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ORIGINAL RESEARCH

Mapping evolving immersive customer experiences (CX) and virtual engagement in the metaverse: insights from bibliometrics-topic modelling synthesis

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Abstract

This study maps the research landscape of immersive customer experience (CX) in the metaverse by synthesizing bibliometric analysis and topic modelling. Using 1,460 Scopus indexed journal articles (2000–2025), we examined publication trends, prolific authors, journals, and country contributions, and applied Latent Dirichlet Allocation (LDA) topic modelling, uncover thematic structures. Findings show 22.78% in publications, with increasing global contributions from countries like India, Malaysia, and South Korea. Seven core themes emerged: CX enhancement, brand engagement and virtual services, marketing research trends in CX, digital marketing and NFT adoption, AI-driven engagement, immersive business value creation, and consumer behaviour in virtual retail. While the field is developing, metaverse-specific CX models and measurement tools remain underdeveloped. The study advances theory by CX frameworks to immersive, co-created, and avatar-mediated experiences, and offer practical guidance for firms to adopt customer-centric strategies that leverage AI, gamification, and virtual branding. To our knowledge, this is the first work to combine bibliometric and topic modelling to chart CX research in the metaverse, highlighting current research frontiers and future research agenda.

Keywords Customer experience (CX) · Immersive experiences · Bibliometrics · Topic modelling · Metaverse · Dual analysis · Latent Dirichlet Allocation (LDA)

JEL Classification M31; L36; D83

1 Introduction

In the domain of computer science and digital technology, the metaverse can be viewed as an immersive, persistent, 3D environment enabled by virtual reality (VR) or augmented reality (AR), artificial intelligence (AI), blockchain and high-speed connectivity [1]. The focus here is infrastructure, digital twins, avatars, interoperability and immersive interfaces [2]. However, in the field of business and management, it is seen as the novel market space and value creation arena where firms can monetize and create a competitive advantage through digital assets (e.g.- non-fungible tokens (NFTs), cryptos etc.), virtual economies, platform economies and business models [3]. In consumer research and marketing studies, metaverse is a new channel for experience delivery and customer engagement [4], with a focus on brand interactions, gamification, customer journey, co-creation [5] and virtual consumption [6]. The

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multiple definitions of the metaverse create conceptual fragmentation Customer experience (CX) research as experiences can be framed economically (value creation), technically (immersion) [7], socially (identify and community) and commercially (brand engagement) [8]. In the same notion, the plurality in definitions brings in the development of interdisciplinary research frameworks which synthesize technology, business, sociology and marketing perspectives. Without this synthesis, CX research becomes more siloed and inconsistent, which may limit theoretical advancement and practical applicability. The increasing digitisation of customer touchpoints, accelerated by emerging technologies, has dramatically reshaped how experiences are designed and delivered across platforms [9].

This study addresses these gaps by mapping the emerging research landscape of CX in the metaverse through a dual-method approach combining bibliometric analysis and topic modelling. The suitability of the applied methodology in the current study is because both (bibliometric analysis and topic modelling) capture structural landscape and conceptual content, making it more appropriate for the rapidly evolving field of CX in the metaverse. In addition, bibliometrics provides a macro level view of publication trends, influential authors, collaboration and journals, while on the other hand, topic modelling uncovers latent thematic structures and research directions within the literature. Dual application of the methods ensures a richer and more reliable analysis, which reduces the limitations and likelihood of relying solely on structural metrics or thematic models which are not with strong validation and context.

Through identifying key theoretical streams, influential contributions, and emerging themes, this paper offers a systematic overview of how the MVCX domain is evolving. Furthermore, it surfaces research priorities, including the need for metaverse-specific measurement scales, integrative theoretical models, and interdisciplinary approaches grounded in sociology, psychology, and immersive design. It seeks to address the following research questions:

- **RQ1:** *What is the annual publication and citation trend in the research domain of customer experience in the metaverse?*
- **RQ2:** *What are the most influential documents, contributing countries, impactful sources, and prolific authors in the domain of customer experience in the metaverse*?
- **RQ3:** *What are the research clusters shaping knowledge in the domain of customer experience in the Metaverse*?
- **RQ4:** *Which topics are the most influential in shaping research within the field of customer experience in the metaverse?*

There is a pressing need for interdisciplinary theoretical development that draws from sociology, psychology, digital ethics, and retail studies to better capture the holistic customer experience within these emerging spaces. Together, these theories present a layered view of CX. They show us that great experiences do not happen by accident. They are co-created, emotional, multi-dimensional, and shaped through every interaction. This is the lens through which we explore how customer participation and service innovativeness can lead to stand out experiences in the digital world. However, the lack of a validated MVCX scale presents a major limitation for both research and practice. Without a structured tool to assess experience quality, businesses cannot accurately evaluate or optimize the effectiveness of their metaverse platforms. Compounding this issue are methodological weaknesses in existing studies, including small sample sizes, qualitative-only designs, and limited generalizability. As metaverse retailing continues to evolve, future research must also move beyond traditional acceptance models and develop metaverse-specific theories that account for interactivity, co-creation, digital ownership, and virtual community participation [10]. This evolution will ensure that theoretical foundations keep pace with the technological and experiential advancements of the metaverse. The research methodology is outlined in the section that follows.

2 Research methodology

A multi method technique is adopted for this study; first bibliometric analysis is followed by topic modelling technique. Bibliometric analysis is one of the most applied techniques to analyze large amount of academic literature to describe, the current scenario of research including best journals, authors, country, paper, affiliations etc. [8, 11]. Topic modelling is a technique which utilizes unsupervised machine learning models to uncover the hidden semantic similarities in a large set of academic literature or any other text data [12, 13]. It helps in deciphering the emerging topics, the most frequent words that further enables the deep understanding of the domain & subdomain of research filed [14, 15]. The following table/fig shows the research flow adopted for this study to gain a deeper insight into the customer experience dynamics on metaverse platforms.

