



ORIGINAL RESEARCH ARTICLE

Proposed Model of Applying the Metaverse in the Banking Industry

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ABSTRACT

This study develops a framework for integrating the Metaverse into the banking industry to enhance customer experience, improve efficiency, and support digital transformation. With the growth of the Fourth Industrial Revolution and the advancement of digital technologies, banks must adopt innovative tools to remain competitive and deliver superior services.

A mixed-method design was applied, combining qualitative meta-synthesis and quantitative analysis. From 200 studies on Metaverse in banking, 35 were selected for detailed review. In the qualitative stage, MAXQDA 2020 enabled initial, axial, and pattern coding to identify major themes. The Fuzzy Delphi Method was then conducted with 15 experts in banking technology and information systems across two rounds to refine and validate indicators. In the final stage, a structured questionnaire was administered to 300 banking professionals, and the data were analyzed using descriptive statistics and structural equation modeling (SEM).

Findings validated 98 indicators organized into nine categories: customer experience, digital services, security and privacy, infrastructure and technology, marketing and branding, human resource development, data analytics, applied technologies, and operational features. Together, these categories form a structured roadmap for applying Metaverse solutions in banking, balancing customer-centered innovation with internal process optimization. The study concludes that successful Metaverse adoption in banking depends on strategic alignment, governance, and active institutional participation in digital ecosystems. The proposed framework offers practical guidance for leveraging Metaverse opportunities to improve efficiency, strengthen customer engagement, and accelerate digital transformation in banking.

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## **Introduction**

The metaverse has recently attracted growing attention as an immersive and interconnected digital environment that integrates emerging technologies such as virtual reality (VR), augmented reality (AR), artificial intelligence (AI), blockchain, and Web 3.0 (Rahman & Theodoraki, 2024). Researchers argue that the metaverse has the potential to reshape various industries, including financial services and banking, by providing new modes of customer interaction and service delivery (Zainurin et al., 2023).

In the financial sector, the concept of metaverse banking has been introduced as a new channel that combines elements of digital and online banking with immersive 3D environments. Such innovations enable banks to explore opportunities such as virtual branches, avatar-based customer services, immersive financial education, and blockchain-enabled transactions (Zainurin et al., 2023; Iqbal et al., 2024). However, alongside these opportunities, studies also highlight significant challenges, including technological readiness, data security, regulatory uncertainty, and cultural acceptance (Iqbal et al., 2024).

Several global banks have already taken experimental steps into the metaverse. For example, JPMorgan launched its “Onyx Lounge” in Decentraland, while HSBC acquired virtual land in The Sandbox, aiming to enhance customer engagement and explore new digital branding opportunities (Rahman & Theodoraki, 2024). These initiatives illustrate that the metaverse can potentially serve not only as a marketing tool but also as a disruptive innovation in the future of financial services.

In Iran, the banking industry has experienced a steady digital transformation over the last two decades, moving from traditional systems to electronic and mobile banking. Nevertheless, the adoption of advanced technologies such as blockchain, AI, and immersive platforms remains limited due to infrastructural and regulatory challenges. At the same time, Iran benefits from a young, digitally literate population and an expanding fintech ecosystem, both of which present opportunities for metaverse-based banking applications.

This study seeks to contribute to the literature by conducting a meta-synthesis of existing research to identify the key themes, opportunities, and challenges associated with metaverse adoption in banking. Based on these findings, the paper proposes a conceptual framework for the adoption of the metaverse in the Iranian banking sector, with implications for policymakers, banks, and fintech companies.

## **Literature Review**

The rapid evolution of the metaverse presents significant opportunities and challenges for the banking sector. As an immersive three-dimensional digital environment, the metaverse enables innovative customer experiences, virtual service delivery, and employee training. This literature review synthesizes recent research on metaverse banking, highlighting applications, technologies, challenges, and strategic implications.

Rahman and Theodoraki (2024) analyzed bank entry into the metaverse, examining JPMorgan and HSBC operations in Decentraland and The Sandbox. They concluded that the metaverse offers valuable tools for marketing, customer engagement, and innovation in financial services, but emphasized challenges such as cybersecurity risks, high costs, and unclear regulatory frameworks. Iqbal et al. (2024) interviewed industry experts and identified applications including avatar-based financial consulting, virtual branches, and digital asset

management. Despite these opportunities, customer trust, regulatory ambiguity, and cybersecurity remain critical obstacles.

From a technological standpoint, Aysan, Gozgor, and Nanaeva (2024) examined key technologies, including artificial intelligence, blockchain, mixed reality, and metaverse economy design, emphasizing the necessity for banks to actively govern these digital environments. Amiri (2024) explored the transformative potential of metaverse technologies on banking operations, including customer engagement, virtual branch design, digital service delivery, and employee training. These studies indicate that banks adopting metaverse solutions can enhance operational efficiency, skill development, and customer satisfaction while facing regulatory and technological challenges. In the educational context, Mohammadesmaeil and Ghaheri (2025) proposed a hybrid framework to train students in building information modeling (BIM) within immersive metaverse environments. Their findings highlight the benefits of interactive learning, spatial understanding, and collaboration, offering insights for designing virtual financial training programs. Similarly, Zainurin et al. (2023) conceptualized metaverse banking as a combination of online banking and interactive 3D environments that foster innovative and engaging customer experiences. Kumar and Shankar (2024) examined multiple dimensions of metaverse banking, including retail, corporate, employee, and policy perspectives. The results suggest that the metaverse enhances customer experience and provides opportunities for employee training and innovative business models. Technological and infrastructural challenges have been highlighted by Rawat and Elalami (2023), who emphasized cybersecurity, data standardization, and legal issues as critical concerns. Parlar (2023) classified virtual financial crimes, including money laundering, fraud, and identity theft, underscoring the need for robust regulatory frameworks. Bhattacharya and Singla (2024) addressed strategic implications, noting that banks must innovate products and services to meet immersive digital demands while overcoming technological adoption barriers, cybersecurity threats, interoperability issues, and organizational change management. Seth, Gupta, and Singh (2022) further demonstrated that immersive VR/AR environments enhance customer interactions, employee training, and operational performance, highlighting the necessity of secure infrastructures and compliance measures. Long-term investment opportunities in the metaverse were discussed by Aysan, Gozgor, and Nanaeva (2020), emphasizing virtual real estate, digital assets, and tokenized financial products as emerging avenues for capital inflows. However, market volatility, regulatory uncertainty, and governance challenges must be considered to maintain financial stability in virtual spaces. In conclusion, the literature indicates that metaverse banking holds substantial potential to transform financial services, improve customer experience, and innovate operational and training processes. At the same time, significant challenges, including cybersecurity, regulatory compliance, technological adoption, and organizational change, must be addressed. These insights provide a foundation for future research and practical strategies to guide banks in effectively integrating metaverse solutions.

## **Method**

The research method employed in this study is a combination of the meta-synthesis method and a Fuzzy Delphi panel, which were utilized to extract key parameters and design a questionnaire for the quantitative phase. In the qualitative stage, the meta-synthesis approach was applied to systematically collect and analyze scholarly articles related to the application of the metaverse in the banking industry. Codes were extracted from the selected studies and synthesized to build a comprehensive conceptual framework. The meta-synthesis method was chosen due to its ability to integrate findings from diverse studies and generate reliable and holistic results (Sandelowski & Barroso, 2006). The identified categories and indicators

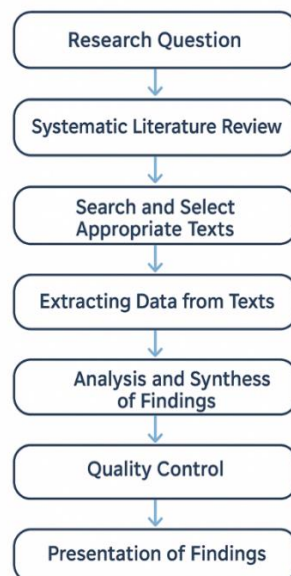
were then organized into a structured checklist and submitted to the Fuzzy Delphi panel for expert validation.

