Metaversalize

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Metaverse. Vol. 2, No. 4 (2025) 204–215.

Paper Type: Original Article

Metaverse Technologies and Their Future Impact on Financial and Accounting Services

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Citation:

Received: 27 April 2025 *Revised: 25 June 2025* *Accepted: 18 Agust 2025*	Lalbar, A., & Farahani, H. (2025). Metaverse technologies and their future impact on financial and accounting services. *Metaversalize*, 2(4), 204-215.

Abstract

The emergence of the metaverse—driven by advancements in the Internet, Augmented Reality (AR), and Virtual Reality (VR)—is reshaping business models and transforming operational processes across industries, particularly in financial and accounting services. The integration of Financial Technologies (FinTech) with metaverse platforms has enabled banks and financial institutions to introduce new digital services, while the rapid expansion of Non-Fungible Token (NFT) markets has created both opportunities and challenges for accounting, auditing, and financial reporting. This study introduces the key technologies that underpin the metaverse, including AR, VR, Digital Currencies (DCs), blockchain, 3D design, the Internet of Things (IoT), and Artificial Intelligence (AI). Through a review of reputable international and domestic research databases, the study synthesizes current developments and examines their implications for the future of financial and accounting services. The findings provide an integrated perspective on the potential benefits of digital transformation and highlight strategic considerations for organizations seeking to operate within metaverse-driven financial ecosystems.

Keywords: Metaverse, Augmented reality, Virtual reality, Blockchain, Artificial intelligence, Financial and accounting services.

1 | Introduction

The metaverse is an evolving, three-dimensional virtual environment that blurs the boundaries between physical and digital worlds. Enabled by the convergence of Internet technologies, Augmented Reality (AR), and Virtual Reality (VR), it allows users to interact with one another and with digital objects in immersive and persistent spaces. This decentralized, always-accessible environment is supported through a network of servers and enables users to create and engage through virtual identities [1–3]. The metaverse offers extensive potential across a wide range of domains, including social interaction, business and banking, finance and

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https://doi.org/10.22105/metaverse.v2i4.88

accounting, education, entertainment, health, tourism, fashion, real estate, transportation, and agriculture. Within these environments, users can navigate 3D spaces using avatars, communicate globally, participate in virtual events, exchange digital or physical goods, join online training sessions, and create or share digital content [1]. Key characteristics of the metaverse include continuity, real-time interaction, interoperability, economic functionality, connectivity, and creativity.

The integration of virtual and real interactions is rapidly transforming how businesses and industries operate, particularly within finance and accounting. Driven by advancements in Financial Technology (FinTech) and the increasing demand for digital innovation, many financial institutions, corporations, and banks are exploring metaverse-based services. Although this transition presents significant opportunities—such as enhanced customer engagement and innovative service delivery—it also introduces new challenges. In the metaverse, companies can design interactive virtual environments in which customers experience financial services in novel ways; for instance, AR and VR can be used to simulate investment scenarios or asset-management activities. According to the Financial Industry Regulatory Authority (FINRA), global metaverse revenue is projected to reach USD 800 billion by 2024 and exceed USD 3 trillion in contribution to global GDP in the long term. Similarly, a report by JP Morgan estimates that the metaverse could generate over USD 1 trillion in annual economic value for major enterprises. At the same time, market forecasts predict a compound annual growth rate of 39.5% and revenue of USD 400 billion by 2028. These estimates highlight the substantial transformational potential of metaverse technologies, particularly for the financial sector.

The metaverse also enables financial firms to diversify their services. Virtual financial advisory environments allow clients and advisors to interact transparently and conveniently, while digital twins—virtual representations of real-world assets—can facilitate improved investment analysis and decision-making. The future role of the metaverse in financial services depends largely on the pace of FinTech innovation and its adoption by firms and consumers. As these technologies mature, more financial institutions are expected to enter the metaverse ecosystem and modernize their service offerings.

In metaverse environments, accounting and auditing functions emerge in response to economic activity among users, who can buy and sell digital assets. As with traditional markets, the existence of economic exchange necessitates reliable accounting systems to safeguard limited and valuable resources. The metaverse economy relies heavily on Non-Fungible Tokens (NFTs), where each digital or physical asset is represented by a unique token. These tokens function as digital assets with intrinsic value and can be owned, transferred, or traded. Consequently, companies and individuals establishing virtual branches for the exchange of digital assets must consider accounting and auditing requirements related to NFT measurement, classification, reporting, disclosure, and financial statement preparation [3], [4].