As depicted in Fig. 1, the data is extracted from the Scopus database using Boolean combination of keywords. Scopus database is having large number of articles, conference papers, book chapters, editorial and short notes etc. [16]. It has been used by various social science researchers to extract data and perform bibliometric analysis to reveal the research paradigm in variety of domains [17–19]. The following

Stage	Process	Criteria / Actions	Included	Excluded
1. Identification	Data Extraction	Source: Scopus - Query using keywords combimation - Fields: Title-Abstract-Keywords (TIT-KEY-ABS) - Period: 2000–2025	6,538 records	–
2. Screening	Document Type Filter	- Included: Peer-reviewed journal articles - Excluded: Reviews, conference papers, book chapters, editorials	5,277 records	1,261 records
3. Eligibility	Language Filter	- Included: English-only publications - Removed non-English articles	5,229 records	48 records
4. Thematic Screening	Title/Abstract Review	- Removed off-topic documents (e.g., medicine, agriculture, engineering) based on manual relevance review	1,460 records	3,769 records
5. Descriptive Bibliometric Analysis	SciNetopy (Python-based)	- Analyzed trends, citation patterns, productive authors, source impact	–	–
6. Topic Modeling	Text Preprocessing & LDA	- Stopword & punctuation removal - Tokenization & Lemmatization - DTM or TF-IDF matrix creation - Latent Dirichlet Allocation (LDA) - Coherence score optimization	–	–

Fig. 1 Data and Methodology Flow Diagram. **Source:** Authors' (2025)

keywords were searched from the Scopus search engine in TIT-KEY-ABS field "customer experience" OR "consumer experience" OR "user experience" OR "customer engagement" OR "customer journey" OR "brand experience") AND (metaverse OR "virtual reality" OR "augmented reality" OR "immersive environment" OR "extended reality" OR "mixed reality")). This search query returned a total of 6538 documents published between 2000–2025 (April 1–Date of extraction), the data was extracted in.CSV format to proceed further. Next, we screened the data using various inclusion criteria like we have considered only articles other article types such as conference papers, review papers, book chapters short notes etc. were excluded, it counted as 1261 documents that made the data set to 5277. The data set further screened for languages, 48 documents written in other than English language were removed.

The next stage was to make sure that the data has a central theme of customer experience research within a metaverse context. At this stage we looked carefully at each paper's title and abstract to ascertain the theme of the research, 3769 documents were removed at this stage having published in the field of agriculture, medicine and engineering that made the final sample of 1460 for further processing and analysis. We conducted descriptive data analysis using Scinetopy, it offers state of the art platform to analyze large bibliometric data and obtain results in tabular & graphics forms [20, 21]. The topic modelling was performed using LDA (Latent Dirichlet Allocation) technique as shown in Fig. 2, LDA works by assuming that each document consists of a mixture of topics and that each topic is a probability distribution over words. It analyses word co-occurrence patterns to uncover the latent topics within a large text body.

3 Results and analysis

3.1 Annual publication and citations trends

Figure 3 is about annual trends in publications and citations related to CX in the metaverse from 2000 to 2025. The data shows the evolution of academic interest during the past two decades. From 2000 to 2010, the average publication output

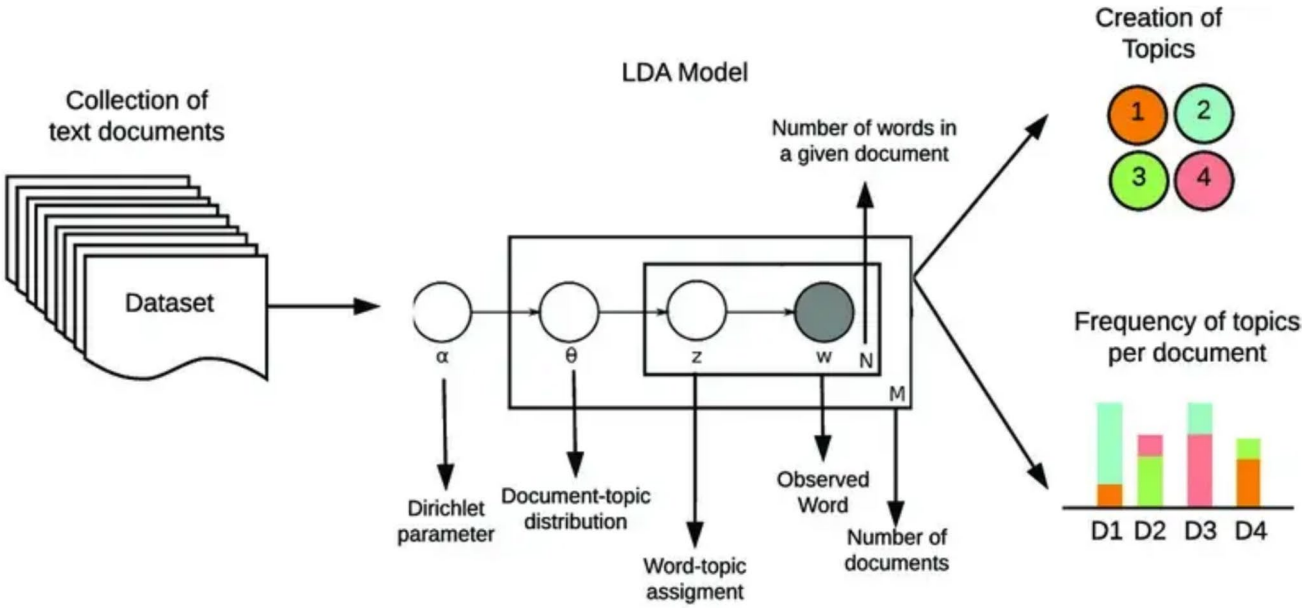

Fig. 2 LDA Algorithm Source: [22]