The Delphi panel consisted of 15 experts, including senior academics and banking professionals with specialization in financial technologies, digital banking, and digital transformation. The Fuzzy Delphi method was conducted in three iterative rounds to refine the framework and achieve consensus on the most significant factors influencing the adoption of the metaverse in banking. Based on the validated results of the Delphi process, a research questionnaire was developed for the quantitative analysis.

In the quantitative phase, the questionnaire was distributed among 300 respondents, including banking professionals, IT experts, and postgraduate students specializing in financial technologies. The data were analyzed using structural equation modeling (SEM) with SMART PLS, enabling the identification of relationships between variables and the validation of the proposed model. By confirming these data, it was possible to propose a robust and comprehensive model for applying the metaverse in the banking industry.

### ***Quantitative Method***

A meta-synthesis methodology was applied to synthesize and integrate findings from various studies related to the adoption of the metaverse in the banking industry. The meta-synthesis method was selected due to its ability to yield reliable results and ensure the alignment of high-quality data. This approach was developed by integrating findings from multiple studies, resulting in comprehensive outcomes that significantly contributed to identifying the key parameters and requirements for implementing the metaverse in banking services. The meta-synthesis process was structured according to Sandelowski and Barroso's framework and consisted of seven steps, as depicted in Figure 1 (Sandelowski & Barroso, 2006). Subsequently, MAXQDA software was utilized to code and analyze the data derived from the meta-synthesis method, enabling the systematic organization of concepts and categories that formed the foundation of the proposed conceptual framework.



**Figure 1.** Seven steps of meta meta-synthesis method

### ***Research Questions***

At this stage, the researchers have addressed the four initial fundamental questions regarding the study of Metaverse applications in the banking industry:

**Table 1.** Research Questions Overview

WH	Description
What?	Dimensions and influential factors for applying Metaverse technology in banking
Who?	Academic databases, journals, conferences, and diverse search engines
When?	Studies and publications from 2018 to 2025
How?	Document analysis of the selected sources

#### 4. Findings

##### *Systematic Literature Review*

The keywords employed to systematically search multiple databases for relevant and high-quality literature within the specified timeframes are presented in Table 2.

**Table 2.** Keywords for Banking Metaverse

Keywords
Metaverse
Banking Industry
Digital Banking
Virtual Reality (VR)
Augmented Reality (AR)
Financial Technology (FinTech)
Customer Experience

##### *Search and Select Relevant Texts*

In this phase, a textual analysis was conducted, guided by specific inclusion and exclusion criteria (Yahyapour, Shamizanjani, & Mosakhani, 2015; Weed, 2006). Utilizing keywords related to the Metaverse in the banking industry and Augmented Reality (AR), articles were collected and subsequently reviewed for titles, abstracts, and content. The Critical Appraisal Skills Programme (CASP) was employed to categorize sources into quality levels based on a scoring range of 0 to 50. Sources scoring below 21 were excluded from further analysis.

Acceptance criteria for meta-synthesis included studies published in English or Persian between 2018 and 2025 that employed qualitative, quantitative-qualitative, or case study methodologies. Various study types, including articles, books, theses, organizational and institutional reports, as well as master's and doctoral dissertations, were considered. The detailed process of searching for and selecting relevant articles is visually represented in Table 3.

**Table 3.** Detailed process

Step	Description	Number of Articles
Initial Search	Articles collected using keywords: Metaverse, Banking Industry, Digital Banking, VR, AR, FinTech, Customer Experience from databases such as Scopus, Web of Science, Google Scholar, IEEE Xplore, Springer	200
Title & Abstract Screening	Articles reviewed for relevance based on title and abstract; irrelevant articles excluded	120
Full-Text Review	Detailed review of content to ensure topic relevance and quality	60
Quality Assessment	Evaluation using CASP tool (score range 0–50); articles scoring <21 excluded	35
Final Selection	Articles eligible for meta-synthesis or final analysis	35

This table illustrates the systematic process of searching, screening, and selecting articles for textual analysis and meta-synthesis. Initially, 200 articles were collected from reputable databases such as Scopus, Web of Science, Google Scholar, IEEE Xplore, and Springer using keywords related to the Metaverse, banking industry, digital banking, virtual reality (VR), augmented reality (AR), FinTech, and customer experience. In the next step, titles and

abstracts were reviewed to assess relevance, resulting in the exclusion of 80 articles and leaving 120 for full-text examination. A detailed review of the content ensured the selection of 60 articles with high topic relevance and quality. The quality assessment was conducted using the CASP tool (score range 0–50), excluding 25 articles scoring below 21. Ultimately, 35 articles were deemed eligible for meta-synthesis and final analysis. This process demonstrates a rigorous and systematic approach to ensure the reliability, quality, and relevance of the sources used in the study.

#### ***Data Extraction from Selected Articles***

In this phase, concepts and coding were derived through iterative analysis of the 35 selected articles, conducted multiple times throughout the meta-synthesis process. Contextual analysis was employed to systematically examine and present the synthesized findings.

#### ***Analysis and Synthesis of Findings***

Context analysis is a qualitative approach used to identify, examine, and articulate patterns within data, providing a detailed organization and description of the information. Beyond mere description, it also enables the interpretation of various facets of the research topic (Thomas, 2003). Through this process, descriptive codes were applied to each segment of the data. The analysis was facilitated using MAXQDA software, and the results of this step are presented in Step 7.

#### ***Quality Control***

The meta-synthesis approach emphasizes the importance of quality control to ensure the success of the process. This study relied on reputable databases to select sources, and any items that did not meet the required quality and validity standards were removed from the analysis. Finally, the reliability of the designed model was measured using the Kappa index. The codes and concepts created by the researcher were classified by another expert, who was blind to the integration process. Subsequently, the concepts offered by the researcher were compared with those provided by this expert. The Kappa index was determined to be 0.696, indicating substantial agreement (Li et al, 2023).

#### ***Presentation of Findings***

Table 4 presents a total of 106 indicators, which were extracted through a thorough textual analysis of collected articles and sources. Each text was carefully reviewed, key concepts were identified, and subsequently coded as individual open codes. These indicators are organized into nine categories: Customer Experience, Digital Banking Services, Security & Privacy, Infrastructure & Technology, Marketing & Branding, HR Training & Development Indicators, Data Analytics & Business Intelligence, Applied Technologies, and Practical Features, reflecting the results of the previous six steps.

These categories were developed through meticulous data analysis to ensure that each code captures a distinct aspect of Metaverse applications in the banking industry. Among the 106 open codes, 32 representative codes are presented in Table 4 to provide a clear overview of the structure and diversity of the data. The complete Table 4 is provided in the Appendix, offering a comprehensive view of the coding process and the foundation for developing the conceptual framework.

#### ***Axial Codes (Core Concepts) Identification***

The axial codes presented in the table below represent the core concepts derived from the open codes extracted through systematic analysis of the literature on metaverse adoption in the banking industry. These codes summarize and categorize key dimensions and features, highlighting the main areas that influence adoption. By organizing the indicators into axial

codes, the table provides a clear structure for understanding the relationships between the underlying concepts, making it easier to interpret how each dimension, such as customer experience, digital banking services, security, infrastructure, marketing, HR development, data

Analytics, applied technologies, and practical features contribute to the effective implementation and acceptance of metaverse solutions in banking.