The transformative nature of the metaverse presents new opportunities and challenges for financial managers, accountants, and auditors. These developments demand innovative approaches to traditional practices. Metaverse technologies can enhance education, training, and professional practice by providing immersive environments for learning and digital asset evaluation. They also enable more efficient audit planning and evidence collection in virtual settings. Furthermore, integrated metaverse-based accounting information systems can strengthen data assurance, reduce the risk of errors or fraud, and serve as supplementary tools for practitioners. Although these systems may reshape elements of accounting practice, the foundational principles and objectives of accounting remain unchanged [5].

Given these developments, the intersection of FinTech, digital asset accounting, and metaverse technologies represents a critical emerging challenge for future business activities. Identifying and adapting to rapidly evolving technological trends is essential. While the metaverse is still in an early developmental stage, many industries and companies are already exploring its potential to transform business operations and address new challenges through innovation. Although existing studies have examined the definition, importance, and economic potential of the metaverse, as well as its influence on investment, finance, accounting, and banking, few have proposed a comprehensive conceptual framework for these enabling technologies. Therefore, the purpose of this article is to introduce key metaverse technologies—including AR, VR, Digital Currencies

(DCs), blockchain, 3D design, the Internet of Things (IoT), and Artificial Intelligence (AI)—and to present an integrated framework that highlights their implications for digital business transformation. Additionally, the study outlines future directions for metaverse development and examines the outlook for financial and accounting services within this emerging digital landscape.

2 | Theoretical Foundations and Research Background

Dionisio et al. [6] define the metaverse as a fully immersive, computer-generated 3D environment that extends beyond the physical world. Similarly, Ball [7] describes it as a scalable and interoperable network of real-time virtual worlds in which users interact through persistent identities, objects, communications, and payments. Most studies generally portray the metaverse as a digital environment where individuals can live, learn, work, and construct virtual identities through avatars [8].

Recent technological advancements associated with the Fourth Industrial Revolution—including blockchain, AI, AR, VR, and advanced mobile networks—have accelerated the development of metaverse ecosystems [10], [11]. Global metaverse revenue was approximately USD 500 billion in 2020 and is projected to reach USD 800 billion in 2024 and USD 1 trillion by the end of the decade [12], [13]. Hollensen et al. [14] identify essential metaverse building blocks such as hardware, networking, computing, virtual platforms, standards, payment systems, content services, and user behaviors. Other researchers have categorized metaverse types (e.g., AR, mirror worlds, virtual worlds) and identified key elements including immersion, advanced computing, socialization, and decentralization [15–20].

Several core technologies support metaverse ecosystems. AR and VR enable immersive interaction, while DCs allow value exchange without physical presence. Blockchain provides decentralization, transparency, and immutability for digital ownership, NFTs, and secure transactions. 3D design and reconstruction create realistic virtual spaces, and IoT devices supply real-time data to enhance simulations. AI and ML further optimize metaverse experiences by modeling intelligent behaviors, generating realistic avatars, improving rendering efficiency, and enabling personalization [21].

Connectivity infrastructure—particularly edge computing and 5G—plays a critical role in reducing latency and enabling real-time interaction in large-scale virtual environments [22–27]. These technologies allow the offloading of intensive computations to nearby edge nodes, improving responsiveness and supporting multi-user, high-bandwidth interactions essential for metaverse performance.

In terms of services and applications, the metaverse enables immersive entertainment, virtual events, digital commerce, and decentralized economic systems [28]. Blockchain and smart contracts enhance the security and transparency of virtual property transactions and digital asset management [29], [30]. Cryptocurrencies also support fast, low-cost payments, investment opportunities, micropayments, and the creation and sale of digital content, contributing to sustainable virtual economies.

Based on the above, this study addresses the following key research questions:

I. Is there a clear conceptual framework for metaverse technologies?

II. What are the future directions of metaverse technological development?

III. What is the outlook for metaverse applications in financial and accounting services?

3 | A Framework for Metaverse Technology

The metaverse is expected to transform numerous industries, including tourism, fashion, finance and accounting, commerce and banking, gaming and entertainment, real estate, transportation, healthcare, education and training, and agriculture. Achieving this potential requires a set of foundational technologies, such as AI, AR, blockchain, and edge computing. The rapid development of products by companies such as Apple, Google, and Meta (Facebook) has further accelerated attention toward these technologies. Industry analysts predict that the metaverse could become a trillion-dollar market by the end of this decade.

