training), procedural skills development (e.g., surgery), AR-based training, language learning and management systems [7,63,100,178,179]. In the manufacturing sector, the metaverse can help train employees on safety precautions, foster participation in the simulation of risk scenarios, and facilitate the development of products and processes [10].

More ‘emerging themes’ are related to consumer goods and services. For example, fashion labels and retail chains are using the metaverse extensively. They exploit the metaverse technologies to create new products (e.g., 2D and 3D design and rendering);

virtual events; collaboration and partnership, and enhance the customer experience and journey (e.g., virtual shopping, virtual try-on, digital twin stores and showrooms [180,181].

In the hospitality and tourism field, companies are capitalising on the metaverse to create tourism experiences, such as virtual flights, hotel experiences, destinations visits, and tours, but also to enhance real-life customer experience and attract new visitors [3,182,183].

A very specialised application of the metaverse is that related to the healthcare sector, which constitutes a 'niche theme' for scholars. The best example of metaverse applications is the prevention and treatment of clinical conditions, education, training, and research. The metaverse has emerged as a vital technology for empowering medical students' skills and knowledge. In addition, different technology, such as digital twins, can be adopted to monitor patients' health conditions directly at home, connecting real life with the virtual world [184,185].

5.3. Marketing and Consumer Behaviours

Marketing in the Metaverse is a field of study that has attracted a lot of the attention of scholars, to the point of being present both in 'motor themes' and 'basic themes'. According to several authors, the metaverse is likely to have a significant and direct impact on both customers and businesses, changing customer relationships, advertising, communication [11], customer decision-making processes [16], customer experiences and service co-creation processes [3].

Among the 'basic themes', particular attention has been paid to experiences mediated by the metaverse. Two dimensions can describe the metaverse experience: interactivity (high or low) and type of motive (hedonic or functional) [3]. According to these dimensions, different immersive experiences can be created, such as virtual shopping and retailing [132], augmented physical experiences, teaching and learning experiences, virtual classrooms [78], virtual exhibitions [7], and virtual smart cities and tourism destinations [182].

On the other hand, everything related to consumer behaviour constitutes a 'motor theme'. According to some authors, metaverse dynamics changed the traditional consumer journey, which begins with awareness and ends in purchase and loyalty and is intended more as a stream than a process marked by predetermined phases [3]. In this stream of engagement, individuals can interact with the metaverse-scape, have immersive experiences and experience virtual consumption of products and services [16]. In addition, observable changes in consumer behaviours can be directly associated with changes in the metaverse [3,16,18]. Changes may affect customers' attention toward products and services, buying behaviour, perceived value and value propositions, choice preferences, consumption patterns, and decision-making processes [3].

5.4. Sustainable Development

Sustainability, sustainable development, and the economic and social effects of the metaverse represent 'emerging themes' for scholars [41,106,125]. According to the authors, the metaverse affects them in different and multiple ways regarding resource management, governance, quality of life, social interaction, cultural heritage conservation and preservation. A recent and challenging line of studies is smart urbanism and the potential contributions of the metaverse to smart cities. In the metaverse, the virtual dimension of smart cities focuses on environmental, economic, and social sustainability goals [41,186].

The social and economic effects of this extended reality have also been a concern for scholars [41]. If, on the one hand, the metaverse helps to decrease demand for physical infrastructure, minimises waste, enhances accountability and transparency, and ensures more equitable access to services, on the other hand, different challenges emerge. In particular, concerns about energy consumption and carbon emissions of compute-intensive transactions have come to the fore, despite substituting physical goods with digital ones and replacing a real-world presence with virtual interactions.

The focus has also been on the metaverse's ethical, moral, human, and cultural influence on the quality of human social interactions and its prospective scope in reconstructing

the quality of life. This is due to the absence and confusion of the corresponding moral norms, which conflict with the ethical norms of the whole society [10].

6. Conclusions

This paper contributes to the academic debate on the metaverse by analysing, discussing, and synthesising the existing literature on the topic. This research provides an overarching picture of what has already been studied. It identifies four streams of research: metaverse technologies, metaverse areas of application, and marketing and consumer behaviours and sustainability.

The research designs consolidated research streams and opens up emerging but undeveloped streams for future research that academics and practitioners should explore. It also contributes towards a systematic advancement of knowledge in the field of metaverse investigation, and provides some preliminary theoretical contributions, shedding light on future research avenues. Moreover, the paper offers preliminary insights into business opportunities and challenges.

Firstly, the paper confirms the metaverse as a combination of different existing and emerging technologies, such as VR, AR, MR, digital twins, blockchain, and AI. Metaverse technologies connect interoperable virtual worlds, allowing users to switch worlds cross-platform while maintaining their digital properties, purchases, and identities [10]. They open new scenarios for immersive experiences and provide new business spaces and challenges.

Secondly, the paper sees the metaverse as composed of several digital spaces and experiences currently being created by companies to offer more realistic and immersive digital experiences, enhance simulations and training, and foster remote working, teaching and learning. Among the different applications, the use of the metaverse in healthcare, education and training, and tourism, will be of particular importance in the future.

Thirdly, researchers are called to examine the metaverse's transformative impact on marketing and consumer behaviours, which deserve particular interest on the part of academics and practitioners. In particular, scholars should explore ways to promote user purchasing decisions, assess and evaluate consumer attitudes and behaviours in the metaverse, and create an experience in the metaverse-scape. In this sense, new forms of communication and marketing models are challenging practitioners. Because the metaverse is interactive and involves embodied users through avatars, the original interactivity models might need to be updated by including, for example, the second or embodied self-perspective [11].

Finally, the paper suggests sustainability and sustainable development as an emerging stream of research in which to invest for the future of firms and cities. It would be fascinating for scholars to be able to understand whether or not the metaverse opens up new dimensions of sustainability, or if it is just a fad linked to the greater opportunities for publication in this sector.

Furthermore, although the metaverse could have potential benefits for different sectors, the paper also underlines its dark side, which scholars should consider in future studies. Governance, ethics, information security issues, and data privacy are the biggest concerns and threats to the rise of the metaverse that need to be addressed in future research.

This study has limitations to be considered in future research. Firstly, the systematic literature review only includes English articles, as the metaverse is an emerging research topic, especially in Asian countries; other languages should also have been included to deepen the understanding of the topic. Secondly, this research was conducted on the database Scopus of Elsevier. Researchers could use a combination of different databases and keywords to search for new contributions and insights. Thirdly, although the paper adopts a systematic literature review, this methodology reveals the subjectivity in the social sciences. As this is a relatively young field of research, a further academic investigation is needed to overcome the study's limitations and outline new scenarios and directions for future research.

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