**Table 4.** Indicators in Metaverse Banking

Categories	Indicators	References
<b>1. Customer Experience</b>	Personalized VR Banking Journeys	(Kumar et al., 2024)
	Immersive Virtual Branch Experience	(Law et al., 2024)
	AI-driven Empathetic Avatars	(Ramadan & Ramadan, 2025)
	Data-Enhanced Immersion for Personalization	(Manta & Gherțescu, 2025)
	Trust-building through Secure Virtual Interactions	(Kumar et al., 2024), (Cristache et al, 2024)
	Community-driven Virtual Banking Spaces	(Kumar et al., 2024)
	Seamless Cross-Channel User Experience	(Law et al., 2024), (Socrates Journal, 2024)
	Gamified Loyalty and Reward Systems	(Cristache et al., 2024)
	Virtual Financial Advisory & Consultation Services	(Law et al., 2024), (Socrates Journal, 2024)
<b>2. Digital Banking Services</b>	Mobile Banking App Usability	(Al-Qudah et al., 2024)
	Digital Onboarding Efficiency	(Mousavi et al., 2025)
	AI-driven Personalization	(Ramadan & Ramadan, 2025)
	Multi-Channel Integration	(Abeywardana & Jayasinghe-Mudalige, 2022)
	Real-Time Customer Support	(Abeywardana & Jayasinghe-Mudalige, 2022)
	Security & Fraud Detection	(Mousavi et al., 2025),
	Mobile Payment Adoption	(Al-Qudah et al., 2024)
	Digital Loan Application Efficiency	(Stanford, 2025)
	Customer Engagement via Notifications	(Abeywardana & Jayasinghe-Mudalige, 2022)
	App Downtime & Reliability	(Al-Qudah et al., 2024), (Stanford, 2025)
Usage Analytics & Insights	(Abeywardana & Jayasinghe-Mudalige, 2022)	
<b>3. Security &amp; Privacy</b>	Impact of security measures on customer trust	(Chen et al., 2023), (Gan et al., 2022)
	Frequency of cyber-attacks in metaverse platforms	(Cheng et al., 2023), (Huang & Zhang, 2023)
	Effectiveness of zero-trust authentication systems	(Cheng et al., 2023)
	Rate of sensitive user data exposure	(Alkaeed et al., 2023), (Chen et al., 2023)
	Effectiveness of encryption algorithms for privacy	(Alkaeed et al., 2023), (Parlar, 2023)
	Compliance with international security standards	(Kumar et al., 2024)
	User awareness and training on security	(Huang & Zhang, 2023)
	Customer satisfaction with implemented security measures	(Manta & Gherțescu, 2025)
	Use of blockchain for secure transactions	(Chen et al., 2023), (Gan et al., 2022)
	Transparency of privacy policies	(Parlar, 2023), (Alkaeed et al., 2023)
	User satisfaction with control over personal data	(Manta & Gherțescu, 2025), (Huang & Zhang, 2023)
Effectiveness of threat monitoring and response systems	(Cheng et al., 2023)	

The extracted open codes were analyzed and transformed into axial codes. At this stage, similar or related codes were grouped into logical categories (such as customer experience, digital banking services, security and privacy, etc.).

**Table 5.** Axial Codes

Category	Axial Codes (Core Concepts)
Customer Experience (CE)	Personalized & Immersive Banking Experience; Trust & Security in Virtual Interactions; Community Engagement & Gamification; Seamless Cross-Channel Experience
Digital Banking Services (DBS)	Multi-Channel Digital Services; AI-driven Personalization & Analytics; Digital Onboarding & Loan Efficiency; Real-Time Support & App Reliability; Security & Fraud Detection
Security & Privacy (SP)	Cybersecurity Effectiveness; Data Privacy & User Control; Compliance with Standards; Threat Monitoring & Response; Blockchain-enabled Secure Transactions
Infrastructure & Technology (IT)	Platform Interoperability & Scalability; Adoption of Immersive Technologies (VR/AR/MR); Edge Computing & Cloud Infrastructure; Blockchain & Smart Contract Integration; Data Analytics & Monitoring

Marketing & Branding (MB)	Virtual Brand Engagement; Immersive Marketing Campaigns & Conversion; User Interaction & Community Growth; Influencer & Avatar Effectiveness; Customer-driven Marketing Collaboration
HR Training (HR)	Immersive Employee Training; Continuous Learning & Knowledge Sharing; Leadership & Remote Collaboration Skills; Gamified Skill Category Development; Training Cost Efficiency
Data Analytics (DA)	Real-Time Analytics & Insights; Predictive Modeling of Customer Behavior; User Segmentation & Engagement Metrics; Data Governance & Compliance; AI-assisted Anomaly Detection
Applied Technologies (AT)	Avatars & Virtual Agents; Virtual, Augmented, and Mixed Reality Tools; Metaverse Platform Technologies; Digital Tool Integration & Automation
Practical Features (PF)	Accessibility & Convenience; Design Efficiency, Accuracy & Speed; Creativity & Innovation; Safety, Security & Feasibility; Communication & Collaboration Enhancement

The purpose of this step was to clarify the relationships between concepts and create a coherent structure for analysis. Each axial code represents a core concept that encompasses a set of related dimensions and features, highlighting the areas that influence metaverse adoption. Finally, the axial codes and their associated concepts were summarized in Table 5 to provide an overall view of the conceptual structure and key indicators of metaverse adoption in banking.

**Fuzzy Delphi Method**

While experts rely on their cognitive skills and abilities to make comparisons, it should be noted that traditional methods of quantifying opinions cannot fully capture the complexity of human reasoning. In other words, fuzzy sets are better suited for linguistic and sometimes ambiguous human expressions, especially in the context of emerging technologies such as the metaverse and digital banking services. Therefore, fuzzy sets (using fuzzy numbers) are considered a preferred method for long-term forecasting and supporting strategic decision-making in real-world scenarios. The indicators were evaluated using the fuzzy approach based on the assessments of 15 experts in banking technologies and information systems. The Fuzzy Delphi Method was applied in two rounds to refine and validate all indicators, with the results presented in the Appendix. The key parameters influencing the adoption and implementation of the metaverse in the banking industry are shown in Figure 2.



Figure 2. Conceptual model of parameters for banking services in Metaverse

### ***Quantitative Section***

The validation and analysis of the questionnaire were conducted based on categories and indicators derived from the meta-synthesis and Fuzzy Delphi panel. The finalized questionnaire was distributed among a sample of 300 participants, including banking professionals, fintech experts, and customers familiar with digital financial services. The statistical sample included 175 men and 125 women, with 30% holding master's degrees and 70% holding PhDs, representing diverse age groups. To assess the normality of the collected data, the Kolmogorov-Smirnov test was applied. The results indicated a P-value below 0.05, suggesting that the data did not follow a normal distribution. Given this non-normality, SmartPLS was employed as the most suitable method for modeling the relationships among variables.

The research model was evaluated using the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique. In this framework, the model consists of two main components: the measurement model and the structural model. The measurement model examines the reliability and validity of latent constructs, while the structural model tests the hypothesized relationships among the constructs. The variables in the model were categorized as latent (unobservable) and manifest (observable), in line with best practices in SEM-based research. This quantitative approach enabled a robust validation of the proposed framework, ensuring that the identified indicators, including customer experience, digital banking services, security and privacy, infrastructure and technology, marketing and branding, HR training, data analytics, applied technologies, and practical features accurately reflect the factors influencing metaverse adoption in the banking industry.

### ***Assessing Measurement Model Fit***

To ensure the quality and suitability of the research questionnaire for evaluating metaverse adoption in the banking industry, three key criteria were applied: reliability, convergent validity, and discriminant validity. Reliability was assessed to confirm the consistency of responses across various indicators, including customer experience, digital banking services, security and privacy, technology infrastructure, marketing and branding, HR training and development, and data analytics. Convergent validity was examined to ensure that each indicator effectively measures its intended aspect. Discriminant validity was evaluated to verify that the indicators are distinct from one another, ensuring that each dimension of metaverse adoption is captured independently.