As illustrated in *Fig. 1*, metaverse development is occurring in distinct stages. Although the metaverse is not expected to reach full maturity before 2030, Gartner emphasizes the need for business leaders to proactively evaluate opportunities, develop strategic plans, and build the necessary infrastructure. Effective planning depends on understanding the metaverse's strategic value and its underlying technological building blocks.

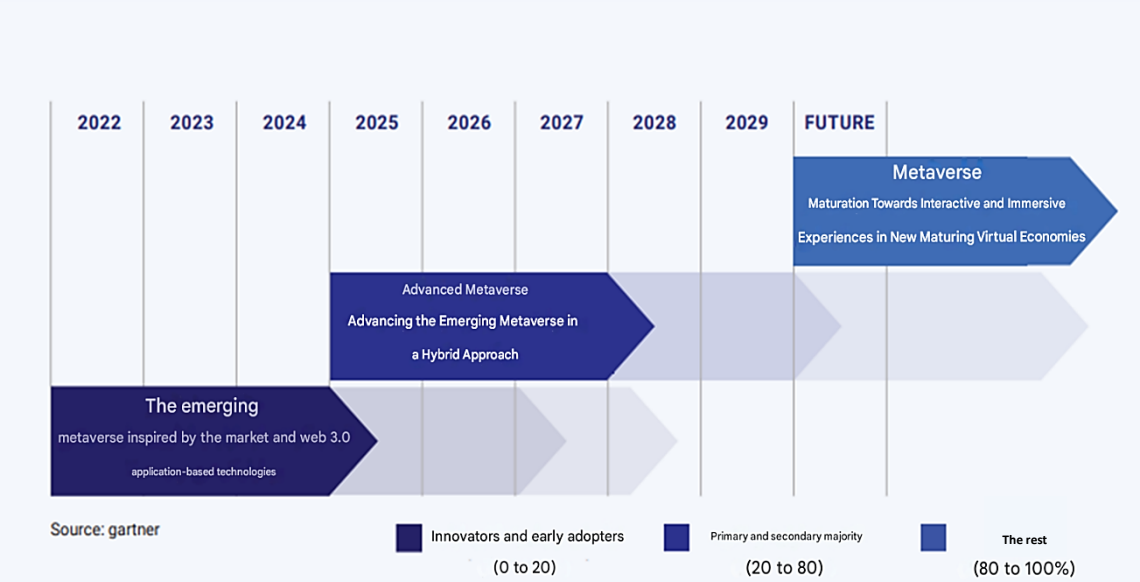

Fig. 1. Metaverse evolution process.

Phase 1. Emerging metaverse: by 2024, the market will explore potential use cases that can generate long-term value.

Phase 2. Advanced metaverse: between 2024 and 2027, development will focus on tools and technologies that integrate physical and digital content, including interoperable frameworks and protocols.

Phase 3. Metaverse maturity: from 2028 onward, the market landscape and technological capabilities are expected to become fully established.

The metaverse framework can be categorized into five major technological layers: 1) user experience, 2) AR hardware interface, 3) virtualization engine, 4) economic infrastructure, and 5) computing and network infrastructure. Each layer contains essential components and subcomponents that collectively support the metaverse ecosystem. This framework will continue to evolve as metaverse technologies advance.