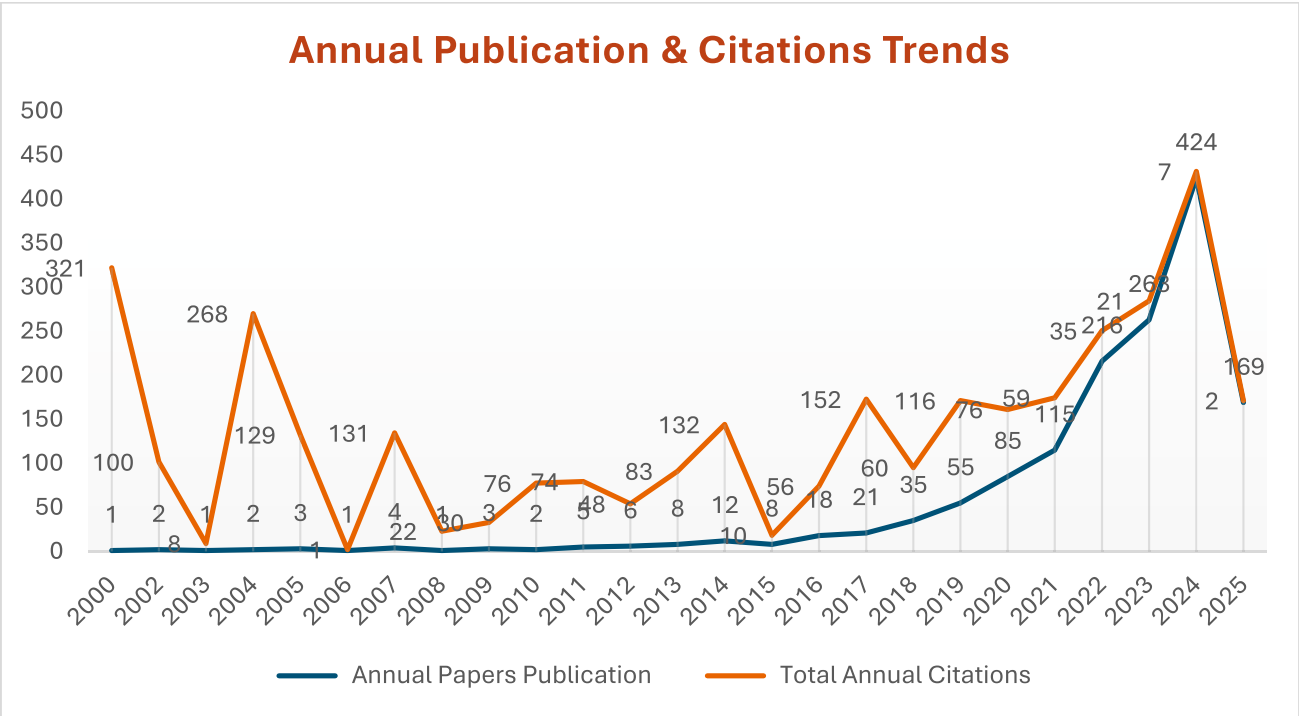

Fig. 3 Annual Publications & Citations. **Source:** Authors' conception (2025)

was less than 10 per year. The total number of citations were 321, 268, and 131 in the years 2000, 2004, and 2005 respectively which shows significant attention towards this field, apparently few papers were used as foundational concepts for further research during these years. After 2019, publications jumped from 55 to 216, and citations reached 424 in 2024. An increase in publication between 2011 and 2018 shows growing academic interest in this field. This suggests a major shift in academic engagement and influence.

3.2 The prolific authors

Figure 4 presents the total number of publications by key authors in the field of immersive technologies and

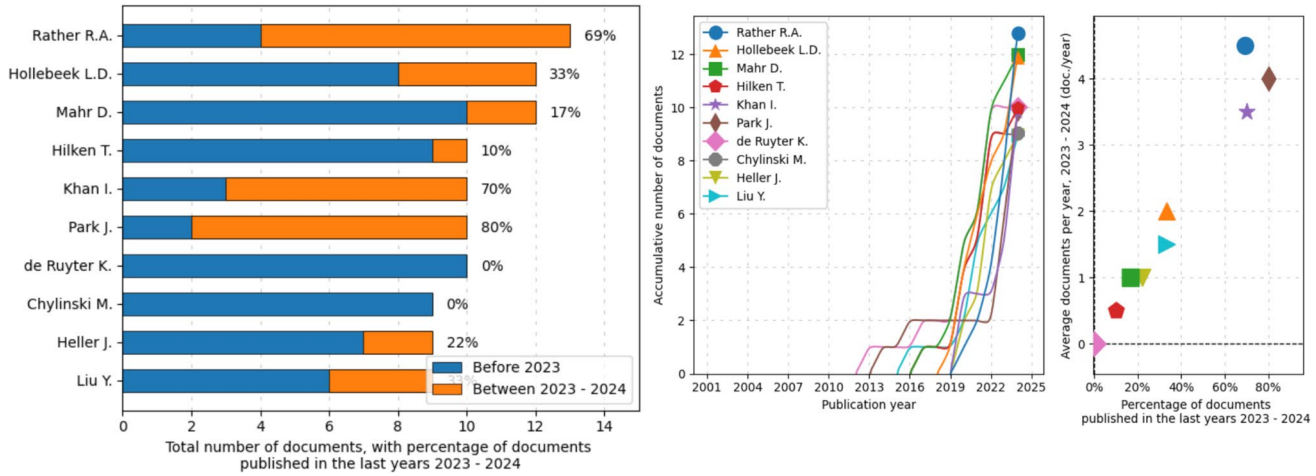

Fig. 4 10 Most Contributing authors. **Source:** Authors' conception (2025)

customer-focused research, highlighting the proportion of work published in the years 2023–2024 (orange) versus earlier contributions (blue). Rather R.A. emerges as the most prolific and currently active author, with 69% of their publications appearing in the recent period. Similarly, Khan I. and Park J. demonstrate a high concentration of recent output (70% and 80% respectively), signifying their strong contemporary research presence. In contrast, authors like de Ruyter K. and Chylinski M. show no recent publications, suggesting a past focus in the domain.

3.3 Influential journals

Figure 5 shows leading journals by publication volume and recent research activity (2023–2024) contributing to the research domain of immersive technologies and customer experience. Journals such as the International Journal of Contemporary Hospitality Management (73%), Psychology and Marketing (61%), and Sustainability (Switzerland) (51%) demonstrate significant recent contributions. Journals like IEEE Access show lower recent activity, suggesting a broader or shifting thematic focus. This distribution helps identify high-impact publication venues currently shaping discourse in this research area.

3.4 Most contributing countries

Figure 3 illustrates the country-wise distribution of publications and recency of research output (before 2023 vs. 2023–2024). It presents the total number of publications from the top contributing countries in the domain of immersive technologies and customer-related research, segmented by publication period. The orange segment denotes the percentage of documents published in 2023–2024, while the blue segment represents earlier contributions. The chart shows that the United States leading in total publications initially has dropped recently (46%). It suggests early dominance in the field. However, recently India (70%), Malaysia (65%), and South Korea (57%) have published a significant number of documents (Fig. 6).

3.5 Topic modelling using LDA

To determine the optimal number of topics for the LDA model, a coherence score analysis was conducted using a range of topic numbers (k = 2 to 10) using python Jupyter notebook. It is a widely used method to find out the optimal number of topics in a dataset [23]. The plot of coherence scores and number of topics are depicted in Fig. 7. The model with the highest coherence scores 0.567 was selected, that corresponds to 7 distinct topics in the research domain of customer experience in metaverse.

3.6 LDA topic modelling visualization

The output of LDA topic modelling is represented in Fig. 8. Each circle in the figure represents a topic, the size of the circle shows the prevalence of that topic across the whole dataset. The semantic similarity among topics can be understood by looking at the distance between the circles. There are more semantic similarities if the circles are closer to each other. The topics 1 & 2 overlap are overlapping that show that they share various common themes and words. The topic 4 and 6 are very far and that shows they are very distinct from each other and other topics of the model.

Fig. 5 Top Contributing Journals. **Source:** Authors' conception (2025)

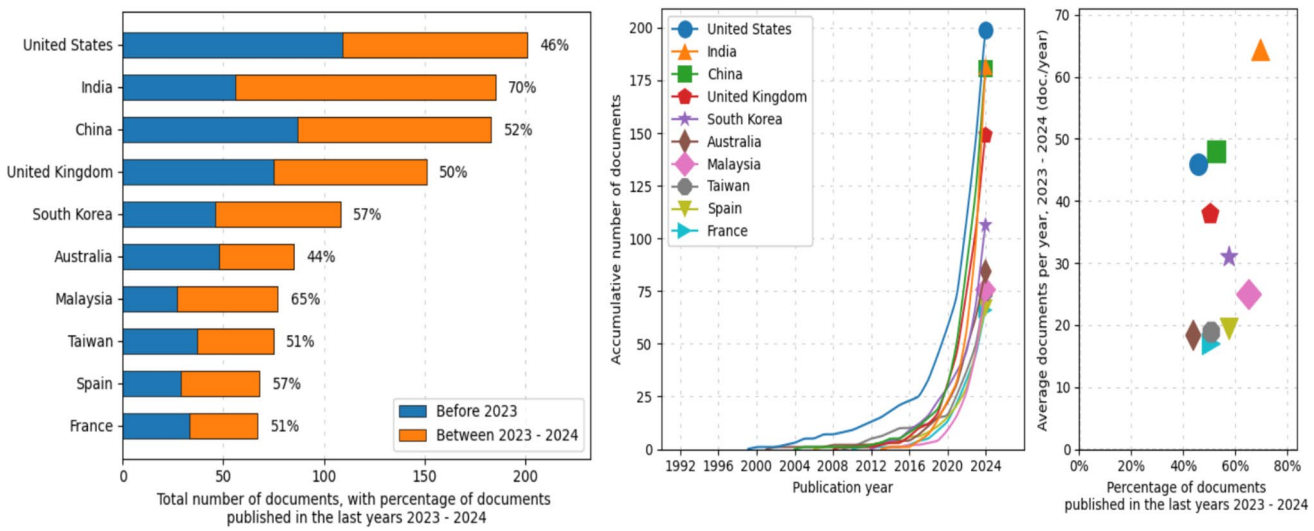

Fig. 6 Contribution of Countries in the Research Domain of CX on Metaverse. **Source:** Authors' conception (2025)

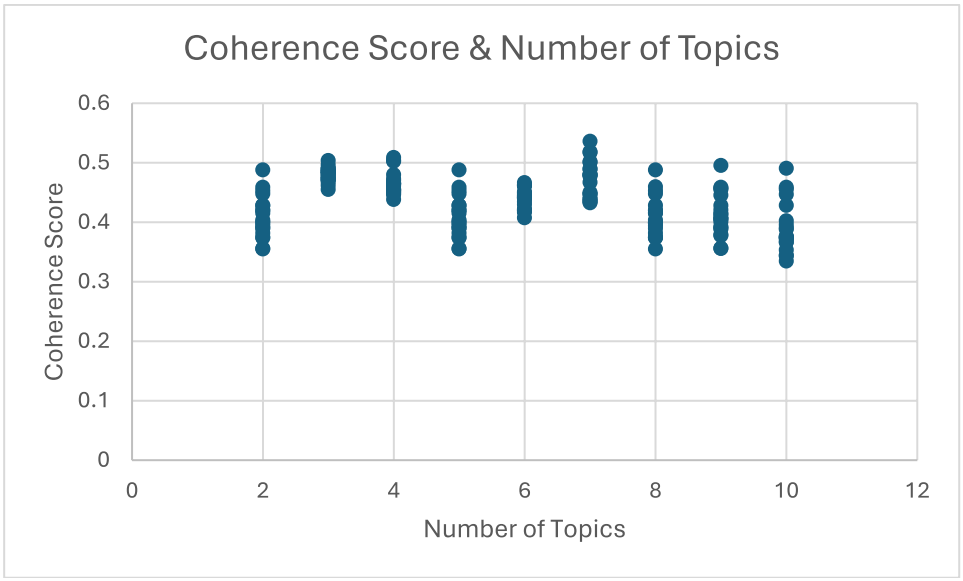

Fig. 7 Coherence Score and Number of Topics. **Source:** Authors' conception (2025)

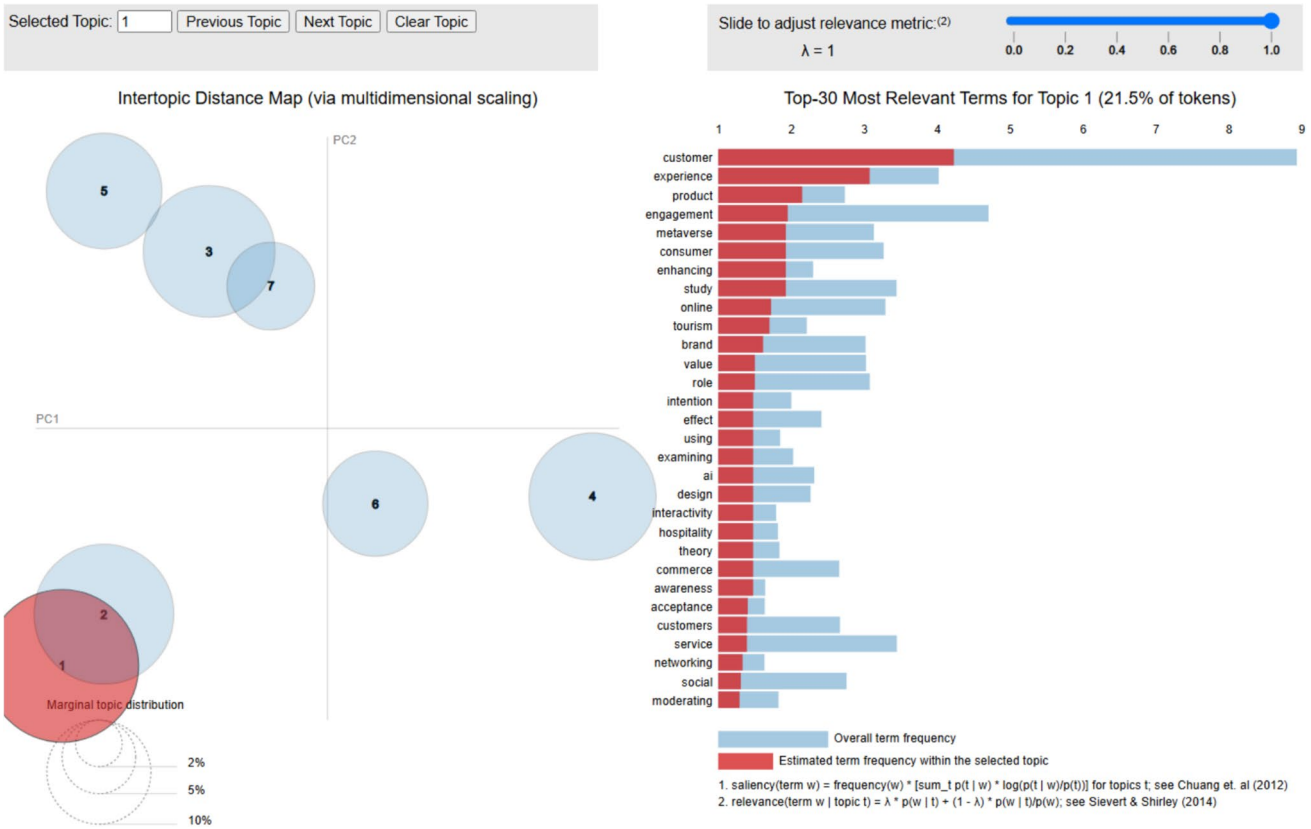

Fig. 8 Visualization of LDA Topic Modelling Output. **Source:** Authors' conception (2025)

3.7 Frequency distribution of word counts in documents

The number of words in each document are depicted in the following Fig. 9, it shows a visualization of how many documents fall into a certain word count. Most of the documents have words count between 7 and 13, with a peak at 9 words, where 15 documents fall into this category. The distribution is slightly right skewed, meaning a few documents have higher word counts (e.g., 15, 16, and 42), but most are clustered at lower counts. Very few documents have fewer than 6 words or more than 15 words, indicating that your corpus is relatively consistent in length for most records. The