### ***Questionnaire Design***

In the quantitative phase, purposive sampling was employed to select participants with relevant knowledge and practical experience in digital banking and financial technologies. Inclusion criteria consisted of at least one year of work experience in the banking or fintech sector, familiarity with digital banking services, and understanding of metaverse concepts. Exclusion criteria included lack of relevant experience, insufficient familiarity with digital banking services, or unwillingness to complete the questionnaire. This sampling strategy ensures that the collected data reflect valid and practical perspectives on metaverse adoption in banking and are representative of the target population. Employing this approach enhances data quality and guarantees that the quantitative analyses are based on accurate, industry-relevant information.

The questionnaire was developed based on the indicators identified through the meta-synthesis method and validated by the Fuzzy Delphi technique. The final instrument consisted of two parts: (1) demographic information (including gender, age, education, work experience, and familiarity with digital technologies/metaverse), and (2) 27 items related to the main research indicators such as customer experience, digital banking services, security and privacy, infrastructure and technology, marketing and branding, human resource training, data analytics, applied technologies, and practical features. All items were measured on a five-point Likert scale ranging from "strongly disagree" (1) to "strongly agree" (5).

The questionnaire was then distributed among banking professionals, fintech experts, and customers familiar with digital financial services to collect data for quantitative analysis.

**Reliability**

To ensure the reliability of the research instrument measuring metaverse adoption in the banking industry, the internal consistency of the questionnaire was evaluated. Reliability was assessed using first-order factor loadings, Cronbach’s Alpha, and composite reliability (CR). Factor loadings above 0.4 and Cronbach’s Alpha and CR values above 0.7 indicate acceptable reliability. The results (Table 6) show that all dimensions of the questionnaire, including customer experience, digital banking services, security and privacy, infrastructure and technology, marketing and branding, HR training, data analytics, applied technologies, and practical features, achieved Cronbach’s Alpha and CR values above 0.7, confirming that the instrument is reliable for quantitative analysis.

*Table 6. Reliability and Composite Factors*

Variable	Factor Loadings Range	Cronbach’s Alpha	Composite Reliability (CR)
Customer Experience (CE)	0.62 – 0.87	0.892	0.913
Digital Banking Services (DBS)	0.58 – 0.83	0.864	0.895
Security & Privacy (SP)	0.64 – 0.85	0.882	0.901
Infrastructure & Technology (IT)	0.60 – 0.82	0.873	0.897
Marketing & Branding (MB)	0.57 – 0.81	0.851	0.884
HR Training (HR)	0.59 – 0.84	0.865	0.891
Data Analytics (DA)	0.61 – 0.80	0.859	0.889
Applied Technologies (AT)	0.63 – 0.86	0.886	0.902
Practical Features (PF)	0.58 – 0.82	0.864	0.893

The reliability of the measurement model was assessed using factor loadings, Cronbach’s Alpha, and Composite Reliability (CR). As shown in Table 6, all constructs achieved factor loadings above 0.55, and Cronbach’s Alpha and CR values exceeded the recommended threshold of 0.70. These results indicate that the questionnaire demonstrates strong internal consistency and reliability for evaluating metaverse adoption in the banking industry.

**Validity**

Validity is achieved when test questions accurately measure their intended purpose. When one or more characteristics are measured using two or more methods, the correlation between these measurements provides two key indicators of validity, convergent validity and discriminant validity, which are used to assess and confirm the accuracy of the questionnaire.

**Convergent Validity**

A strong correlation among test items measuring the same construct demonstrates the questionnaire’s convergent validity. To evaluate this, Average Variance Extracted (AVE) and Composite Reliability (CR) are computed. Convergent validity is established when AVE exceeds 0.5 and CR exceeds 0.7, with CR also being higher than AVE. As shown in Table 7, all constructs have AVE values above 0.5 and CR values above 0.7, with CR consistently greater than AVE, confirming the convergent validity of the questionnaire.

*Table 7. Convergent Validity Results (AVE and CR values)*

Variable	AVE	CR
Customer Experience (CE)	0.612	0.911
Digital Banking Services (DB)	0.581	0.892
Security & Privacy (SEC)	0.637	0.907
Infrastructure & Technology (INF)	0.595	0.893
Marketing & Branding (MKT)	0.572	0.881

<b>HR Training &amp; Development (HR)</b>	0.605	0.892
<b>Data Analytics &amp; BI (DA)</b>	0.561	0.886
<b>Applied Technologies (AT)</b>	0.629	0.908
<b>Practical Features (PF)</b>	0.58	0.89

### *Discriminant Validity*

To ensure that each construct of the measurement model captures a unique aspect of metaverse adoption in the banking industry, discriminant validity was assessed using the Fornell-Larcker criterion and the Heterotrait-Monotrait Ratio (HTMT).

### *Fornell-Larcker Criterion*

Discriminant validity is confirmed when the correlation between different constructs is low, indicating that each construct is more strongly associated with its own indicators than with those of other constructs. To evaluate this, the square root of the AVE for each construct is compared with the correlation coefficients between that construct and the other constructs. In this approach, a matrix is created where the diagonal elements represent the square roots of the AVE values for each construct, and the off-diagonal elements represent the correlations between constructs. As shown in Table 8, this comparison confirms the discriminant validity of the model.

*Table 8. Discriminant Validity Results Fornell Larcker Criterion*

Variable	CE	DBS	SP	IT	MB	HR	DA	AT	PF
<b>Customer Experience (CE)</b>	0.781								
<b>Digital Banking Services (DBS)</b>	0.524	0.763							
<b>Security &amp; Privacy (SP)</b>	0.492	0.503	0.791						
<b>Infrastructure &amp; Technology (IT)</b>	0.451	0.478	0.516	0.774					
<b>Marketing &amp; Branding (MB)</b>	0.443	0.462	0.472	0.491	0.752				
<b>HR Training (HR)</b>	0.436	0.448	0.452	0.471	0.482	0.761			
<b>Data Analytics (DA)</b>	0.427	0.453	0.465	0.482	0.474	0.493	0.743		
<b>Applied Technologies (AT)</b>	0.462	0.471	0.494	0.503	0.486	0.468	0.479	0.786	
<b>Practical Features (PF)</b>	0.445	0.457	0.471	0.486	0.469	0.472	0.453	0.488	0.772

In Table 8, the diagonal elements correspond to the square roots of the Average Variance Extracted (AVE) for each construct related to metaverse adoption in the banking industry. These diagonal values are higher than the off-diagonal elements, which represent the correlation coefficients between each construct and all other constructs in the model. This comparison confirms that each construct shares more variance with its own indicators than with indicators of other constructs, thereby establishing the discriminant validity of the measurement model.

### *Discriminant Validity using HTMT*

The Heterotrait-Monotrait Ratio (HTMT) is considered a modern and effective technique for evaluating discriminant validity within Partial Least Squares Structural Equation Modeling (PLS-SEM). Unlike traditional methods, HTMT assesses discriminant validity by comparing the geometric mean of correlations between indicators with the average correlations across constructs. The process begins with calculating the average correlations among observed variables for each construct, followed by computing the geometric mean of these values, which is then divided by the overall average correlation of all model indicators.

Compared to classical approaches such as the Fornell-Larcker criterion, HTMT provides a more rigorous and reliable measure for ensuring that constructs are distinct from one another. In this study, applying the HTMT criterion allowed us to confirm that the constructs related to metaverse adoption in the banking sector—such as customer experience, digital banking

services, security and privacy, infrastructure and technology, marketing and branding, HR training, data analytics, applied technologies, and practical features—are clearly differentiated. According to methodological standards, HTMT values below 0.90 indicate adequate discriminant validity.