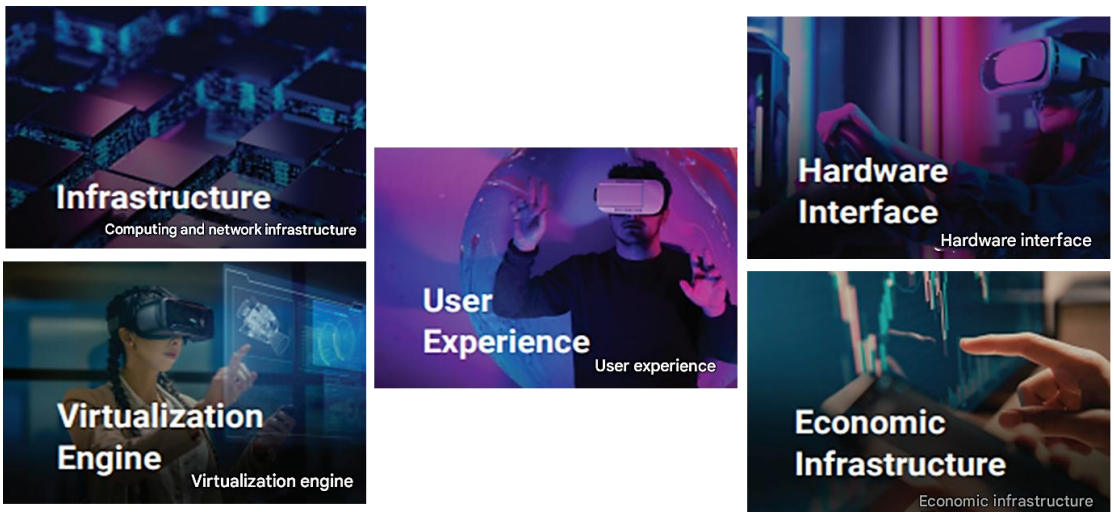

Fig. 2. Metaverse technology layers.

3.1 | User Experience

In the metaverse, individuals interact much as they do in the physical world, using digital avatars to represent themselves, connect socially, and participate in virtual communities. Users access the metaverse through interfaces such as VR headsets, controllers, and other immersive devices. As adoption increases, the experience layer will expand with new use cases and applications, eventually integrating into everyday life.

Key application areas include:

Remote work: virtual environments enable avatar-based communication, collaboration, and interaction, fostering productive remote work cultures.

Healthcare: the metaverse can eliminate geographic barriers, allowing patients to access leading institutions worldwide. Applications include remote consultations, medical training, surgical preparation, and virtual operating simulations.

Education: immersive learning environments offer enhanced engagement and interactivity. Several universities already employ metaverse platforms to deliver enriched educational experiences.

Tourism: VR allows travelers to preview destinations and explore hotels before booking.

Retail and shopping: metaverse-based commerce enhances customer engagement and loyalty. Brands increasingly use NFTs and AI-driven insights to personalize shopping experiences.

Real estate: virtual property tours using 3D visualization enable remote inspection and improve decision-making.

Agriculture: AR and VR support remote farm monitoring, real-time assessment of inventory and environmental conditions, and improved operational management.

3.2 | Augmented Reality Hardware Interface

Extended Reality (XR)—which includes AR and VR—enhances metaverse experiences through specialized devices such as AR smart glasses, haptic systems, holographic displays, and VR headsets. These devices enable users to interact with digital environments intuitively and seamlessly.

Key components include:

VR headsets: these devices employ computer vision, eye tracking, and hand tracking to deliver immersive audiovisual experiences. AR smart glasses and contact lenses further blur the boundaries between physical and virtual worlds.

Haptics: haptic gloves and devices provide tactile feedback, enabling users to feel pressure, texture, and even temperature changes in virtual environments.

Holographic displays: using advanced light technologies, holographic displays integrate 3D content into the physical environment, enhancing realism across industries beyond gaming.

Omnidirectional treadmills: these devices allow 360-degree movement in virtual spaces, enabling users to walk, run, kick objects, or follow paths within VR environments.

3.3 | Virtualization Engine

The virtualization engine encompasses programming engines, computing engines, virtual platforms, and various development tools essential for building the metaverse.

Key technologies include:

AI: AI enhances blockchain-based metaverse environments by generating realistic virtual worlds and analyzing user activity to improve experiences.

Computer vision: this AI branch extracts meaningful information from images and videos, enabling XR devices to recognize user actions and interpret physical surroundings.

Avatar creation: avatars generated from selfies or user inputs enable personalized identity representation. Industries such as fashion use hyper-realistic avatars for virtual shows and brand engagement.

Volumetric video: multi-angle capture creates 3D video content suitable for virtual concerts, gaming, and immersive events.

3D design engines: game engines and design tools create high-fidelity 3D environments and serve as foundational tools for advanced metaverse development.

3D modeling: widely used in e-commerce and real estate, 3D modeling enables interactive product visualization and virtual property exploration.

3.4 | Economic Infrastructure

The metaverse supports a growing creator economy in which digital tools enable the production and exchange of digital assets, typically transacted through cryptocurrencies and supported by blockchain technology.

Key components include:

Blockchain: a decentralized, immutable ledger that records all transactions in the metaverse. It enables secure ownership of NFTs and ensures the integrity of virtual goods.

DCs and cryptocurrencies: DCs support metaverse transactions, while cryptocurrencies—secured by blockchain—offer enhanced cybersecurity and decentralized operation.

Crypto wallets: users access decentralized environments through wallets that store digital assets and serve as unique identifiers.