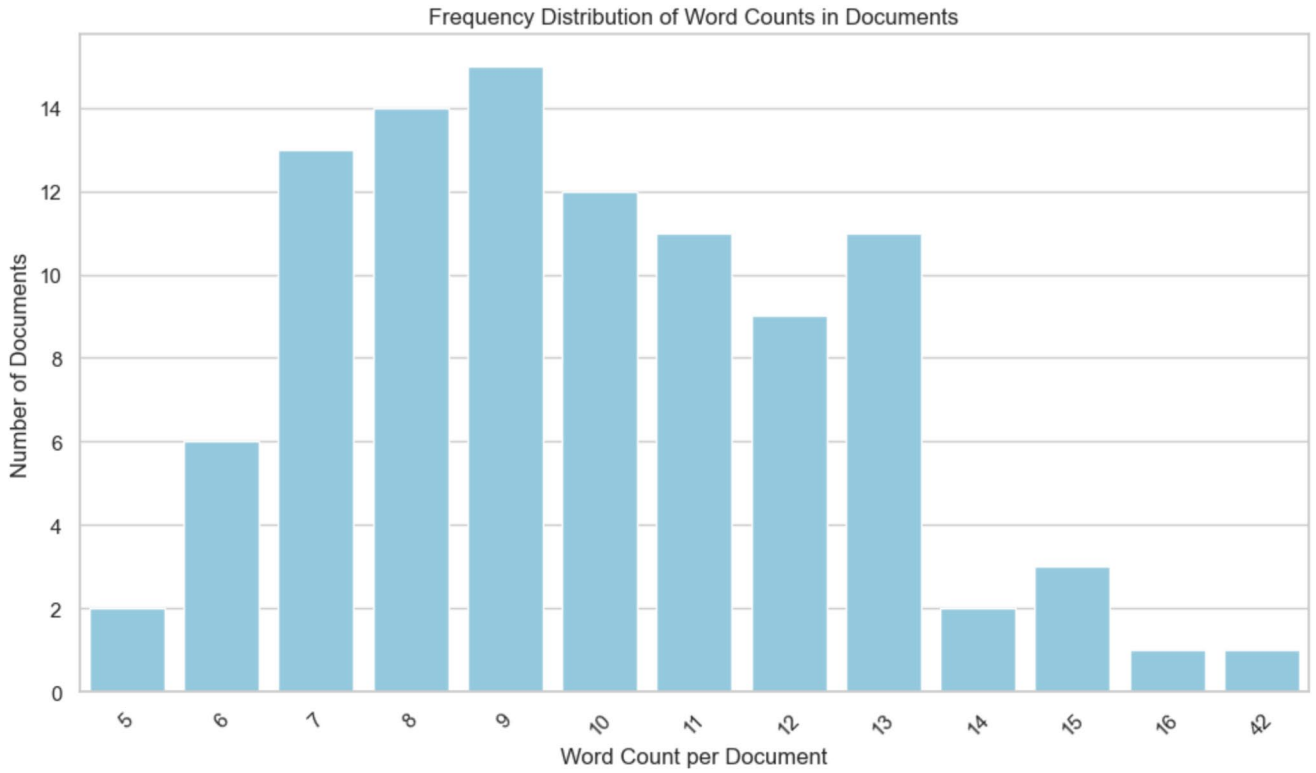

Fig. 9 Word Frequency and Document Count (whole Corpus). **Source:** Authors' conception (2025)

document with 42 words appears to be an outlier, possibly a longer abstract or unfiltered record.

For LDA to work well and infer the credible results it should have moderate number of word counts, greater than 5. LDA doesn't work efficiently and interpret probable topics, if a document is containing less than 5 words [12]. This visualization reaffirms that the modelling is done in an efficient & optimized manner.

3.8 Emerging themes and subthemes

Table 1 represents the theme and sub-themes in the research domain of customer experience on metaverse as per our analysis and results of topic modelling. The tables present the emerging sub-themes for each dominant topic.

3.9 Conceptual model

A conceptual model synthesizing research landscape mapping of Customer Experience (CX) in the Metaverse and reflecting dual analysis of bibliometrics and topic modelling is presented in Fig. 10. The main forces processes and results of Metaverse Customer Experience (MVCX) are depicted in the conceptual model. The choice of constructs is informed by bibliometric research at the macro level guaranteeing a thorough empirically supported framework. Technological and platform affordances like immersion presence extended reality (XR) and avatars are examples of antecedents AI and analytics capabilities like chatbots sentiment detection and personalization digital assets and economy components like NFTs and tokenization consumer factors like trust identity and social influence and organizational capabilities like data management ethics and design competence. The MVCX itself is shaped by the mediators that are influenced by these antecedents, particularly co-creation flow and emotional engagement. Results like engagement purchase intent loyalty customer lifetime value (CLV) and advocacy are subsequently fueled by the improved customer experience. Platform type device continuity cultural context and regulatory environment are examples of moderators that the model acknowledges as having the power to either reinforce or erode the connections between antecedents, mediators and outcomes. The dynamic interaction of technology consumer behavior and organizational strategy in creating engaging significant metaverse experiences is generally captured by this framework.

3.10 Implications

The following sections address the practical and theoretical implications of the current research study.

Table 1 Emerging Topics and Sub-topics in the research stream of customer Experience on Metaverse

Main Topic	Sub-Topic	Citations
Customer Experience Enhancement	Personalized Virtual Experiences	[24, 25]
	Customer Journey Mapping in Metaverse	[26, 27]
	Gamification in Enhancing Engagement	[28]
	Virtual Tourism Experiences	[29, 30]
Brand Engagement and Virtual Services	Immersive Brand Storytelling	[31]
	Virtual Service Co-creation	[32]
	Trust-building in Virtual Commerce	[24]
	Virtual Customer Relationship Management (VCRM)	[31, 32]
Marketing Research Trends in CX	Systematic Reviews on CX in Virtual Contexts	[33]
	Bibliometric Analyses of CX Literature	[34]
	Evolution of Marketing Models in Virtual Environments	[35, 36]
	CX Metrics and Measurement in Immersive Settings	[29]
Digital Marketing Impact and NFT Adoption	Perceived Value and Ownership in NFTs	[37]
	NFTs and Brand Identity Formation	[38]
	Digital Scarcity and Exclusivity Marketing	[39]
AI-Driven Engagement and Mediation	AI-powered Personalization in CX	[40]
	Ethical Considerations in AI-mediated CX	[41, 42]
	Chatbots and Conversational Agents in Engagement	[43]
Immersive Business and Value Creation	Immersive Customer Value Co-creation	[44]
	Smart Retail and XR Integration	[43]
	Business Model Innovation in Virtual Economies	[45]
Consumer Behavior in Virtual Retail	Virtual Store Atmospherics and Customer Response	[45, 46]
	Social Influence and Peer Reviews	[47, 48]
	Impulse Buying in Virtual Environments	[49, 50]

Source: Authors' conception (2025)

3.10.1 Theoretical implications

This study employs a structured approach to understand the evolution of CX research in the metaverse. A methodology combining bibliometric analysis with Latent Dirichlet Allocation (LDA) topic modeling was used to identify the core clusters. The conceptualization of the studies were mostly found to have extensive employment of foundational theories such as Service-Dominant Logic (SDL), Flow Theory, Presence Theory, etc. This study shows AI and ML are transforming marketing theory, challenging existing ideas and creating new perspectives across the key areas summarized below.

a) *Marketing Theory:* AI/ML-driven personalization, dynamic pricing, and predictive targeting have changed the traditional marketing frameworks. While the 4Ps are based on product, price, place, and promotion, AI/ML relies on adaptation of these elements in real time. Therefore theories based on consumer behavior models and predictive analytics are providing insights into decision-making and reshaping theories of brand loyalty, customer journey mapping, etc. [51]. Similarly, SDL framework views service as the fundamental basis of exchange, where operant resources (skills, knowledge, relationships, etc.), and operands (things, artifacts, etc.), can be visualised as the primary factors in value co-creation [52]. The metaverse provides an environment in integrating haptic and 3D presence to enhance the experience as the bibliometric mapping revealed a strong association in marketing, Human–Computer Interaction (HCI), and psychology. The convergence of customer experience with human skills, personalization, processes, etc. was evident and implies that the classical theories should be revisited for adaptation of marketing mixes and brand engagement.

b) *Technology Adoption and Diffusion Theory:* The Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) are centered on the usefulness and ease of use [53]. The determinants of adoption of technology and in the context of metaverse it is not confined to the efficiency but also to experiential value, ease in navigation, social connectivity etc. [54]. Emerging research suggests that the TAM must be expanded with new constructs focused on trust, interaction quality, presence and immersion, etc. The other influencing factors may be identified as the privacy, personalization quality, and digital well-being that essentially impacts the adoption [55]. In AI/ML contexts, perceived usefulness and experiential outcomes are derived from trust, fairness, immersion, and personalization [56]. Similarly, innovation diffusion theory assess the organizational readiness, consumer adoption, transparency, and ethical safeguards to succeed [57]. The broad implication of adoption and diffusion theories is to integrate algorithmic trust, data privacy, and perceived fairness as antecedents in AI/ML adoption.

c) *Data-Driven Analytics, Organizational and Strategic Theories:* AI/ML contributes significantly to data-driven marketing theories as predictive and prescriptive modeling creates new constructs that are associated with data maturity, marketing dynamics and performance [58]. Theories of marketing intelligence should therefore evolve to accommodate automated pattern recognition, adaptive learning loops, and predictive foresight as key drivers of performance [59]. Therefore, data-driven frameworks should theorize how analytics capabilities co-evolve with organizational maturity, producing

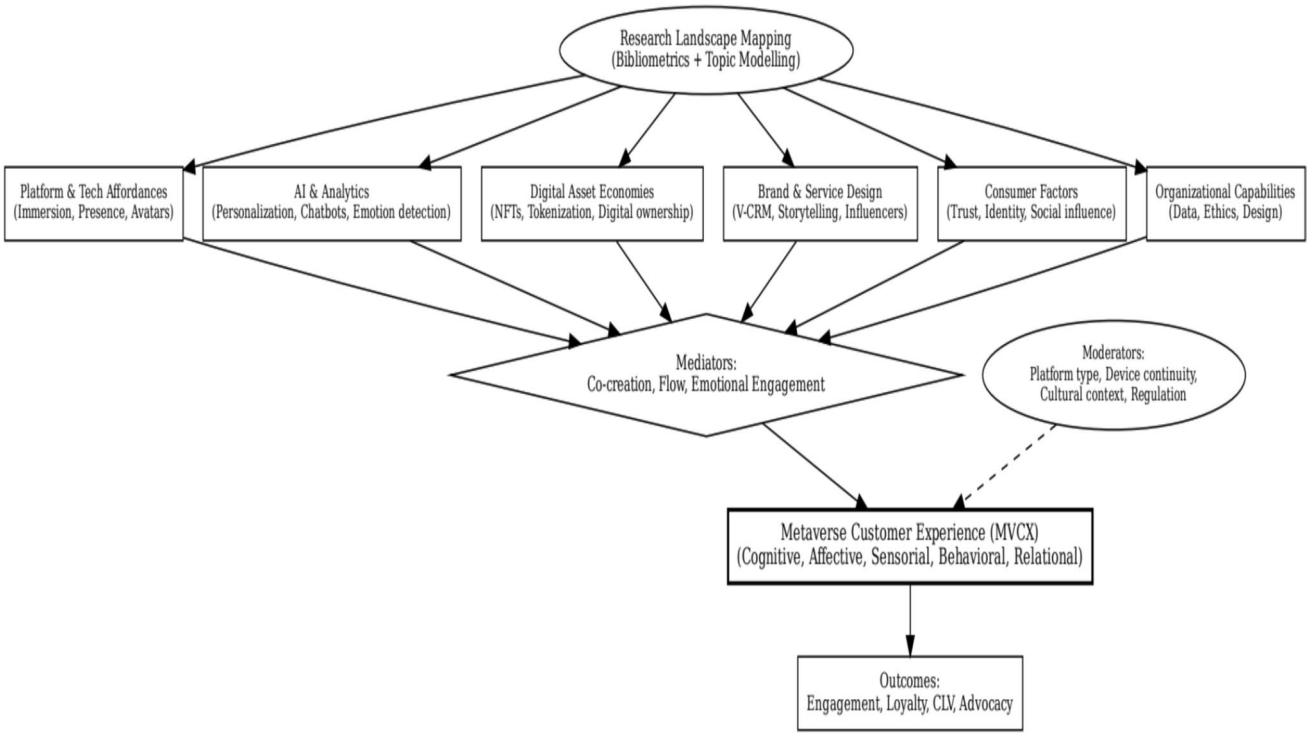

Fig. 10 Conceptual Model for CX in Metaverse. **Source:** Authors' conception (2025)

new pathways for customer insight and competitive advantage. From a Resource-Based View (RBV), AI/ML constitutes not just technological assets but strategic capabilities that enable sustained advantage [60]. Dynamic capabilities theory is similarly extended as firms use algorithmic agility, data infrastructure, and cross-functional integration to reconfigure marketing strategies in real time [61]. Strategic marketing theories, such as relationship marketing and competitive positioning, are being reframed by AI-mediated collaboration and adaptive decision-making autonomy [3]. Strategic and organizational theories should theorize AI/ML as both operant resources and dynamic enablers that enhance marketing agility, collaboration, and positioning.

3.10.2 Managerial implications

The thematic maps and trends reveal strong managerial relevance. Practically, it offers insights to organizations seeking to optimize brand presence and engagement strategies in virtual environments, actionable insights on designing transformational immersive avatar-mediated experiences, leveraging artificial intelligence (AI), gamification, and virtual branding to enhance enhancement and value co-creation. Businesses aiming to enter or expand within metaverse platforms must shift from conventional experience strategies toward hyper-personalized, gamified, and emotionally resonant interactions. The insights on AI-driven engagement and ethical mediation imply that real-time feedback loops and adaptive virtual service agents are becoming essential. Topics like NFT adoption, immersive brand storytelling, and virtual CRM provide strategic guidance for marketers seeking to leverage tokenized loyalty programs and branded virtual goods to drive engagement and trust. Moreover, the global expansion of scholarly attention with countries like India, Malaysia, and South Korea taking the lead, suggests practical collaborations for metaverse product localization and market-specific adaptation.

Based on the above implications for the marketers a decision tree is prepared and presented in Fig. 11 for a reference and action point for the marketers. The decision tree provides marketers with a structured roadmap for navigating customer experience (CX) strategies in the metaverse.

3.11 Limitations, conclusion and future research directions

3.11.1 Limitations

Although the use of both bibliometric and topic modelling techniques provides robust analytical depth, this study has several limitations. Firstly, the dataset is limited to publications indexed in selected databases, potentially excluding grey literature or non-English contributions that may hold cultural or regional insights. Secondly, while topic

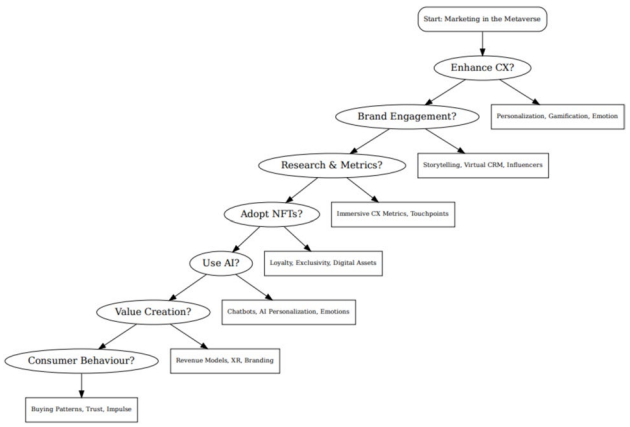

Fig. 11 Decision Tree for Marketers. **Source:** Authors' conception (2025)

modelling via LDA offers semantic structure, it does not account for deeper contextual relationships or citation networks across themes. Thirdly, the partial data for 2025 may underrepresent recent publication trends and citations.

4 Conclusion

This study mapped the emerging research landscape of customer experience in the metaverse through a dual lens of bibliometric and topic modelling analysis, covering over two decades of scholarly output. It identified seven dominant themes, highlighting both mature areas (e.g., CX enhancement, consumer behaviour in virtual retail) and nascent topics requiring deeper inquiry (e.g., NFT marketing strategies, AI-based mediation). The findings underscore the shift from transactional digital touchpoints to deeply immersive, co-created, and emotionally anchored customer journeys. Through the integration of foundational theories with emerging constructs, the paper offers a conceptual springboard for scholars and practitioners to rethink customer engagement in three-dimensional, avatar-based economies. The metaverse, as an experiential space, challenges existing paradigms of consumer behaviour, loyalty, and brand experience thus necessitating a reconceptualization of both theoretical frameworks and practical applications.

4.1 Future research directions

Numerous directions for further research become apparent. First off to improve empirical rigor validated Metaverse Customer Experience (MVCX) scales that consider interactivity immersion co-presence and digital ownership are obviously needed. In addition to creating new concepts like avatar identity digital embodiment and persistent social presence scholars must address how the current CX theories—Service-Dominant Logic Flow TAM and Touchpoint Theory—can be expanded for immersive environments. Resolving theoretical tensions between presence versus detachment and acceptance versus resistance to technology requires hybrid theoretical frameworks that integrate consumer psychology affective computing social presence and digital ethics. In the future comparative studies between platforms (Roblox vs. sectors (retail vs. travel versus. healthcare) as well as cultural settings that investigate how people react to virtual experiences individually versus collectively. Methodologically CX evolution can be tracked through longitudinal studies that use new data sources such as biometric information VR eye tracking in-world behavioral logs and voice sentiment analysis in conjunction with mixed-methods approaches. Concerns about privacy manipulation informed consent and digital well-being must be urgently examined as AI-driven avatars conversational agents and blockchain technologies mediate interactions more. Negative CX dimensions (disorientation digital fatigue) temporal CX phases (pre-experience anticipation in-experience flow post-experience recall) cross-device experience continuity and societal themes of inclusivity and accessibility are among the understudied areas. Proactive research is required for future ecosystems that integrate Web3 IoT and smart cities. The metaverse ultimately signifies a compelling redefinition of the customer experience as one that is participatory persistent and deeply personal—both a challenge and a frontier.

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