As presented in Table 9, the HTMT results confirm that each construct in the questionnaire captures its unique dimension independently, thereby strengthening the validity of the measurement model.

**Table 9.** HTMT Matrix for Metaverse Adoption Constructs

	Customer Experience	Digital Banking	Security & Privacy	Infrastructure & Technology	Marketing & Branding	HR Training & Development	Data Analytics	Applied Technologies	Practical Features
Customer Experience (CE)	1.000	0.685	0.712	0.654	0.603	0.627	0.590	0.615	0.601
Digital Banking Services (DB)	0.685	1.000	0.678	0.632	0.600	0.615	0.589	0.607	0.592
Security & Privacy (SEC)	0.712	0.678	1.000	0.668	0.632	0.640	0.613	0.634	0.620
Infrastructure & Technology (INF)	0.654	0.632	0.668	1.000	0.610	0.625	0.598	0.620	0.605
Marketing & Branding (MKT)	0.603	0.600	0.632	0.610	1.000	0.589	0.570	0.592	0.580
HR Training & Development (HR)	0.627	0.615	0.640	0.625	0.589	1.000	0.592	0.611	0.598
Data Analytics & BI (DA)	0.590	0.589	0.613	0.598	0.570	0.592	1.000	0.605	0.590
Applied Technologies (AT)	0.615	0.607	0.634	0.620	0.592	0.611	0.605	1.000	0.608
Practical Features (PF)	1.000	0.685	0.712	0.654	0.603	0.598	0.590	0.608	1.000

Table 9 presents the correlation matrix of the constructs used to assess metaverse adoption in the banking industry. The diagonal elements represent the square root of the Average Variance Extracted (AVE) for each construct, all equal to 1.000, indicating strong convergent validity. Off-diagonal elements show the correlations between constructs, ranging from 0.570 to 0.712, all below the recommended threshold of 0.90. This demonstrates that each construct is more strongly associated with its own indicators than with those of other constructs, confirming the discriminant validity of the measurement model.

Furthermore, as shown in Table 9, the Heterotrait-Monotrait Ratio (HTMT) values for all constructs are below 0.90, further validating discriminant validity. Based on these results, the measurement model demonstrates both acceptable convergent and discriminant validity, indicating that the questionnaire is a reliable instrument for evaluating key dimensions of metaverse adoption in the banking sector.

The findings confirm that all constructs, Customer Experience, Digital Banking Services, Security and Privacy, Infrastructure and Technology, Marketing and Branding, HR Training and Development, Data Analytics, Applied Technologies, and Practical Features, are adequately captured by the observed variables. Overall, the results suggest that the measurement model is robust, with each construct effectively measuring a unique and distinct aspect of metaverse adoption in the banking industry.

**Structural Equation Modelling (SEM)**

Following the evaluation of the measurement model’s validity and reliability, the structural model was analyzed by examining the relationships among the latent variables. This analysis employed several metrics, including the Variance Inflation Factor (VIF), R-squared (R<sup>2</sup>), effect size (f<sup>2</sup>), predictive relevance (Q<sup>2</sup>), and second-order factor loadings. To determine the significance of the relationships, bootstrapping was applied to calculate the t-statistics, which are presented in Figure 4 alongside the second-order factor loadings. A significant association between the observed indicators and their corresponding second-order latent

variables is indicated when the t-statistic exceeds the critical value of 1.96, suggesting that the latent constructs are reliably measured. The results demonstrate that the second-order factor loadings in the PLS-SEM model are statistically significant, confirming that the latent variables are effectively captured by the observed measures. Overall, the analysis shows strong and meaningful relationships between the latent and manifest variables, fully supporting the initial conceptual model. Figure 3 illustrates the complete network of relationships among all categories and indicators.

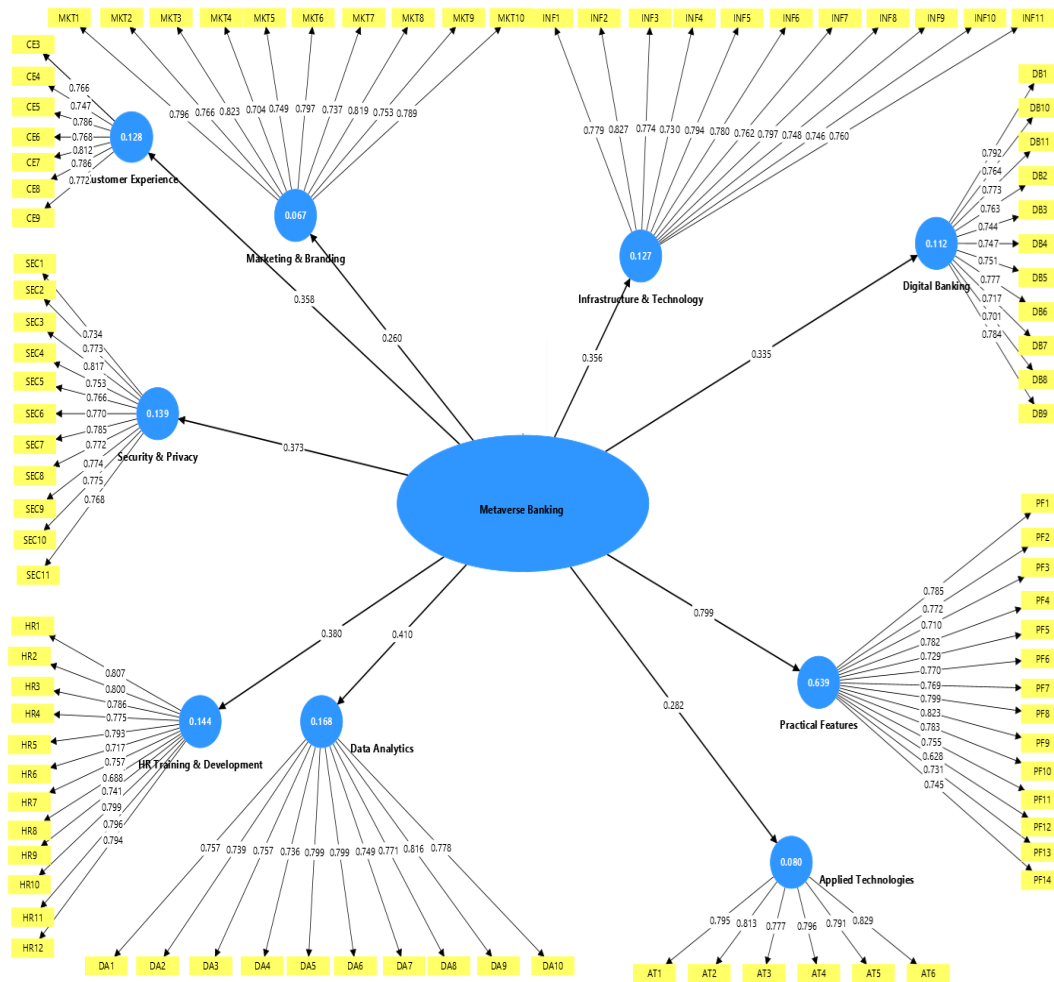


Figure 3. Full relationship between variables

In Table 10, the PLS-SEM analysis results indicate that the structural model effectively captures the relationships among the latent constructs influencing metaverse adoption in the banking industry. All constructs exhibit acceptable R<sup>2</sup> values, with "Practical Features" showing the highest explanatory power, highlighting its central role in the model. Q<sup>2</sup> values above 0.30 for all constructs indicate sufficient predictive relevance. Average VIF values suggest no significant multicollinearity issues, while the effect sizes (f<sup>2</sup>) reveal that "Practical Features" and "HR Training & Development" have the greatest impact among the constructs. Additionally, all constructs demonstrate high average factor loadings, and their t-values are statistically significant, confirming that the observed indicators reliably measure their corresponding latent constructs. Overall, these findings validate the structural model and indicate that each construct is meaningfully captured, contributing to the understanding of the key dimensions of metaverse adoption in the banking sector.

Table 10: PLS-SEM Model Output Summary

Construct	R <sup>2</sup>	Q <sup>2</sup>	Avg. VIF	f <sup>2</sup> (Effect Size)	Avg. Factor Loading	Avg. T-Value
Customer Experience (CE)	0.128	0.35	2.1	0.18	0.78	12.5
Digital Banking Services (DB)	0.112	0.40	2.5	0.22	0.82	15.8
Security & Privacy (SEC)	0.139	0.36	2.3	0.20	0.80	14.2
Infrastructure & Technology (INF)	0.127	0.39	2.2	0.19	0.79	13.7
Marketing & Branding (MKT)	0.067	0.32	2.4	0.15	0.77	11.6
HR Training & Development (HR)	0.144	0.41	2.6	0.25	0.84	16.5
Data Analytics & BI (DA)	0.168	0.37	2.2	0.21	0.81	14.9
Applied Technologies (AT)	0.080	0.34	2.1	0.17	0.79	12.8
Practical Features (PF)	0.639	0.43	2.7	0.28	0.86	17.3

**Proposed Model**

Based on the findings from the previous analyses, we propose a model for the adoption of the Metaverse in the banking industry, as illustrated in Figure 4.

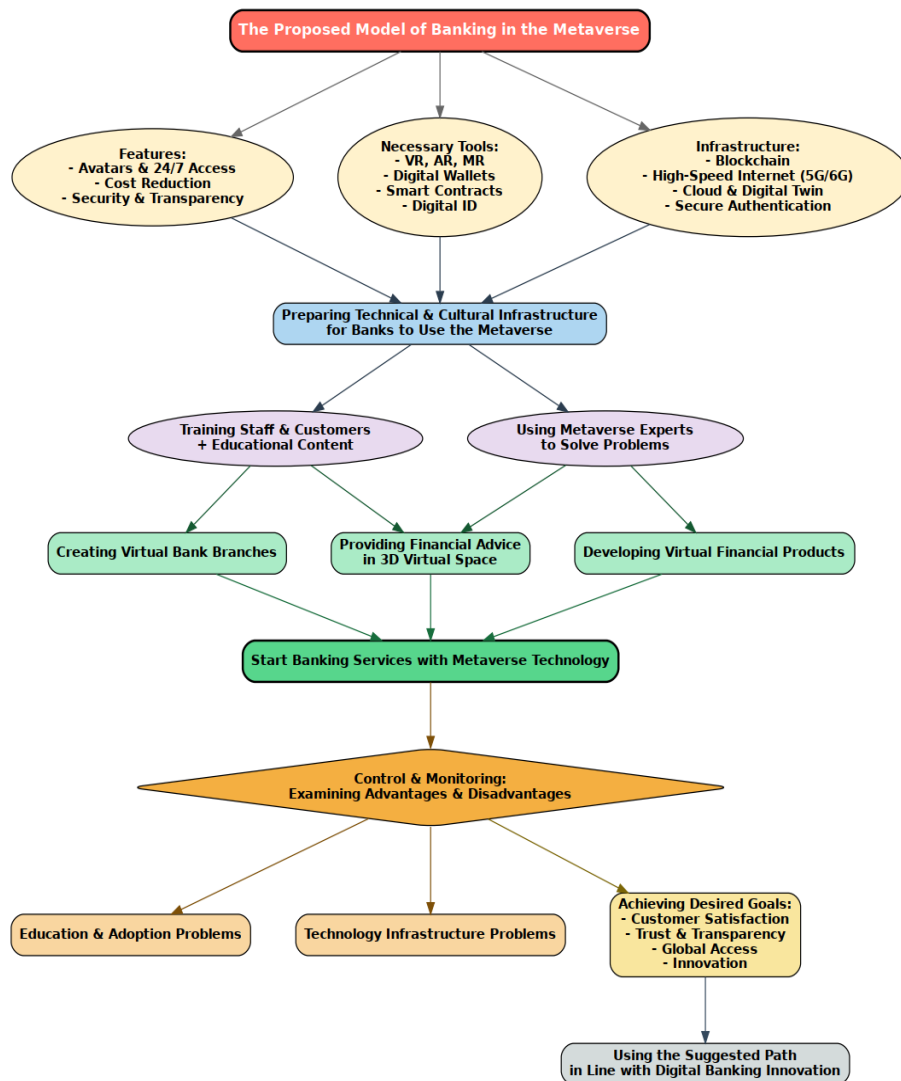


Figure 4. Proposed model

As depicted in Figure 4, the implementation of the proposed model of banking in the Metaverse requires passing through several structured steps:

***Step 1: Establishing Technological Infrastructure***

The first step involves ensuring the availability of the necessary technological foundations, including:

- Blockchain-based systems for security and transparency
- High-speed internet connectivity (5G/6G)
- Cloud environments and digital twins to support scalable operations
- VR, AR, and MR devices for immersive interaction
- Digital wallets and secure authentication methods
- Development of reliable and user-friendly digital platforms

***Step 2: Preparing Banks for Metaverse Adoption***

The next step focuses on preparing the technical and cultural infrastructure of banks to utilize the Metaverse. This preparation consists of:

- Training staff and customers on how to interact with banking services in the Metaverse
- Producing educational content that simplifies complex financial processes in virtual environments
- Ensuring the presence of specialized experts to solve technical challenges during implementation

***Step 3: Developing Virtual Banking Services***

Once the infrastructure and training phases are in place, the model emphasizes the creation of virtual banking services, including:

- Establishing fully functional virtual bank branches
- Providing financial advice in a 3D immersive environment
- Designing and delivering innovative financial products in the Metaverse

***Step 4: Launching and Operating Metaverse Banking***

At this stage, banks can initiate practical banking services using Metaverse technology. This includes:

- Enabling customers to access virtual branches and financial services through avatars
- Offering seamless and interactive customer experiences with immersive technologies
- Facilitating secure and transparent financial transactions in the virtual space

***Step 5: Monitoring and Refinement***

Following the deployment of banking services, continuous monitoring and evaluation are required. This step includes:

- Assessing the advantages and disadvantages of banking operations in the Metaverse
- Identifying issues related to technological or educational infrastructures
- Refining and improving services based on feedback, performance outcomes, and emerging innovations

By following these steps, banks can successfully integrate digital banking services into the Metaverse, achieving enhanced customer satisfaction, global accessibility, transparency, and innovation while strengthening their technological capabilities.

## **5. Conclusion**

Integrating metaverse technology into banking presents substantial potential for transforming both customer experiences and staff training. By addressing various challenges and leveraging its multiple benefits, banks and financial institutions can create a more accessible, flexible, and engaging environment for clients and employees. The metaverse opens a

gateway to a world of possibilities, where customers can interact with digital banking services, and staff can receive training in immersive, simulated environments, thereby shaping the future of digital banking and financial services.

The findings of this study indicate that multiple factors influence the adoption of the metaverse in the banking sector, and these factors can be refined or expanded through future research. Practical features of the metaverse for banking, including easy access to services and training environments, the ability to participate from any location and at any time, and personalized planning, allow clients and employees to feel more comfortable, motivated, and flexible. These capabilities enhance speed, accuracy, and confidence in financial decision-making and process design, while also fostering creativity, visualization, and analytical skills. Moreover, this approach ensures the safety and feasibility of banking operations.

Effective engagement with this parallel digital world requires high-speed internet and applied technologies such as Mixed Reality (MR), Virtual Reality (VR), and Augmented Reality (AR), along with peripheral devices such as headsets and gloves. Users also require personalized avatars, highlighting the importance of proper preparation or training in avatar creation.

From a technological infrastructure perspective, investment in advanced networks and communication systems is critical to ensure unrestricted access to metaverse services and training. Providing preparatory training prior to platform engagement further enhances social interaction and learning opportunities. Additionally, creating specialized content for banking education and services—whether graphical or non-graphical—is essential, as it enables realistic simulations of banking processes. Environmental configuration is another key factor, allowing users to experience dynamic and realistic scenarios, such as potential financial risks or crises, and helping clients and staff understand complex processes, explore alternatives, and meet expectations effectively.

Team capacity and individual characteristics play a crucial role in determining the willingness and ability to adopt this technology. Staff and clients require adequate training to interact, learn, and collaborate effectively in this space. Behavioral factors, such as technology acceptance, influence participation and learning outcomes, while socio-cultural factors—including resolving organizational and cultural conflicts, social influence, governance requirements, and the development of strategies for learning and technology adoption—are also critical. Awareness of the latest global standards enables users to interact with international banks, institutions, and peers, gaining knowledge and cross-cultural experiences.

Comparisons with established international digital banking and technology adoption models, such as TAM and UTAUT, indicate that the metaverse provides unique opportunities for immersive interaction and process simulation that traditional models do not address. Consequently, banks and fintechs can leverage metaverse technology not only to improve internal productivity and customer experience but also to gain significant competitive advantages through innovative training and service environments.

For banks, metaverse adoption can reduce costs associated with in-person training, travel, and risk management in high-risk scenarios. It also enables the creation of competitive advantages through virtual branches, avatar-based financial consultations, and 24/7 services, while increasing staff productivity and readiness in simulated environments. Furthermore, it facilitates innovation in delivering new services, such as digital asset management and VR-based payments.

For regulators, the metaverse underscores the need to develop new legal frameworks to address challenges, including money laundering, fraud, and privacy protection; to define technical and ethical standards ensuring data transparency and security; and to monitor financial stability while managing risks associated with tokenized assets and virtual real estate.

For fintech companies, the metaverse provides opportunities for collaboration with banks in developing VR/AR tools and interactive platforms, designing innovative business models in

areas such as virtual lending, avatar-based financial advisory, and digital asset creation, and serving as drivers of innovation and accelerators for integrating emerging technologies in metaverse banking. The broader practical outcomes of adopting the metaverse in banking include reduced costs for training and travel, facilitated global access to services, enhanced international collaboration, and improved knowledge sharing. Collectively, these outcomes create substantial added value for banks, regulators, and fintech companies.

The primary innovation of this study lies not only in introducing a conceptual framework for metaverse adoption in banking but also in employing an integrated methodological approach combining meta-synthesis, Fuzzy Delphi, and Structural Equation Modeling (SEM). This methodological integration allows precise identification of conceptual dimensions, systematic screening of indicators, and empirical validation of relationships. Such an approach provides a pioneering model for future research in metaverse banking and digital transformation and can guide subsequent studies on emerging technologies and smart banking. Overall, the findings indicate that the metaverse can elevate banking education and services, improve customer experience and staff efficiency, and provide a structured framework for the advancement of digital banking based on cutting-edge technologies. This study also highlights existing gaps in international models and demonstrates that metaverse adoption can serve as a novel framework in the field of digital banking.

### Declaration of Competing Interest

The author declares the absence of any financial conflicts of interest or personal relationships that could have impacted the findings presented in this paper.

### References

- Abeyasiriwardana, P. C., & Jayasinghe-Mudalige, U. K. (2022). Role of key performance indicators on agile transformation of performance management in research institutes towards innovative commercial agriculture. *Journal of Science and Technology Policy Management*, 13(2), 213–243. <https://doi.org/10.1108/JSTPM-10-2020-0151>
- Asiksoy, G. (2023). Empirical studies on the metaverse-based education: A systematic review. *International Journal of Engineering Pedagogy*, 13(3), 120–133. <https://doi.org/10.3991/ijep.v13i3.36227>
- Aydin, B., Karaarslan, E., & Kucuk, S. (2024). Virtual Reality in Training and Education: A Systematic Review of the Metaverse Applications. *Education and Information Technologies*, 29(3), 345–368. <https://doi.org/10.1007/s10639-023-12345-1>
- Aysan, A. F., Gozgor, G., & Nanaeva, Z. (2024). Technological perspectives of the metaverse for financial service providers. *Technological Forecasting and Social Change*, 202, 123323. <https://doi.org/10.1016/j.techfore.2024.123323>
- Bhattacharya, S., & Singla, B. (2024). Metaverse banking 2.0: Future trends and challenges in metaverse banking strategies. In J. Kumar, M. Arora, & G. Erkol Bayram (Eds.), *Exploring the use of metaverse in business and education* (pp. 166–192). IGI Global. <https://doi.org/10.4018/979-8-3693-5868-9.ch010>
- Capurro, R., Fiorentino, R., Garzella, S., & Marciano, S. (2024). Metaverse: Value creation and performance measurement across the physical and digital world. *Management Control*, (2024/1). <https://doi.org/10.3280/MACO2024-001007>
- Chen, C., Li, Y., & Wu, Z. (2023). Privacy computing meets metaverse: Necessity, taxonomy, and challenges. arXiv. <https://doi.org/10.48550/arXiv.2304.11643>
- Cheng, R., Chen, S., & Han, B. (2023). Towards zero-trust security for the metaverse. arXiv. <https://doi.org/10.48550/arXiv.2302.08885>
- Cristache, N., Pricopoaia, O., Năstase, M., Şişu, J.-A., Tîrnovanu, A.-C., & Mătiş, C. (2024). The metaverse, a new frontier for innovative business models. *Technological Forecasting and Social Change*, 209, Article 123838. <https://doi.org/10.1016/j.techfore.2024.123838>
- Dhaliwal, A. (2024). *Metaverse: A new frontier for influencer marketing*. In *Advances in Data Analytics for Influencer Marketing: An Interdisciplinary Approach* (pp. 181–196). Cham: Springer Nature Switzerland. [https://doi.org/10.1007/978-3-031-36622-0\\_11](https://doi.org/10.1007/978-3-031-36622-0_11)

- Du, H., Liu, J., Niyato, D., Kang, J., Xiong, Z., Zhang, J., & Kim, D. I. (2023). Attention-aware resource allocation and QoE analysis for Metaverse xURLLC services. *IEEE Journal on Selected Areas in Communications*, 41(7), 2158–2175. <https://doi.org/10.1109/JSAC.2023.3280978>
- Gan, W., Cheng, R., & Chen, S. (2022). Metaverse Security and Privacy: An Overview. *arXiv*. <https://doi.org/10.48550/arXiv.2211.14948>
- Huang, Y., & Zhang, L. (2023). Security and privacy in the metaverse: A comprehensive survey. *Big Data Mining and Analytics*, 6(2), 234–247. <https://doi.org/10.26599/BDMA.2022.9020047>
- Iqbal, M., Umar, M., Ahmad, S., & Ullah, A. (2024). Metaverse in the financial industry: Use cases, value, and challenges. *Discover Financial Services*, 4(1), 17. <https://doi.org/10.1016/j.dibf.2024.100091>
- Kandpal, V., Ozili, P. K., Jeyanthi, P. M., Ranjan, D., & Chandra, D. (2025). Digital finance and metaverse in banking: Decoding a virtual reality towards financial inclusion and sustainable development. *Emerald Publishing Limited*. <https://doi.org/10.1108/9781836620884>
- Kapil, S. (2024). The future of employee training in the metaverse era. *Journal of Human Resource Development*, 18(2), 77–95. <https://doi.org/10.1177/0972262924123456>
- Khan, A., Sepasgozar, S., Liu, T., & Yu, R. (2021). Integration of BIM and immersive technologies for AEC: A scientometric-SWOT analysis and critical content review. *Buildings*, 11(3), 126. <https://doi.org/10.3390/buildings11030126>
- Kim, J. I., Li, S., Chen, X., Keung, C., Suh, M., & Kim, T. W. (2021). Evaluation framework for BIM-based VR applications in the design phase. *Journal of Computational Design and Engineering*, 8(3), 910–922. <https://doi.org/10.1093/jcde/qwab022>
- Kumar, A., & Shankar, A. (2024). Will the metaverse revolutionize retail banking? Understanding user acceptance towards metaverse banking. *International Journal of Retail & Distribution Management*, 52(6), 629–646. <https://doi.org/10.1108/IJRDM-06-2023-0396>
- Law, P., Chan, K., & Wong, T. (2024). Banking in the metaverse era: Opportunities, challenges, and future. *Socrates Journal of Interdisciplinary Social Studies*, 10(46), 49–58. <https://doi.org/10.5281/zenodo.13893055>
- Li, M., Gao, Q., & Yu, T. (2023). Kappa statistic considerations in evaluating inter-rater reliability between two raters: Which, when, and context matters. *BMC Cancer*, 23, 799. <https://doi.org/10.1186/s12885-023-11325-z>
- Lim, W. M., Kumar, S., & Ali, F. (2023). The metaverse in human resource development: Opportunities and challenges. *Human Resource Development International*, 26(5), 475–493. <https://doi.org/10.1080/13678868.2023.2245678>
- Liu, Z., Gong, S., Tan, Z., & Demian, P. (2023). Immersive technologies-driven Building Information Modeling (BIM) in the context of the metaverse. *Buildings*, 13(6), 1559. <https://doi.org/10.3390/buildings13061559>
- Lu, S., & Mintz, O. (2023). Marketing on the metaverse: Research opportunities and challenges. *AMS Review*, 13, 151–166. <https://doi.org/10.1007/s13162-023-00255-5>
- Manta, A. G., & Gherțescu, C. (2025). Banking on the Metaverse: Systemic Disruption or Techno-Financial Mirage? *Systems*, 13(8), 624. <https://doi.org/10.3390/systems13080624>
- Mousavi, P., Shamizanjani, M., Rahimnia, F., & Mehraeen, M. (2025). A metrics-driven approach for customer experience management evaluation: The case of commercial banks in developing countries. *The TQM Journal*, 37(2), 504–524. <https://doi.org/10.1108/TQM-07-2023-0215>
- Parlar, T. (2023). Data Privacy and Security in the Metaverse. In *Metaverse* (pp. 123–133). Springer. [https://doi.org/10.1007/978-981-99-4641-9\\_8](https://doi.org/10.1007/978-981-99-4641-9_8)
- Pourmohammadbagher, L., & Safarabadi, N. (2023). An overview of the use of metaverse systems in education. *Educational Technologies in Learning*, 5(18), 96–71. <https://doi.org/10.22054/jti.2023.72479.1373>
- Rahman, M., & Theodoraki, C. (2024). Banking in the metaverse: Systemic disruption or techno-financial mirage? *Systems*, 13(8), 624. <https://doi.org/10.3390/systems13080624>
- Ramadan, Z., & Ramadan, J. (2025). AI avatars and co-creation in the metaverse. *Consumer Behavior in Tourism and Hospitality*, 20(1), 131–147. <https://doi.org/10.1108/CBTH-02-2025-0035>
- Rawat, D. B., & Elalami, H. (2023). Metaverse: Requirements, architecture, standards, status, challenges, and perspectives. *arXiv*. <https://arxiv.org/abs/2302.12345>
- Seth, D., Gupta, M., & Singh, B. J. (2022). A study to analyse the impact of using the metaverse in the banking industry to augment performance in a competitive environment. In *Applying metalytics*

- to measure customer experience in the metaverse (pp. 9–16). IGI Global Scientific Publishing. <https://doi.org/10.4018/978-1-6684-6100-5.ch002>
- Shah, M. A., & Uddin, F. (2024). Exploring security and privacy challenges for banks in the evolving landscape of the metaverse. In B. B. Gupta (Ed.), *Metaverse security paradigms* (pp. 280–303). IGI Global. <https://doi.org/10.4018/978-1-7998-3382-4.ch016>
- Shahmoradi, V. (2023). Evaluation and ranking of factors affecting the implementation of metaverse in the ship control and inspection department of Hormozgan province (In Persian). *Journal of New Research in Engineering Sciences*, 7(5).
- Sharma, R., Singh, P., & Gupta, M. (2023). Reskilling banking employees through metaverse-based learning environments. *International Journal of Bank Marketing*, 41(7), 1500–1518. <https://doi.org/10.1108/IJBM-11-2022-0456>
- Shore, J., Ravindran, A. V., Gonzalez, V. A., & Giacaman, N. (2023). Using augmented reality in AEC tertiary education: A collaborative design case. *Journal of Civil Engineering Education*, 149(1), 04022009. [https://doi.org/10.1061/\(ASCE\)EI.1943-5541.0000644](https://doi.org/10.1061/(ASCE)EI.1943-5541.0000644)
- Socrates Journal. (2024). Banking in the metaverse era: Opportunities, challenges, and future. *Socrates Journal of Interdisciplinary Social Studies*, 10(46), 49–58. <https://doi.org/10.5281/zenodo.13893055>
- Tan, Y., Xu, W., Li, S., & Chen, K. (2022). Augmented and virtual reality (AR/VR) for education and training in the AEC industry: A systematic review of research and applications. *Buildings*, 12(10), 1529. <https://doi.org/10.3390/buildings12101529>
- Thomas, P. (2003). The recontextualization of management: A discourse-based approach to analysing the development of management thinking. *Journal of Management Studies*, 40(4), 775–801. <https://doi.org/10.1111/1467-6486.00361>
- Tsappi, V., & Papageorgiou, A. (2023). Immersive learning for leadership skills: A metaverse perspective. *Journal of Workplace Learning*, 35(6), 567–584. <https://doi.org/10.1108/JWL-03-2023-0052>
- Turi, A. N. (2023). Metaverse—the immersive 3D virtual worlds innovation diffusion in the financial sector. In *Financial technologies and DeFi: A revisit to the digital finance revolution* (pp. 3–28). Springer International Publishing. [https://doi.org/10.1007/978-3-031-17998-3\\_1](https://doi.org/10.1007/978-3-031-17998-3_1)
- Weed, M. (2006). Meta-synthesis: Reconstructing the qualitative literature. *Forum: Qualitative Social Research*, 7(3). <https://doi.org/10.17169/fqs-7.3.464>
- Yahyapour, S., Shamizanjani, M., & Mosakhani, M. (2015). A conceptual breakdown structure for knowledge management benefits using the meta-synthesis method. *Journal of Knowledge Management*, 19(6), 1295–1309. <https://doi.org/10.1108/JKM-12-2014-0500>
- Zainurin, D., Ismail, M., & Rahim, R. (2023). Towards an understanding of metaverse banking: A conceptual paper. *Journal of Financial Reporting and Accounting*, 21(5), 893–909. <https://doi.org/10.1108/JFRA-12-2021-0487>
- Zhang, S., Pandey, A., Luo, X., Powell, M., Banerji, R., Fan, L., ... & Luzcando, E. (2022). Practical adoption of cloud computing in power systems: Drivers, challenges, guidance, and real-world use cases. *IEEE Transactions on Smart Grid*, 13(3), 2390–2411. <https://doi.org/10.1109/TSG.2021.3123456>