Payments: blockchain-based payment systems facilitate Decentralized Finance (DeFi) services and cryptocurrency transactions.

Cryptocurrency exchanges: these platforms allow users to buy, sell, and trade digital assets.

NFTs: NFTs represent unique digital objects—such as avatar accessories, videos, and virtual land—and form the backbone of virtual economic activity.

3.5 | Computing and Network Infrastructure

The metaverse requires extensive data processing capabilities and minimal latency. The following technologies play a central role in sustaining seamless, large-scale virtual environments:

5G networks: high-bandwidth, low-latency 5G networks support immersive applications and real-time rendering, enabling smooth AR/VR experiences. Decentralized blockchain nodes further enhance security and transactional efficiency.

Cloud infrastructure: cloud platforms host virtual worlds, store massive datasets, and process high-resolution graphics and AI workloads before streaming them to user devices.

Chips and processors: metaverse devices require high-performance, energy-efficient processors capable of supporting advanced graphics and AI in lightweight form factors.

Edge computing: by processing data near the user, edge computing reduces latency and supports real-time interactions, saving bandwidth and improving data security.

IoT and robotics: IoT sensors collect real-world data that can update and enhance virtual environments. Sensor Service Providers (SSPs) can supply live data feeds to Virtual Service Providers (VSPs) to maintain dynamic virtual ecosystems.

4 | Financial and Accounting Services in the Metaverse Era

As metaverse technologies advance, banks, financial institutions, and financial and accounting service providers are increasingly investing in the metaverse to meet evolving customer needs. Although financial services in the metaverse remain in an early developmental stage, a growing body of evidence demonstrates institutional efforts to leverage its technological innovations and economic opportunities. This section highlights key early initiatives undertaken by financial institutions in virtual environments to understand emerging trends better.

4.1 | Meta-Banking

Korean financial institutions were among the first to invest in the metaverse by establishing virtual offices. Kookmin Bank (KB), one of South Korea's largest financial institutions, launched the KB Metaverse VR branch to offer banking, education, and training services. Similarly, the Industrial Bank of Korea (IBK) plans to establish a virtual bank, IBK Dotori, on the Cyworld Z platform, enabling financial services through its virtual currency, Dotori [31]. These early initiatives allow banks to explore future opportunities and identify the technological infrastructure required to support virtual operations.

Following these developments, global institutions such as HSBC and JP Morgan have acquired land in Decentraland to expand their virtual presence. JP Morgan opened the Onyx Lounge in a virtual Tokyo shopping district [32], and HSBC launched a metaverse investment portfolio for its Asian clients [33]. Standard Chartered also purchased virtual land in Sandbox in March 2022 [34] to create a Hong Kong-inspired cultural hub. As traditional banks close physical branches, the metaverse may offer an alternative form of virtual "face-to-face" interaction. However, banks may face challenges in attracting customers to virtual venues such as the Onyx Lounge, where user activity remains limited [35], [36].

Fidelity established the Fidelity Base in the metaverse to engage young investors and promote ETFs. HSBC also announced further collaboration with Sandbox to deliver new virtual customer experiences. Such initiatives indicate that banks and fintechs have significant room to innovate in the metaverse.

A prominent example of the future direction of virtual financial services is EQI Bank, founded in 2015 as a digital bank offering conventional banking alongside DeFi on a unified platform. Through its EQIFI DeFi platform, the bank bridges traditional and digital assets while maintaining a regulated banking license [37], [38]. EQIBank cardholders can use virtual currencies for physical purchases and fiat currencies to access digital assets in virtual environments [39], [40]. The bank also enables users to purchase virtual land on the Polka City platform using liquid cryptocurrencies instead of native POLC tokens, with the option to exchange them for Bitcoin via secondary markets [41]. This approach addresses liquidity issues associated with NFTs and some cryptocurrencies. POLC tokens may also be converted into fiat currency, allowing debit card holders to transact in the physical world. Moreover, EQIBank provides loans for virtual asset purchases in exchange for physical assets [37], [38] and plans to establish branches across different platforms to improve interoperability among NFTs.

Another example is the Index Coop crypto investment platform, which introduced the Metaverse Index (MVI). Built on Ethereum's ERC-20 protocol, MVI includes metaverse-related tokens used in virtual sports, gaming, and trading, offering simplified investment processes, reduced risk, and enhanced transparency [42]. Additionally, platforms such as NFTfi have launched virtual mortgages backed by NFT collateral [43].

4.2 | Metaverse Foresight in Financial and Accounting Services

Economic and financial developments in the metaverse provide a foundation for anticipating the future of financial services. Metaverse-based financial services aim to support seamless transactions, instant access to resources, and efficient management of virtual assets [35]. Achieving this requires instant virtual payment systems, fair cryptocurrency exchange rates, and effective management of complex digital wealth portfolios

and customer big data. Based on these objectives, metaverse foresight includes short-, medium-, and long-term scenarios.

Metaverse evolution is progressing toward the Digital Twins phase and eventually the Digital Natives phase. The Digital Twins phase involves creating virtual replicas of physical environments, while brands, companies, and financial institutions establish virtual locations mirroring their real-world presence. The next phase will introduce virtual worlds without physical counterparts, increasing the demand for digital assets and virtual real estate. Metaverse finance is expected to operate primarily on DeFi systems, supplemented initially by centralized financial protocols. Financial institutions may serve as intermediaries during the early stages.

In the short term, the metaverse economy must manage volatility in digital assets such as cryptocurrencies and NFTs due to limited regulation. Over time, these markets are expected to mature and stabilize. Tokenized assets may be bundled into portfolios to mitigate volatility and serve as collateral [44], [45].

Significant investments by large technology companies suggest that industry giants could dominate virtual world ownership, creating barriers to entry for smaller firms. Money supply within the metaverse—primarily DCs—may be difficult to regulate without central bank oversight. Financial institutions may therefore play a stabilizing role by providing liquidity. They must also prepare to manage digital money such as in-game tokens, stablecoins, and CBDCs.

Data governance is expected to remain a central challenge due to the enormous volume of sensitive data generated in the metaverse. Protocols for data collection, ownership, and distribution will significantly influence virtual finance. Lessons from open finance initiatives point toward granting users greater control over their data, allowing for personalized financial products. Managing large data volumes may require techniques such as K-means clustering, vector quantization, and advanced error detection. AI will be essential for processing big data and automating associated tasks [44].

Smooth financial flows across decentralized platforms require interoperability among cryptocurrencies and wallets. Financial institutions may address this challenge by maintaining a presence across multiple metaverse platforms, enabling exchange among cryptocurrencies and NFTs. Products that operate across both physical and virtual realms will be essential—for example, debit and credit cards that support both fiat and virtual currencies. Digital wallets should be linked to real-world bank accounts, and virtual mortgages should be collateralized by either NFTs or physical assets. "Real-world NFTs" may tokenize physical objects, allowing purchases in the metaverse and enabling DeFi loans backed by tangible assets.

Growing technological complexity will require extensive training for both customers and financial professionals. Financial institutions are expected to launch more virtual offices and use avatars for customer interaction, necessitating expertise in immersive technologies such as VR and AR [46]. Attracting users may require additional engagement mechanisms such as games or virtual goods sales.

Managing complex digital portfolios—including NFTs, cryptocurrencies, and other virtual assets—will require advanced robo-advisory and AI-driven systems. Identity verification in avatar-based environments poses challenges; persistent, verifiable digital credentials and zero-knowledge proofs may provide secure authentication mechanisms. Financial institutions may also offer escrow-like services for digital wallets, similar to securing valuables in physical vaults. Trusted Execution Environments (TEEs) can further enhance security and build customer trust.

Ethical considerations must guide each stage of metaverse development. Financial service providers must prepare for cybersecurity threats by adopting blockchain-based solutions and emerging technologies such as quantum computing. Competition from major technology firms such as Meta, Amazon, and Alphabet is expected to intensify as they expand into metaverse-based financial services. Consequently, financial institutions should prioritize workforce upskilling and investments in new technologies [44].

In the long term, the metaverse is envisioned as a unified ecosystem where currently separate platforms converge into a single interconnected virtual world. Users may carry out core daily activities—studying,

working, and socializing—entirely within virtual environments. New cultural and ethical norms will emerge, shaping how individuals consume, interact, and communicate. The metaverse economy will likely develop into a global marketplace that increases customer access but also introduces high levels of competition, potentially consolidating market dominance among a few major players. Furthermore, AI may automate many workflows, reducing or even eliminating human involvement in certain financial processes [44].

The financial sector will undergo profound changes as payment services become fully integrated into virtual environments, allowing users to access real-world facilities without leaving the metaverse. Increasing use of AI, algorithmic systems, and Brain-Computer Interface (BCI) technologies may further automate financial services and simplify transactions. In the long run, the traditional role of financial service providers may diminish as advanced technologies support fully automated financial ecosystems.

In virtual environments where digital products and NFTs are regularly exchanged, accounting and auditing remain essential to measure and classify metaverse economic activities. NFTs pose unique accounting challenges related to revenue recognition and determining appropriate accounting treatments for development costs, which may be capitalized, deferred, or expensed [47]. Virtual branches also raise issues regarding their legal and financial independence and accounting structures. VR technologies can enhance accountants' and auditors' skills by simulating real-world scenarios, improving communication, leadership, and teamwork capabilities [1], [48].

The presence of independent companies in the metaverse and the publication of financial reports for virtual stakeholders require continued auditor participation. Integration of VR and blockchain technologies is expected to transform the audit process fundamentally. Auditors will need deep knowledge of accounting information systems and internal controls for metaverse-based firms. Instead of costly and time-consuming travel, auditors can conduct virtual site visits, improving efficiency and enhancing security [4]. The metaverse also enables real-time collaboration between auditors and managers through VR tools. Opportunities for accounting and auditing include services for virtual businesses, virtual audits, big data analysis, financial consulting, and the development of new accounting tools [1]. At the same time, security concerns, regulatory frameworks, and the need for new professional skills represent major challenges.

5 | Conclusion

Although still in its early stages, the metaverse is poised to transform communication and service delivery across finance, accounting, commerce, education, and other sectors. Despite rapid technological development, many financial institutions remain unprepared for the operational and regulatory demands of immersive and decentralized environments. This study highlights the importance of early adaptation by showing how financial and accounting service providers can integrate metaverse-enabling technologies—such as blockchain, AI, AR, and VR—to enhance service quality, improve data management, and strengthen customer engagement. It also underscores the need for interdisciplinary collaboration, strong cybersecurity measures, clear data governance, and continuous investment in digital literacy to build trust and ensure readiness for the evolving virtual economy. This research outlined a conceptual framework for metaverse technologies and examined their implications for future financial and accounting services. Future studies should address regulatory requirements for virtual commerce, digital currency stability, platform design for metaverse-based financial services, the interaction between centralized finance and DeFi, accounting and auditing of digital assets, and the role of generative AI in shaping metaverse innovation.

References

[1] Sabour Nahtani, M. (2024). The future of accounting and auditing in the world of metaverse. *Scientific journal of modern research approaches in management and accounting, 8*(28), 914-930. (**In Persian**). https://majournal.ir/index.php/ma/article/view/2527

[2] Tahourian, H. (2022). Exploring the impact of the metaverse on the future of humanity. *The 6th international conference on applied research in science and engineering*, Aachen, Germany. Civilica. (**In Persian**). https://civilica.com/doc/1447286/

[3] Ren, Z., & Li, Z. (2025). The historical achievements and future prospects of AI/AR/VR/XR/robot art under the current development situation of the metaverse. *Mediterranean archaeology and archaeometry*, *25*(3), 348–354. https://www.maajournal.com/index.php/maa/article/view/1931/1379

[4] Filsaraei, M., & Esmaeili, F. (2023). Examining the role of metaverse on the future of accounting and auditing. *Professional auditing research*, *4*(13), 58-85. (**In Persian**). https://doi.org/10.22034/jpar.2023.2005200.1180

[5] Jamalianpour, M., & Zandi, Z. (2023). Accounting and auditing in the metaverse from a virtual reality perspective: A future research. *Accountant magazine*, *39*(348), 48-59. (**In Persian**). https://b2n.ir/gg2984

[6] Rostami Mazoui, N., Moezzi, S., & Irannejad, V. (2024). Metaverse in accounting and auditing - a vision for the future. *New explorations in computational science and behavioral management*, *2*(1), 160-174. (**In Persian**). https://civilica.com/doc/2072736/

[7] Dionisio, J. D. N., Iii, W. G. B., & Gilbert, R. (2013). 3D virtual worlds and the metaverse: Current status and future possibilities. *ACM computing surveys (CSUR)*, *45*(3), 1–38. https://doi.org/10.1145/2480741.2480751

[8] Ball, M. (2022). *The metaverse: and how it will revolutionize everything*. Liveright Publishing. https://www.amazon.nl/-/en/Matthew-Ball-ebook/dp/B09KMWYHX8

[9] Ng, D. T. K. (2022). What is the metaverse? Definitions, technologies and the community of inquiry. *Australasian journal of educational technology*, *38*(4), 190–205. https://doi.org/10.14742/ajet.7945

[10] French, A., Shim, J. P., Risius, M., Larsen, K. R., & Jain, H. (2021). The 4th industrial revolution powered by the integration of AI, blockchain, and 5G. *Communications of the association for information systems*, *49*(1), 6. https://doi.org/10.17705/1CAIS.04910

[11] Philbeck, T., & Davis, N. (2018). The fourth industrial revolution. *Journal of international affairs*, *72*(1), 17–22. https://www.jstor.org/stable/26588339

[12] Bloomberg Professional Services. (2021). *Metaverse may be $800 billion market, next tech platform*. https://www.bloomberg.com/professional/insights/trading/metaverse-may-be-800-billion-market-next-tech-platform/

[13] Divulging Technological Landscape of Metaverse. (2022). *The metaverse technology framework*. https://www.centific.com.cn/sites/default/files/2022-06/The Metaverse - Key Technologies.pdf

[14] Hollensen, S., Kotler, P., & Opresnik, M. O. (2023). Metaverse--the new marketing universe. *Journal of business strategy*, *44*(3), 119–125. https://doi.org/10.1108/JBS-01-2022-0014

[15] Suh, A., & Prophet, J. (2018). The state of immersive technology research: A literature analysis. *Computers in human behavior*, *86*, 77–90. https://doi.org/10.1016/j.chb.2018.04.019

[16] Mystakidis, S. (2022). Metaverse. *Encyclopedia*, *2*(1), 486–497. https://doi.org/10.3390/encyclopedia2010031

[17] Tlili, A., Huang, R., Shehata, B., Liu, D., Zhao, J., Metwally, A. H. S., ... & Burgos, D. (2022). Is metaverse in education a blessing or a curse: A combined content and bibliometric analysis. *Smart learning environments*, *9*(1), 1–31. https://doi.org/10.1186/s40561-022-00205-x

[18] Park, S. M., & Kim, Y. G. (2022). A metaverse: Taxonomy, components, applications, and open challenges. *IEEE access*, *10*, 4209–4251. https://doi.org/10.1109/ACCESS.2021.3140175

[19] Díaz, J., Saldaña, C., & Avila, C. (2020). Virtual world as a resource for hybrid education. *International journal of emerging technologies in learning (IJET)*, *15*(15), 94–109. https://doi.org/10.3991/ijet.v15i15.13025

[20] VanHorn, K. C., Zinn, M., & Cobanoglu, M. C. (2019). *Deep learning development environment in virtual reality*. https://arxiv.org/abs/1906.05925

[21] Lalbar, A., Sajjadi Hazavah, M. S., & Arabi, N. (2024). The future of accounting and auditing in the metaverse technology era. *Accountant magazine*, (358), 14-25. (**In Persian**). https://www.magiran.com/p2793174

[22] Braud, T., Pengyuan, Z. H. O. U., Kangasharju, J., & Pan, H. U. I. (2020). Multipath computation offloading for mobile augmented reality. *2020 IEEE international conference on pervasive computing and communications (PerCom)* (pp. 1-10). IEEE. https://doi.org/10.1109/PerCom45495.2020.9127360

[23] Shi, W., Cao, J., Zhang, Q., Li, Y., & Xu, L. (2016). Edge computing: vision and challenges. *IEEE internet of things journal*, *3*(5), 637–646. https://doi.org/10.1109/JIOT.2016.2579198

[24] Yang, B., Yu, Z., Lan, J., Zhang, R., Zhou, J., & Hong, W. (2018). Digital beamforming-based massive MIMO transceiver for 5G millimeter-wave communications. *IEEE transactions on microwave theory and techniques*, *66*(7), 3403–3418. https://doi.org/10.1109/TMTT.2018.2829702

[25] Luong, N. C., Wang, P., Niyato, D., Liang, Y. C., Han, Z., & Hou, F. (2018). Applications of economic and pricing models for resource management in 5G wireless networks: A survey. *IEEE communications surveys & tutorials*, *21*(4), 3298–3339. https://doi.org/10.1109/COMST.2018.2870996

[26] Hassan, N., Yau, K. L. A., & Wu, C. (2019). Edge computing in 5G: A review. *IEEE access*, *7*, 127276–127289. https://doi.org/10.1109/ACCESS.2019.2938534

[27] Lee, L. H., