

Metaverse and immersive technologies in supply chain management and operations: A systematic review of research trends, theories, and future directions

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Abstract

The metaverse and related immersive technologies are increasingly discussed as enablers of digital transformation in supply chain management and operations (SCM&O), yet the research base has not been systematically mapped. This study reviews how the field has developed, which research approaches and theories it uses, and where future research is needed. A systematic literature review was conducted on Scopus for the period 1996 to 2025, following the protocols of Tranfield and colleagues and the PRISMA framework. Thirty eight peer reviewed articles in ABDC listed journals (ratings A*, A, and B) were selected using predefined inclusion and exclusion criteria, and VOSviewer was used for complementary bibliometric analysis. Publication activity was sporadic before 2020 and peaked in 2023, with contributions concentrated in the United States, the United Kingdom, and India. Conceptual studies (10), systematic reviews (7), analytical and mathematical modelling (7), and mixed methods studies (6) dominate, while case based and quantitative studies are scarce. Thirty one of the 38 studies (81.6 percent) report no explicit theoretical foundation, and game theory and the technology organization environment framework are the only theories used more than once. The synthesis identifies seven research directions: theory development, empirical and methodological strengthening, geographic and sectoral expansion, technology integration, sustainability and resilience, governance, security and trust, and human and organizational dimensions. The findings should be read with caution because the search used a single database and a journal rating filter.

Keywords: Metaverse, Supply Chain Management, Operations Management, Immersive Technologies, Systematic Literature Review, Bibliometric Analysis, Digital Transformation

JEL Classification: M11, M15, L23

1. Introduction

The global metaverse market size was valued at USD 132.60 Billion in 2024. Looking forward, IMARC Group estimates the market to reach USD 1583.87 Billion by 2033, exhibiting a compound annual growth rate (CAGR) of 36.35% from 2025-2033. North America currently dominates the market, holding a market share of over 43.80% in 2024 (IMARC Group, 2024). In 2024, the United States accounts for 86.70% of the North America metaverse market. Rapid advancements in “virtual reality (VR)”, “augmented reality (AR)”, “blockchain (BC)”, and “cloud computing (CC)”, the increasing user interest and engagement with immersive digital experiences, online gaming, and social media platforms, improved internet connectivity, and the rising desire for immersive and personalized experiences are some of the major factors propelling the market (IMARC Group, 2024). North America is expected to hold the largest metaverse market share due to rising investments in metaverse platforms by leading players such as “Meta”, “Roblox Corporation”, “NVIDIA Corporation”, and others (Fortune Business Insights, 2025). The Metaverse market holds vital potential worldwide. The metaverse market is booming globally, with countries such as “USA”, “China”, and “Japan” leading the way in terms of technological advancements and user adoption (Statista, 2024). The advent of “non-fungible tokens (NFTs)” and the digital asset economy is driving the growth of the market. The increasing preference for virtual events and entertainment is another major driver for the market (IMARC Group, 2024). The market is subjected to several challenges, such as “security concerns”, “lack of awareness”, government rules & regulations, and others. Also, leading industry players have incurred losses worth billions of dollars owing to cyberattacks in the virtual environment. This factor, along with high “sensitivity issues” in the “virtual environment”, may hinder the market expansion (Fortune Business Insights, 2025). In 1992, the term Metaverse was coined in Neal Stephenson’s literary work *Snow Crash* (Stephenson, 1992), where it was visualised as a black spherical planet accessible to users through terminals with integrated VR potential via which users can emerge as avatars (Dolgui & Ivanov, 2023). It involves the use of avatars supported by smart devices (i.e. smartphones, tablets, smart glasses, headsets, etc.) and a set of cutting-edge technologies such as “artificial intelligence (AI)”, “simulation”, “VR”, “AR”, “extended reality (XR)”, “BC” and “digital twin (DT)”, which allow connection and interaction between people to perform different activities (Dwivedi et al., 2023; Park & Kim, 2022).

“Metaverse” in “tourism” will primarily take advantage of “mixed reality (MR)”, integrating “VR” and “AR” with a range of new technologies to effectively blend the “physical and virtual worlds” (Dwivedi et al., 2023). Specialized metaverse tourism organizations are expected to integrate physical and virtual experiences across the customer journey, supported by wearable technologies, the “internet of bodies (IoB)”, and the “internet of senses (IoS)” enabled by future “6G networks” (Ericsson, 2020). The “internet of things (IoT)” and the “internet of everything (IoE)” will increasingly integrate resources in a metaverse environment (Buhalis, 2020).

The “Metaverse” can transform multiple “SC activities”, including “manufacturing”, “purchasing”, and “warehouse management”, particularly by enabling greater “product and service customization” and more personalized customer experiences (Ng et al., 2015; Spanaki et al., 2018). In “purchasing”, the metaverse can improve “SC transparency”, “visibility”, and “responsiveness”, thereby supporting more effective purchasing decisions involving direct and indirect suppliers (Williams et al., 2013). In “warehouse management”, “VR” and “AR” can enable “virtual simulation” and “optimization” of warehouse designs before physical construction, improving storage and inventory planning (Hassan et al., 2015). The “Metaverse” remains in an early stage of development across organizations and “SC”, despite rapidly increasing investments by technology companies and governments worldwide. The study highlights its potential, opportunities, and challenges for “OSCM” (Queiroz et al., 2023). The study examines the impact of the metaverse on “SCOM” and proposes a socio-technological framework based on structured literature analysis and concepts including “cyber physical system (CPS)”, “digital SC twins”, “cloud SC”, and “Industry 4.0/5.0 (I4.0/ I5.0)” (Dolgui & Ivanov, 2023).

To provide an overview of the research activities concerning AR in some shop floor operations, a total 96 relevant papers are reviewed for the period from 2011 to 2018. The paper highlights the state of the art, the current challenges, and future directions of manufacturing related to the AR research through a systematic literature review and a citation network analysis (Egger & Masood, 2020). The study systematically reviews 96 papers (2011-2018) on AR applications in manufacturing shop-floor operations, identifying the research landscape, challenges, and future directions through “SLR” and “citation network analysis (CNA)” (Egger & Masood, 2020). Despite its potential, the “Metaverse and related immersive technologies” raises concerns related to “privacy”, “security”, “regulation” and “governance”. However, research on its role in “Supply Chain Management and Operations (SCM&O)” remains relatively limited, with much of the existing literature focusing on “technological” and “consumer-oriented” applications. Systematic reviews specifically addressing the Metaverse and related immersive technologies in “SCM&O” are also limited. This study therefore conducts a “Systematic Literature Review (SLR)” of metaverse and related immersive technologies published between 1996 and 2025 to examine the development of the field, its “methodological” and “theoretical foundations”, and directions for future research. The review addresses three research questions:

RQ1: What are the publication trends and key contributors, including journals, authors, institutions and countries, in research on the metaverse and related immersive technologies in SCM&O?

RQ2: What research methodologies, theoretical foundations and key findings characterize the existing literature on the metaverse and related immersive technologies in SCM&O?

RQ3: What future research directions can be identified for advancing research on the metaverse and related immersive technologies in SCM&O?

To address these questions, the study applies a systematic review protocol and predefined study-selection criteria. The remainder of the paper is organized as follows. Section 2 describes the research methodology, review protocol and literature selection process. Section 3 presents the descriptive analysis of the reviewed literature. Section 4 synthesizes the research methodologies and theoretical foundations identified in the selected studies and summarizes their key findings. Section 5 discusses future research directions. Section 6 presents the bibliometric analysis. Section 7 discusses the main findings and managerial implications. Finally, Section 8 outlines the limitations and conclusion.

2. Research Methodology

This study employs a “SLR” to synthesize research on the metaverse and related immersive technologies in “SCM&O”. The review follows Tranfield et al. (2003), Denyer & Tranfield (2009), and the PRISMA framework (Moher et al., 2009). The review protocol, including the “database”, “search strategy”, “publication period”, “eligibility criteria”, “quality assessment” and “data extraction” procedures, is presented in Table 1.

2.1 Research Protocol

Table 1. Research Protocol

Research protocol	Details description
Research online databases	Searches were conducted in Scopus
Publication types	The initial search covered all available publication types, including journal articles, review articles, conference papers, conference reviews, books and book chapters. The final sample was restricted to peer-reviewed journal articles and review articles that satisfied the predefined inclusion criteria.
Language	Only publications in English were considered.
Date (Year) range	1996-2025
Search fields	Title, abstracts and keywords
Search Keywords (Syntax)	TITLE-ABS-KEY (("metaverse" OR "metaverse technology" OR "extended reality" OR "virtual reality" OR "augmented reality" OR "mixed reality") AND ("operations management" OR "supply chain management"))

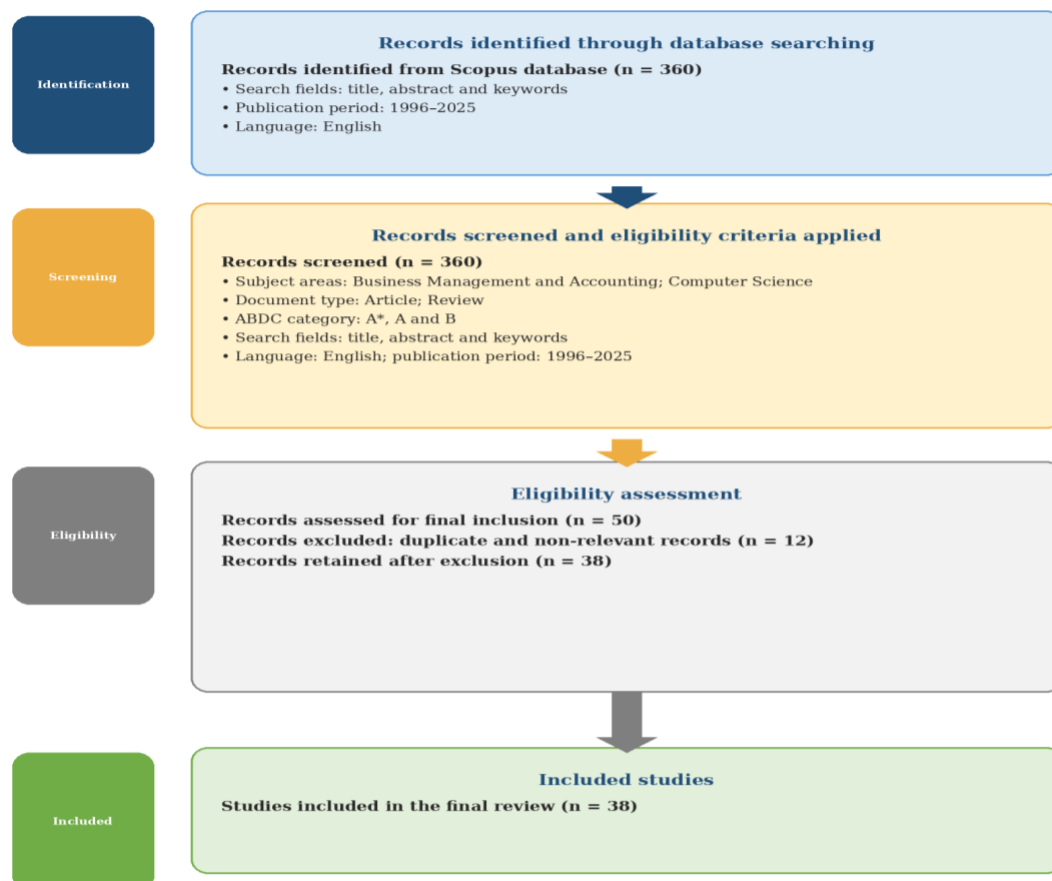
Inclusion criteria	Subject area- Business Management and Accounting, Computer Science Document type- Article, Review Category- ABDC (A*, A and B are considered)
Exclusion criteria	Document type- Conference paper, Conference review, Book chapter

Source: Authors' work

2.2 Literature Selection Process

Scopus was selected as the sole database because of its “multidisciplinary” coverage of “management”, “operations”, “SC” and “technology-related” research and its suitability for “bibliometric analysis”. This provided a consistent basis for “literature retrieval” and analysis.

Figure 1. PRISMA 2009 Flow Diagram for the Study Selection



Source: Authors' work

3. Descriptive Analysis of the Literature

3.1 Publication Trends

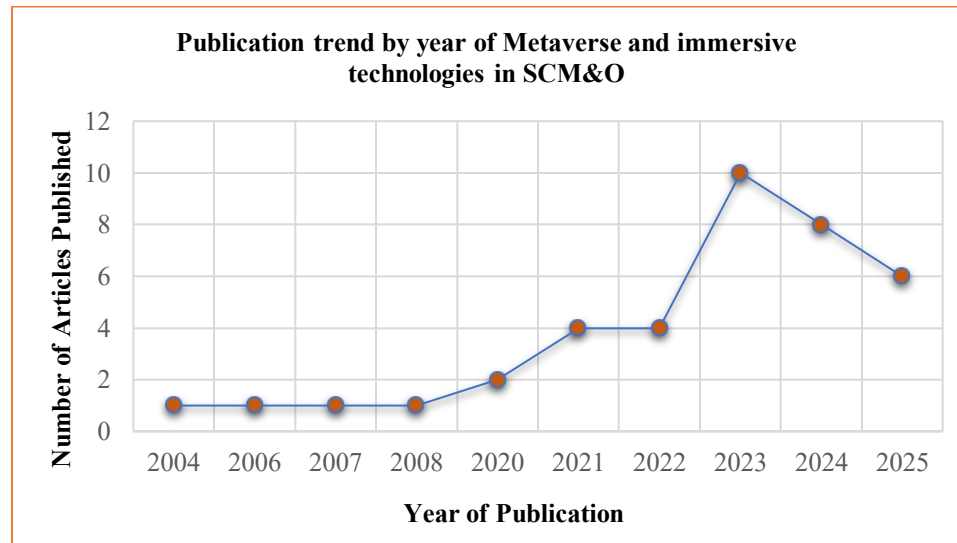
Table 2. Articles Publication Trend of Metaverse and immersive technologies in SCM&O

Year of Publication	Number of Articles Published
2004	1
2006	1
2007	1
2008	1
2020	2
2021	4
2022	4
2023	10
2024	8
2025	6

Source: Authors' work

Table 2 shows the publishing trend over the years in the “Metaverse and related immersive technologies” in “SCM&O”. Publication activity was sporadic before 2020, followed by a marked increase from 2020 onward. The field reached its highest annual output in 2023 with 10 studies, followed by 8 studies in 2024 and 6 in 2025. This pattern reflects increased scholarly attention to “Metaverse and related immersive technologies-enabled SCM&O”, although publication counts alone cannot establish whether the field has matured or whether later studies are more in-depth.

Figure 2. Publication trend by year of Metaverse and immersive technologies in SCM&O



Source: Authors' work

Figure 2 has the same information (Publication trend as displayed by Table 2), but is plotted in a more pictorial representation, which is more likely to convey the direction of the change. The activity in the early years is shown as a flat line, highlighting the lack of significance of the “Metaverse and related immersive technologies” in “SCM&O” during this time. The steep increase starting in 2020 is due to its sudden relevance, with the highest increase taking place in 2022-23. This is a graph that highlights the dramatic impact of the surge, how it quickly went from a field of little renown to a forefront field. Important too is that the “Metaverse and related immersive technologies” isn't going away anytime soon, but the frenzy and hype are being replaced by a more measured rate of “scholarly output” in 2024 and 2025. The figure thus serves as a complement to the first, making these both visual representations of the dynamics of growth and of decline and confirming the story of the novelty of the field and its maturation.

3.2 Journal Distribution

Table 3. Journal Distribution of Studies on Metaverse and immersive technologies in SCM&O

Journal Name	Year of Publication										Total
	2004	2006	2007	2008	2020	2021	2022	2023	2024	2025	
International Journal of	1		1			1		2		1	6



Production Research				
Transportation Research Part E: Logistics and Transportation Review	1	1	1	3
IEEE Transactions on Engineering Management		1	3	4
International Journal of Production Economics	1	1		2
Journal of Cleaner Production		1		1
Production Planning and Control	1			1
Supply Chain Management: An International Journal	1			1
International Journal of Operations & Production Management	1	1		2
Computers and Industrial Engineering		1		1



Decision Support Systems	1	1
Technological Forecasting and Social Change	1	1
Asia Pacific Journal of Marketing and Logistics	1	1

Source: Authors' work

Table 3 continued. Journal Distribution of Studies on Metaverse and immersive technologies in SCM&O

Journal Name	Year of Publication										Total
	2004	2006	2007	2008	2020	2021	2022	2023	2024	2025	
Journal of Innovation and Knowledge								1			1
Journal of Computer Information Systems							1				1
International Journal of Consumer Studies								1			1
European Journal of Marketing					1						1
Journal of Retailing and								1			1



Consumer Services												
Benchmarking: An International Journal						1			1		2	
Journal of Intelligent Manufacturing				1								1
International Journal of Computer Integrated Manufacturing						2					2	
Journal of Manufacturing Technology Management									1		1	
Management Review Quarterly					1							1
Journal of Islamic Marketing									1		1	
Journal of Management Education				1								1
Total	1	1	1	1	2	4	4	10	8	6	38	

Source: Authors' work

The literature is distributed across journals spanning “operations management (OM)”, “manufacturing”, “SCM”, “technology management” and related disciplines, indicating the interdisciplinary nature of metaverse research in “SCM&O”. Various journals have contributed to the area of “Metaverse and related immersive technologies” in “SCM&O” with a maximum of 6 by International Journal of Production Research.

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3.3 ABDC Distribution

Table 4. Distribution of Reviewed Studies by ABDC Journal Category

ABDC Category	Number of documents published	Percentage
A*	5	13.16
A	24	63.16
B	9	23.68
Total	38	100

Source: Authors' work

The number of documents published according to ABDC category are mostly from A (24), then B (9), followed by A* (5). The predominance of A-ranked (63.16%) and A*-ranked (13.16%) journals indicates that the research on metaverse and related immersive technologies in “SCM&O” is increasingly being published in high-quality academic outlets. However, the relatively small proportion of A*-ranked publications suggests that the field is still evolving and offers considerable scope for future high-impact research.

3.4 Leading Authors

Table 5. Leading Authors Contributing to Metaverse and immersive technologies in SCM&O

Author	Number articles published
Tan, G.W.H.	3
Ooi, K.B.	3
Wong, L.W.	2
Treiblmaier, H.	2
Sadeghi, R., K.	2
Rajeb, A.	2
Ojha, D.	2

Lee, V.H.	2
Keogh, J.G.	2
Ivanov, D.	2
Dolgui, A.	2

Source: Authors' work

The main Authors contributing to the area of “Metaverse and related immersive technologies” in “SCM&O” are Garry Wei-Han Tan and Keng-Boon Ooi each with 3 articles published, while other leading authors have published 2 articles each respectively.

3.5 Country-wise Distribution

Table 6. Top Countries contributing to Metaverse and immersive technologies in SCM&O

Country	Number of articles published
USA	10
UK	10
India	9
France	7
China	6
Malaysia	4
South Africa	3
Germany	3
Uzbekistan	2
UAE	2

Source: Authors' work

The country-wise distribution of publications reveals that the “USA” is the largest contributor to metaverse and related immersive technologies in “SCM&O”, followed by the “UK”, “India”,

“France”, and “China”. The concentration of research within these countries suggests that the field is “predominantly” driven by developed and rapidly digitalizing economies. Future studies should explore “metaverse and related immersive technologies” adoption in “underrepresented” regions to enhance the “diversity” and “applicability” of the research findings.

3.6 Institutional Distribution

Table 7. Institutions contributing to the area of Metaverse and immersive technologies in SCM&O

Name of the Institution	No. of affiliations
Swinburne University of Technology Sarawak Campus	3
UCSI University	2
Swansea University	2
CNRS Centre National de la Recherche Scientifique	2
University of Reading	2
North Carolina Agricultural and Technical State University	2
Széchenyi István University	2
Yunnan Normal University	2
University of North Texas	2
North-West University	2
Hochschule für Wirtschaft und Recht Berlin	2
British University in Dubai	2
Tashkent State University of Economics	2
Universiti Tunku Abdul Rahman	2
MODUL University Vienna	2
Université de Bordeaux	2

Symbiosis International (Deemed University)	2
Henley Business School	2
Laboratoire de l'Intégration du Matériau au Système	2
Dijlah University College	2
IMT Atlantique	2
TBS Business School	2
Laboratoire des Sciences du Numérique de Nantes	2
Birla Institute of Management Technology Greater Noida	2
Symbiosis Institute of Business Management, Pune	2
School of Management	2
Xiamen University Malaysia	2

Source: Authors' work

4. Synthesis of the Reviewed Studies

4.1 Summary of the Reviewed Studies

The selected studies were reviewed based on their “research methodologies”, “theoretical foundations” and “principal findings”. This assessment provides an overview of how metaverse and related immersive technologies has been examined in “SCM&O”. Table 8 summarizes the methodology or theoretical foundation reported in each study and its principal findings.

Table 8. Methodologies, Theoretical Foundations and Key Findings of Studies on Metaverse and immersive technologies in SCM&O

Author(s)	Methodologies/ Theoretical Foundations	Key Findings
(Tang* & Qiu, 2004)	Mathematical Modelling,	Higher order volumes increase pressure on system resources. The proposed approach dynamically manages multiple orders and adjusts “VPLs”

	Simulation, and Case Study	speeds according to “machine conditions” and “shop-floor capacity”, improving “machine utilization” and reducing “order tardiness”.
(Seifert et al., 2006)	Mathematical Modelling	The “optimal” wholesale price initially increases with the “no. of retailer stores (N)”, as the manufacturer can stimulate retailer inventory by reducing “inventory” at the “virtual store”. Beyond a certain “N”, the “optimal” wholesale price decreases and gradually approaches the level observed in the “non-coordinated dedicated SC”.
(Molina, et al., 2007)	Conceptual Study	The study proposes a framework for establishing and managing “virtual enterprises”, drawing on the concepts of “virtual industry clusters” and “virtual enterprise brokers”.
(Chokshi & McFarlane, 2008)	Conceptual Study	The findings suggest that “hierarchical control” is effective under “stable” production conditions but becomes less responsive to frequent product changes and demand disturbances. The proposed approach maintains “hierarchical stability” while enhancing system “flexibility” and reconfigurability by distributing “control functions” across adaptable process elements.
(Netland et al., 2020)	Mixed Methods Research	The findings indicate that “VR” can be integrated into “OM” education at relatively low cost, while enhancing student’s perceived learning experiences through active and guided “discovery-based learning”.
(Cai & Lo, 2020)	SLR and CNA	The findings identify gaps in existing “omnichannel” research and propose the “Prescribed Framework for Omnichannel Management (PFOM)”, extending the existing framework by incorporating “omnichannel SCM” and “omni-technology management” domains.

(Rejeb, et al., SLR 2021a)	The findings indicate that “AR” creates value across five key areas: “warehousing”, “manufacturing”, “sales and outdoor logistics”, “planning and design”, and “human resource management (HRM)”. Despite its long-standing development, “AR” remains an emerging technology in “SCM research”, with growing academic interest and publication activity.
(Rejeb, et al., SLR 2021b)	Europe dominated “smart-glasses research” in “logistics and SCM (53.33%)”; Germany contributed 24 of 82 publications. “Asia”, “North America” and “Oceania” accounted for 29.52%, 13.33% and 2.85%, respectively.
(Muñoz-Leiva et al., 2021) Co-word and thematic network analyses, Text mining approach, and Topic modelling	Key merchandising areas included “branding”, “retail”, “consumer behaviour”, “modelling”, “textiles and apparel”, and “visual merchandising”. Simulation tools such as “computer-aided design (CAD)” were also increasingly discussed in “clothing-sector SC”.
(Bressanelli et al., 2021) SLR	“Digitalization”, “government intervention” and “user participation” emerged as key “circular economy (CE) enablers”. “CE enablers” and “levers” appeared in 92% and 71% of studies, respectively; only nine studies addressed all three levers. Environmental benefits received more attention than “economic” and “social” benefits.
(Salvini et al., 2022) Mixed Research Methods	The findings identify “limited collaboration”, “weak customer orientation”, “low urgency”, and “insufficient understanding” of “virtualization” as major sector-wide barriers. “Game-based validation” showed improved awareness of virtualization benefits among 87% of participants, while 89% demonstrated greater willingness to collaborate after the sessions.

(Asokan et al., 2022)	Viewpoint		The study highlights seven technologies: big data analytics (BDA), “DT”, “AR”, “BC”, “three-dimensional (3D) printing”, “AI”, and “IoT” as key enablers of “socially responsible operations”. These technologies can support organizational social performance through improved employment practices, health and safety, and business practices, while also contributing to community outcomes such as “social welfare”, and “economic development”.
(Bhattacharya & Chatterjee, 2022)	Mixed Research	Methods	The findings suggest that Fourth Industrial Revolution (4IR) technologies can significantly transform Architecture, Engineering, Construction and, Operations and Maintenance (AECO) SCs by improving delivery “effectiveness”, “productivity”, “cost efficiency”, “monitoring”, “agility”, “workflow management”, and “waste reduction”. The study proposes an “integrated framework” incorporating technologies such as “IoT”, “CC”, “BD”, “smart factories”, “3D printing”, “CPS”, “AR”, “VR”, and “robotics” to achieve these objectives.
(Feng & Jin, 2022)	Mathematical Modelling, Theory	Game	The findings indicate that under “reselling”, “manufacturer-led innovation” can benefit both SC parties when its effectiveness matches that of platform innovation, supporting policy incentives for manufacturer innovation. Under “agency selling”, profitability depends on the “platform’s commission rate”.
(Kim & Lee, 2023)	Bibliometric Analysis, Modelling	Topic	The findings indicate that “mass customisation (MC)” was explained in terms of the “business and marketing strategy (BMS)” and the “OM”, in accordance with technological development. In BMS, MC topics moved from demand uncertainty to industry transformation. In “OM”, topics

		changed from assembly line for product differentiation to “additive manufacturing”.
(Singh et al., 2023)	Conceptual Study	The study describes only three main uses of I4.0: design, “monitoring”, “machining”, and “control”. Conventional design has grown smarter with technological advances such as “VR” and increased realism (AR). The introduction of “VR prototyping” utilizing additive manufacturing methods has hybrid prototyping. Smart machine tools have “built-in CPS” to enable their ability to capture and transport the real-time data for syncing machine tools and services to a central cloud system to deliver smart production solutions. One major use of “smart control” is to manage many “smart devices” or equipment through a cloud-based platform. “I4.0” may completely transform manufacturing processes if targeted at diverse industry deployments of diverse technologies. Numerous technology advancements, including “CPS”, large-scale data analysis, “CC”, “modelling”, and “simulation”, help smart “decision-making”.
(El Kihel et al., 2023)	Method Development	The findings indicate that “BD”, “AR”, “collaborative robotics”, and “CC” are among PSA’s key technological priorities for improving and monitoring its process-control indicators.
(Koohang et al., 2023)	Conceptual Study (Perspective Paper)	The findings reveal opportunities and challenges related to Metaverse in “marketing”, metaverse in “hospitality and tourism”, “Industrial metaverse and manufacturing OM”, transforming the “education sector” with the metaverse, metaverse in the “retailing industry”, metaverse for “banking services”, “healthcare”, and metaverse for “HRM”.
(Dolgui & Ivanov, 2023)	Conceptual Study	The findings propose a 7-dimensional socio-technological framework for metaverse SCOM,

		covering “organization”, “management”, “people”, “technology”, “scope”, “task”, and “modelling”. They also identify emerging research opportunities involving metaverse-specific forecasting, inventory, pricing, contracting, and performance measures.
(Bag et al., 2023)	Quantitative Research, Technology, organization and environment (TOE) framework	The findings identify technological limitations as the primary barrier to metaverse implementation in “SCM”. “ANN analysis” further ranks governance and standardization gaps, integration difficulties, weak network diffusion, traditional organizational culture, limited stakeholder commitment and collaboration, and low customer-perceived value as important obstacles.
(Possik et al., 2023)	Simulation Modelling (Distributed Simulation)	The findings show that the contact matrix helped identify high-risk ICU staff roles and schedules, supporting better work planning to reduce potential viral transmission. A complementary visualization platform then illustrated disease progression among different “healthcare-worker groups”, tracking exposed, “asymptomatic”, “symptomatic”, and recovered staff over the “45-day simulation period”.
(Wang et al., 2023)	Game-Theoretical Modelling, Game Theory	The findings suggest that retailers’ optimal information-disclosure strategy depends on disclosure intensity and cost: limited and costly disclosure favours information about “higher-quality attributes”, whereas extensive disclosure shifts attention toward “lower-quality attributes”. The analysis also indicates a “U-shaped” relationship between manufacturer profitability and product quality under equilibrium conditions.
(Queiroz et al., 2023)	Mixed Methods Research	The findings show that adopters primarily face challenges related to “technology implementation”, “lack of workforce skills”, and “implementation

		costs”, whereas non-adopters are more concerned with “cost”, “security”, and “technology adoption”. For future development, adopters expect broader organizational and SC adoption, increased use of the metaverse for operational activities, and lower implementation costs.
(Tan et al., 2023)	Multi-Perspective Conceptual Study	The study identifies opportunities and challenges associated with metaverse applications across six areas: “marketing ethics”, “marketing communication”, “relationship marketing”, “retail marketing”, “SCM”, and “transportation management”.
(Sharma et al., 2024)	Mixed Methods Research	The findings identify integrating virtual and physical realities as the most critical barrier to “I5.0 adoption”. For German pharmaceutical firms, enhanced connectivity is particularly important for ensuring secure communication and protecting patient data. The study also highlights limited standardization and inadequate “benchmarking practices” as significant obstacles to adopting high-tech “I5.0 innovations”.
(Ooi et al., 2024)	Multi-Perspective Conceptual Study	The study identifies opportunities and challenges associated with metaverse applications across five areas: “SCM”, “logistics”, “decision-making”, “technology management”, and “knowledge management”.
(Zhong & Zhao, 2024)	Quantitative Research	The findings indicate that “SCM”, “customer collaboration”, “investment recovery”, “sustainable marketing”, “R&D and design”, production, and manufacturing positively contribute to enterprise sustainability performance. However, distribution and retail activities within sustainable marketing show a negative effect.

(Davies et al., 2024)	Conceptual Study, TOE framework	The findings identify “NFT” adoption barriers closely related to broader “BC” challenges, particularly scalability. Although “NFTs” could support sustainable supply chain management (SSCM), their high energy consumption may create environmental trade-offs. Therefore, scalable and energy-efficient “NFT and blockchain solutions” are essential for realizing their sustainability potential.
(Hajian et al., 2024)	SLR	The findings suggest that the metaverse can enhance “organizational performance” as a technological practice. The literature frequently draws on the “Technology Acceptance Model” and “Cognitive Theory”, while the “Practice-Based View” is useful for explaining organizational outcomes and “Social Exchange Theory” for understanding perceptions and behaviours related to privacy and security.
(L. Zhao et al., 2024)	Game-Theoretical Modelling, Game Theory	The findings show that “transparency efforts” can improve both manufacturer and retailer “profitability”, although double marginalization limits the efficiency of decentralized “SCs”. In remanufacturing settings, return-processing and consumer hassle costs can reduce demand and profitability. A “cost-sharing coordination contract” can address these issues by encouraging manufacturers to bear more of the retailer’s transparency costs, thereby motivating greater transparency effort and improving coordination.
(Mahdikhani & Meena, 2024)	Text Mining (Topic Modelling Analysis)	The findings show that “LDA” and “BERTopic” identified 10 and 12 optimal topics, respectively, based on coherence and topic-quality measures. Because “BERTopic” produced more coherent and contextually meaningful results, its 12 topics were used for further analysis. The most prominent theme concerned digital technologies driving

	global supply-chain growth, while metaverse applications were increasingly discussed across “manufacturing”, “warehousing”, “logistics”, “retail”, “media”, “advertising”, “rental”, and “mining”.
(Al-Issa & SLR Thanasi, 2024)	Advanced technologies in “luxury SC” can support “customer experience”, “operational efficiency”, “sustainability” and “market positioning”, with a framework proposed for their integration across the consumer journey.
(Dolgui & Conceptual Study Ivanov, 2025)	The study proposes an “IoB framework” for “SCOM” integrating insights from the “Industrial Metaverse” and “digital SC twins” across management, organizational, and technological dimensions. It highlights “IoB’s” potential to support supply chain design, forecasting, planning, logistics, inventory, production, sourcing, resilience, and sustainability, while strengthening managerial decision-making through real-time behavioural and SC information.
(Dhayal et al., SLR 2025)	The findings emphasize the need to integrate green technologies into “I5.0” to support the transition toward carbon neutrality, while recognizing associated opportunities and challenges. The study identifies four major thematic areas: “green technology initiatives (GTI)”, the metaverse, “green supply chain management (GSCM)”, and “AI”, providing implications for policymakers, researchers, regulators, and environmental stakeholders.

(Benitez et al., 2025)	Quantitative Research, Stakeholder Theory	The findings validate hypothesis H1 by demonstrating that companies which engage their stakeholders are more inclined to develop and effectively implement Lean bundles. Hypotheses H3a and H3b, are supported. Lastly, in line with existing literature the findings suggest that Lean bundles significantly contribute to operational performance, thus supporting our H4. Hypothesis H2a and H2b, are also supported.
(Zhou et al., 2025)	Mathematical Modelling	The findings suggest that “AR adoption” benefits platforms mainly when its accuracy advantage is high and its “entertainment effect” is limited. A strong entertainment effect may negatively affect consumers, while “AR” can enhance overall “SC performance” under favourable accuracy conditions. Higher consumer return costs may also encourage platform adoption of AR.
(Fernando et al., 2025)	Bibliometric analysis	The findings indicate that metaverse research in “Halal logistics”, “Halal SCM”, and “halal consumer behaviour” remains limited. Given the expanding halal market, greater research is needed to develop “Shariah-compliant approaches” to logistics and SCM, while leveraging emerging technologies such as the metaverse to support the sector.
(Sadeghi et al., 2025)	Mixed Methods Research, Practice based theory	The findings indicate that metaverse technology can strengthen “logistics decision-making” and “SC collaboration”, with both contributing positively to sustainability outcomes. Text-mining analysis further identified three dominant themes: “digitalization”, “sustainability”, and “logistics”.

Source: Authors’ work

4.2 Distribution of Research Methodologies

Table 9a. Distribution of Research Methodologies

Methodology	Frequency
SLR	7
Mixed Methods Research	6
Conceptual Study	6
Mathematical Modelling	4
Quantitative Research	3
Game-Theoretical Modelling	2
Multi-Perspective Conceptual Study	2
Bibliometric analysis	2
Conceptual Study (Perspective Paper)	1
Viewpoint	1
CNA	1
Case Study	1
Text Mining (Topic Modelling Analysis)	1
Text Mining Approach	1
Topic Modelling	1
Simulation	1
Simulation Modelling (Distributed Simulation)	1
Co-word and Thematic network analyses	1
Method Development	1

Source: Authors' work

Table 9b. Distribution of Research Methodologies by Combined Categories

Combined Research Methodology	Frequency
[Conceptual Study + Conceptual Study (Perspective Paper) + Multi-Perspective Conceptual Study + Viewpoint]: Conceptual Research	10
SLR	7
[Mathematical Modelling + Game-Theoretical Modelling + Method Development]: Analytical/Mathematical Modelling	7
Mixed Methods	6
[CNA + Co-word & Thematic Network Analysis + Bibliometric Analysis]: Bibliometric and Science Mapping	4
Quantitative Research	3
[Text Mining Approach + Topic Modelling + Text Mining (Topic Modelling Analysis)]: Text Mining and Topic Modelling	3
[Simulation + Simulation Modelling (Distributed Simulation)]: Simulation Research	2
Case Study	1

Source: Authors' work

“Conceptual research” is the most frequently adopted approach, followed by “SLR” and “analytical/mathematical modelling”. “Mixed-method studies” also represent a notable proportion of the literature, whereas “simulation research” and “case studies” remain limited. Overall, the methodological profile indicates that “Metaverse and related immersive technologies” research in “SCM&O” is still developing, with considerable reliance on conceptual, review-based and “analytical” approaches and comparatively less evidence from direct “organizational” and “empirical” investigations.

4.3 Theoretical Foundations of Metaverse and immersive technologies in SCM&O

Table 10. Distribution of Explicit Theoretical Foundations in Research on the Metaverse and immersive technologies in SCM&O

Theory	No. of Studies	Percentage
Game theory	3	7.89
TOE framework	2	5.26
Stakeholder theory	1	2.63
Practice based theory	1	2.63
No Explicit theoretical foundation	31	81.59
Total	38	100

Source: Authors' work

Table 10 shows that 31 of 38 studies (81.59%) do not explicitly report a “theoretical foundation”. “Game theory” is the most commonly used perspective, followed by the “TOE framework”. The limited theoretical grounding indicates a predominantly “technology- and application-focused” literature and points to opportunities for stronger “theory-based” research in “SCM&O”.

5. Future Research Directions

The reviewed studies identify several areas that require further investigation into the applications of the “Metaverse and related immersive technologies” in “SCM&O”. These suggestions cover “theoretical”, “methodological”, “technological”, “contextual” and “managerial” aspects of the field. Table 11 summarizes the future research directions reported across the reviewed studies and highlights the areas that warrant further attention.

Table 11. Future Research Directions for Metaverse and immersive technologies in SCM&O

Author(s)	Future research directions
(Tang* & Qiu, 2004)	Different “heuristic algorithms” to meet different productivity requirements in “VPL operations” should be studied. More experimental tests should also be conducted in different “manufacturing industries”. By focusing on the smoothness and effectiveness of data, information, and knowledge flow, a

	prototype of a complete “plant-wide” information system should be accordingly built and investigated.
(Seifert et al., 2006)	The “Model” can be tested with other product data instead of “HP” product data.
(Molina, et al., 2007)	Future research should examine “cultural” and “trust-related” barriers among SC partners, as well as customer concerns about the value proposition of “virtual enterprise brokers”.
(Chokshi & McFarlane, 2008)	The scope of this paper is limited to “reconfigurability” of process control systems only. It presents a “qualitative” argument to a new research approach based on which further “quantitative” developments can be made.
(Netland et al., 2020)	“Virtual factory” visits have limitations concerning immersion too. Although the current technology offers some “level of immersion”, it is still not the same as being present in an actual factory. It must be explored further in future.
(Cai & Lo, 2020)	The domain of “SCM” and “inventory management” in the omnichannel environment is absent in this SLR. There is a big space to explore the issues of “SCM” in the future research, especially with the concept of sharing, such as “co-opetitive” relationship in the “SC” on data, cost, and “inventory sharing”.
(Rejeb, et al., 2021a)	The study is limited by its focus on “full-length articles”, “book chapters”, and “conference papers”, excluding other sources such as practitioner publications, which may restrict the breadth of insights. Future research incorporating “multidisciplinary AR literature” and diverse publication outlets could provide a more comprehensive understanding of “AR” developments and their implications for researchers and practitioners.
(Rejeb, et al., 2021b)	The “SLR” acknowledges limitations related to the search strategy and source coverage. Future reviews could broaden the “keyword set”, include additional “databases”, and consider a wider range of publication types to improve the comprehensiveness of the findings.

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- (Muñoz-Leiva et al., 2021) It would be interesting to carry a study on reading choice in the “merchandising” literature, centered exclusively on academic publications. It could be insightful to apply other approaches based on “multivariate exploratory techniques” to journal, institution or “author data”.
- (Bressanelli et al., 2021) Future research could expand the evidence base by including additional publications and conference proceedings, examine other “CE enablers and levers”, and extend the analysis beyond the “EEE SC” to other industries for cross-sector comparison and identification of commonalities and synergies.
- (Salvini et al., 2022) Future research is needed to further evaluate and to extend the “game”. 1st research is needed to analyse the effects of the game in different adoption phases of the participants. 2nd there are many research opportunities to extend and further develop the game. Additionally, further research is needed to address other “barriers” which were not included in the “game” because they require a “long-term approach”.
- (Asokan et al., 2022) The role of “data ethics”, including “data ownership”, “sharing” and “integrity” for organisational health might be investigated in future. The transformational capabilities of “I4.0” for addressing “product counterfeiting” and “tampering”, especially for safety-critical products, can be explored. Another research avenue is how to incorporate “SMEs” from the supply network in the adoption of “I4.0 technologies” for “social responsibility”, especially given the likely upfront investment costs.
- (Bhattacharya a & Chatterjee, 2022) The study offers ideas for complete integration of the “AECO SC” to deliver value to end customers. It however relies on “opinions”, “perspectives” and “recollections” of respondents, which is its limitation. Their opinion is expected to be influenced by their “domain” and “project expertise”, which must be eliminated in future research.
- (Feng & Jin, 2022) Future research could “empirically” validate the theoretical findings, extend the model to include multiple manufacturers and competing platforms, and examine how “SC competition” and “information asymmetry” influence firms’ innovation and selling-structure decisions.
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- (Kim & Lee, 2023) Firstly, part of the “data preparation” and processing required the authors’ judgment, such as topic labelling and classification. Secondly in this study, a topic was assigned to only one class: “BMS”, “OM” or others. However, a topic could belong in multiple classes using a representation tool such as fuzzy modelling. Thirdly, future studies should consider establishing secondary criteria to screen studies solely on “mass customisation”.
- (Singh et al., 2023) In the future, real-time data collection in industrial systems may take the following forms: “IoTs enabled data collection”, “Smart devices based on the CPS”. Two directions should prioritize future decision-making: “Decision-making methods” based on “BDA” and “Cloud manufacturing”.
- (El Kihel et al., 2023) The study acknowledges that the model’s validity depends on its underlying assumptions and hypotheses. Since the proposed “GRAILOG”- and “PPTechIP”-based “SC model” was developed within a specific existing “SC” context, future research should assess its applicability across different “SC” settings.
- (Koohang et al., 2023) Future research should examine the commercial implications of metaverse-enabled manufacturing operations, including “modelling”, “automation”, “simulation”, and “prediction”. Other promising areas include “EDI” in metaverse retailing, smart contracts for financial management, co-creation models in metaverse healthcare, and innovative tourism strategies involving customer acquisition, engagement, loyalty, retention, and gamification.
- (Dolgui & Ivanov, 2023) Future research should investigate how digital technologies can support coordination between physical and metaverse “SC&O” environments.
- (Bag et al., 2023) Future research could expand database coverage beyond Scopus, examine firms and supply-chain solutions across different industries and countries, and explore alternative technology-adoption frameworks such as the “Technology Acceptance Model (TAM)” and “Unified Theory of Acceptance and Use of Technology (UTAUT)” alongside the “TOE framework”.
- (Possik et al., 2023) Future research could incorporate “mobile” and “portable” devices into the “simulation” as “additional” agents to assess their potential contribution to virus transmission within the unit.
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- (Wang et al., 2023) Future research could examine consumer returns arising from heightened “product-quality” expectations following greater information disclosure, as well as “multi-channel” manufacturer selling strategies, which may alter retailers’ disclosure decisions under increased online competition.
- (Queiroz et al., 2023) Future research could explore alternative “methodological” approaches beyond “empirical testing” to provide broader insights and validate findings from different “perspectives”.
- (Tan et al., 2023) Future study might be carried out to explore the creation of “decentralized trust” in the “Web3.0 metaverse”, as well as open directions for the roles of marketing ethics in advancing research in the “pseudonymous economy”, “decentralized identity”, and “decentralized society”. More research is required to understand consumers’ personality traits, personas of consumers, attitudes, perceptions, purchasing behaviour and negative emotional patterns such as “regret”, “anxiety” and “addiction” in the metaverse setting. “Blockchain-as-a-service” presents a vital research opportunity in the context of the “metaverse and transportation management”.
- (Sharma et al., 2024) The data collected from the “German pharmaceutical sector” might restrict the “generalizability” of findings to other sectors in other nations which gives an opportunity for research in other sectors as well as other developing and developed nations. Further, distinct sets could be analysed to discover and assess the barriers and SI related to the adoption of “I5.0”. Due to the limited number of experts from a single firm from the same country, the framework provided in this article cannot be “generalized” and used “globally” in different countries as an “assessment model”. Future research might be conducted to extend the current framework to other countries.
- (Ooi et al., 2024) Future research should examine user preferences and behaviours, privacy protection, the organizational implications of “VR” and “5G”, and the social and ethical dimensions of the metaverse, including “inequality”, “diversity”, and “digital citizenship”. In knowledge management, further work could investigate how metaverse integration transforms “KM processes” and how organizations can balance data privacy, security, accessibility, and effective knowledge sharing.
- (Zhong & E. Zhao, 2024) Future research should investigate industry-specific applications of the metaverse, particularly through practical cases in “sustainable marketing” and
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	“SCM”. Further studies could explore how distribution and retail activities can leverage metaverse technologies to overcome sustainability challenges and improve “operational efficiency” and “sustainability performance”.
(Davies et al., 2024)	Future research could investigate “NFT-specific barriers” to adoption in “sustainable SCM”, particularly those that remain unresolved despite “NFT’s” potential to address broader BC-related challenges.
(Hajian et al., 2024)	The study is limited to “English-language”, “peer-reviewed” “empirical” research, which may exclude relevant evidence from other sources and languages. Future research could broaden the evidence base by incorporating theses, newspapers, other non-academic sources, and non-English literature.
(L. Zhao et al., 2024)	Future research could examine return policies for “remanufactured products”, alternative channel-selection and competition strategies under different marketing efforts, and information transparency for remanufactured products sold through online channels.
(Mahdikhani & Meena, 2024)	Future research could examine the integration of “BC”, “5G”, and “IoT” with the metaverse in “SCM”, supported by company-level “case studies” and “mixed-method” approaches. Further investigation across sectors such as healthcare, automotive, and retail could reveal industry-specific challenges, opportunities, and adoption strategies.
(Al-Issa & Thanasi, 2024)	Future research could examine “advanced-technology” applications across different luxury businesses, “quantitatively” assess their contribution to sustainable luxury practices, explore their role in the second-hand luxury market, and investigate consumer perspectives through “empirical studies”.
(Dolgui & Ivanov, 2025)	Future research could investigate “IoB’s” implications for “SCOM” theory and practice, particularly its influence on managerial “decision-making” through real-time behavioural data. Further work should address “ethical and behavioural issues”, “cognitive biases” in “human-AI” interactions, and technological barriers to integrating “IoB” with “DT” in “SCOM”.
(Dhayal et al., 2025)	Broaden “database” and “publication coverage”, refine “search criteria”, and examine additional “I5.0 technologies” relevant to “carbon neutrality”.

- (Benitez et al., 2025) Address “endogeneity” and “common-source bias” through “stronger designs”, including “secondary data” and “multi-respondent” performance assessments.
- (Zhou et al., 2025) Future research could examine how channel structures influence platform and manufacturer decisions, incorporate competition among multiple platforms and manufacturers, and investigate “AR spillover effects” across products to better understand their influence on “platform AR strategies”.
- (Fernando et al., 2025) The study is constrained by limited data on metaverse applications in “Halal logistics”, “Halal SCM”, and “halal behaviour”, as well as the possibility of missing cross-disciplinary keywords in the bibliometric analysis. Future research should employ more targeted approaches and “qualitative methods” to investigate the applications, benefits, and barriers associated with metaverse integration in the “halal sector”.
- (Sadeghi et al., 2025) Future research could examine additional mediators and moderators, investigate the metaverse’s potential contribution to “cyber resilience” in “OSCM”, and assess the roles of “media richness” and “perceived novelty” in influencing the relationships within the proposed research model.

Source: Authors’ work

Table 12. Synthesized Future Research Directions for Metaverse and immersive technologies in SCM&O

Research direction	Gap	Suggested future focus
Theoretical development	Limited explicit “theoretical grounding”	Develop and test “theory-driven” models
Empirical and methodological strengthening	“Conceptual/analytical” work dominates	“Case studies”, “Surveys”, “Longitudinal” and “Mixed methods”
Geographic and sectoral expansion	Evidence concentrated in “selected contexts”	“Cross-country” and “cross-industry” studies
Technology integration	Limited evidence on “technology combinations”	“Metaverse & AI”, “IoT”, “BC”, “5G” and “DT”

Sustainability and resilience	Limited evidence	“outcome-based”	“Sustainability”, “Carbon neutrality” and “Resilience”
Governance, security and trust	“Privacy”, and further study	“Cybersecurity” require	“Governance”, “Ethics”, “Privacy”, “Cybersecurity” and “Standardization”
Human and organizational dimensions	Limited attention to “organizational mechanisms”	“Skills”, “Knowledge sharing”, “behaviour” and	“Readiness”, “Human-AI interaction”

Source: Authors’ work

5.1 Synthesis of Future Research Directions

The future research directions identified in the reviewed studies can be consolidated into several broader areas. Greater attention is needed to “theoretical development”, “empirical research” and methodological diversity, including “case studies”, “longitudinal studies” and “mixed-method” approaches. “Cross-country” and “cross-industry” investigations may further strengthen the “generalizability” of findings. Future studies could also examine the integration of the “Metaverse and related immersive technologies” with complementary technologies such as “AI”, “IoT”, “BC”, “5G” and “DT”, as well as its implications for “Sustainability”, “Circularity”, “Resilience” and “Operational performance”. Further research is also warranted on “Governance”, “Privacy”, “Cybersecurity”, “Trust”, “Regulation” and “Standardization”, together with human and organizational factors such as workforce capabilities, organizational readiness, knowledge sharing and “Human-AI interaction”. Overall, the synthesized research agenda points toward a shift from predominantly conceptual and technology-focused studies to “theory-based”, “empirical” and “context-specific” research on the “Metaverse and related immersive technologies” in “SCM&O”.

6. Bibliometric Analysis

6.1 Co-authorship Analysis

Table 13. Co-authorship Structure of Metaverse and immersive technologies in SCM&O

Author	Articles	Citations	Total link strength
Ooi, Keng-Boon	3	433	15
Tan, Garry Wei-Han	3	433	15

Aw, Eugene cheng-xi	2	412	12
Cham, Tat-huei	2	412	12
Dwivedi, Yogesh, K.	2	412	12
Hughes, Laurie	2	412	12
Al-emran, Mostafa	2	352	10
Wong, Lai Wan	2	352	10
Keogh, John G.	2	158	4
Rejeb, Abderahman	2	158	4
Treiblmaier, Horst	2	158	4
Dolgui, Alexandre	2	51	2
Ivanov, Dmitry	2	51	2
Ojha, Divesh	2	22	2
Sadeghi R., Kiarash	2	22	2

Source: Authors' work using VOSviewer (Van Eck & Waltman, 2010)

The co-authorship results indicate the presence of recurring author collaborations within the emerging “Metaverse and related immersive technologies-SCM&O” literature. The network also highlights authors who occupy relatively central positions based on publication, citation and link-strength measures.

6.2 Citation Analysis

Table 14. Citation analysis of Authors contributing to Metaverse and immersive technologies in SCM&O

Author	Articles	Citations	Total link strength
Ooi, Keng-Boon	3	433	12
Tan, Garry Wei-Han	3	433	12

Al-emran, Mostafa	2	352	10
Wong, Lai Wan	2	352	10
Ojha, Divesh	2	22	8
Sadeghi R., Kiarash	2	22	8
Aw, Eugene cheng-xi	2	412	6
Cham, Tat-huei	2	412	6
Dwivedi, Yogesh, K.	2	412	6
Hughes, Laurie	2	412	6
Dolgui, Alexandre	2	51	4
Ivanov, Dmitry	2	51	4
Keogh, John G.	2	158	0
Rejeb, Abderahman	2	158	0
Treiblmaier, Horst	2	158	0

Source: Authors' work using VOSviewer (Van Eck & Waltman, 2010)

Keng-Boon Ooi and Garry Wei-Han Tan are the mostly cited authors contributing to the area of “Metaverse and related immersive technologies” in “SCM&O”.

Figure 3. Citation analysis by Authors in the area of Metaverse and immersive technologies in SCM&O



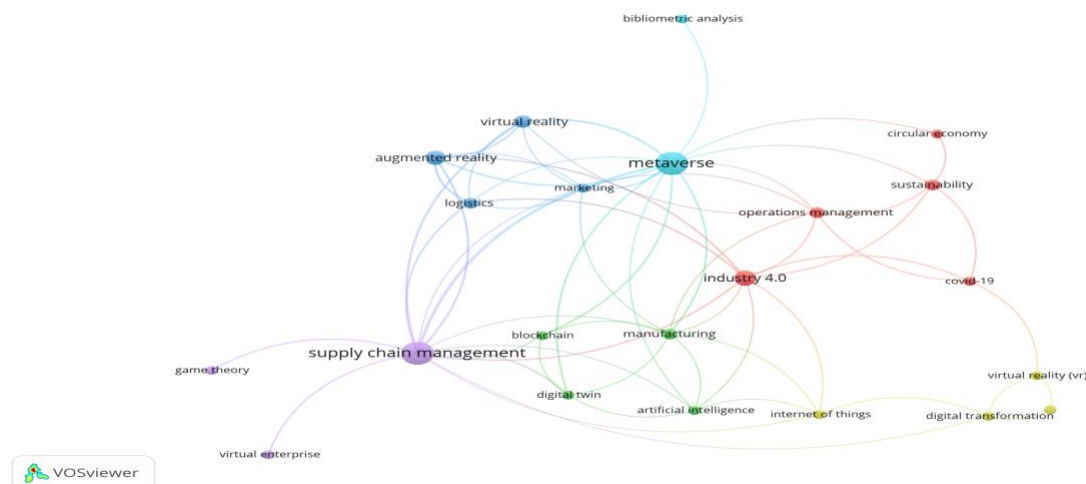
Source: Authors' work using VOSviewer (Van Eck & Waltman, 2010)

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In Figure 3, Citation Analysis by Authors are shown. The diagram created with VOSviewer (Van Eck & Waltman, 2010) is about scholarly influence, not volume of publications. It visualizes the authors who have written about the “Metaverse and related immersive technologies” in the “SCM&O”, as well as their direct and indirect influence on the citizens' intellectual network. Grouping of citations shows that a few authors have a significant impact on the discourse, their texts being used as a basis for other authors. This is a common situation in new areas where pioneering research sets the agenda for future research. Peripheral authors with low numbers of citations suggest that there is still a diversity process, with fresh voices joining in. The diagram thus demonstrates the two processes of consolidation of power among key scholars and the gradual expansion of participation, which are both aspects of academic development, “leadership” and “inclusion”.

6.3 Keyword Co-occurrence Analysis

Figure 4. Keywords Co-occurrence analysis by Author keywords in the area of Metaverse and immersive technologies in SCM&O



Source: Authors' work using VOSviewer (Van Eck & Waltman, 2010)

Figure 4 shows the thematic structure of the literature; it shows the distribution of the keywords selected by the authors. This analysis shows that there are conceptual connections that define the field as a field. The concepts “metaverse,” “supply chain,” “digital twin,” “blockchain,” “virtual reality” and “operations management” are likely to be grouped together, suggesting that the metaverse and related immersive technologies is being researched in conjunction with other “Industry 4.0 technologies”. Scholars are exploring the possibilities of using immersive technologies to solve global problems in the supply chain by using the keywords “sustainability” and “resilience” together. The clusters are close to each other, reflecting the interdisciplinary character of the field and the interplay between technology innovation and operational strategy

6.4 Bibliographic Coupling Analysis

Figure 5 looks at the relationships between documents that have common references. Bibliographic coupling analysis indicates affinities based on ideas, even if the papers have not cited one another. The clusters generated here indicate different approaches of thought - one could be conceptual, another empirical, another technology specific, covering concepts and ideas for Metaverse and related immersive technologies-integrated supply chains, empirical case studies, and enabling technologies like “blockchain” or “internet of things”. Clusters with high densities of connections are considered to be well themed; connections between clusters are considered to be integrative works that try to bring together various viewpoints. This shows the subdomains branching out from the field and a common knowledge base. It also suggests that future research can increasingly start to connect these clusters to develop more comprehensive frameworks including “technological”, “operational” and “strategic” aspects.

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7.1 Discussion of Findings

The reviewed literature indicates that research on the metaverse and related immersive technologies in SCM&O remains at an emerging and predominantly application-oriented stage. The limited use of explicit theoretical foundations and the predominance of conceptual and analytical studies suggest that the field has yet to develop a strong theory-driven research base. These findings highlight opportunities for future studies to connect the adoption and use of the metaverse and related immersive technologies with established SCM&O perspectives and to validate proposed applications through empirical research.

7.2 Managerial Implications

The findings suggest that managers should assess applications of the metaverse and related immersive technologies in light of operational needs, organizational capabilities, and strategic priorities. Applications aimed at improving supply-chain visibility, collaboration and decision-making require appropriate workforce capabilities, coordination, and governance. A phased implementation approach can help managers balance potential operational benefits against implementation challenges, cybersecurity risks, and data-related risks.

8. Limitations and Conclusion

8.1 Limitations

This review is subject to several methodological boundaries. Scopus was used as the sole database because of its broad multidisciplinary coverage and suitability for systematic and bibliometric analysis. The use of ABDC A*, A and B journals and an English-language restriction provided consistent selection and screening criteria but may have excluded relevant studies from other databases, languages or journal categories. The final 38-study corpus also reflects the emerging nature of research on metaverse and related immersive technologies in SCM&O.

8.2 Conclusion

The review shows that research on the metaverse and related immersive technologies in SCM&O remains at an emerging and predominantly application-oriented stage, with studies spanning manufacturing, logistics, supply-chain activities, decision-making, retailing and sustainability. Conceptual, review-based and analytical studies dominate, while empirical and case-based evidence remains limited. Moreover, 31 of 38 studies (81.59%) lack an explicit theoretical foundation, highlighting substantial opportunities for stronger theory-driven and empirical research in SCM&O.

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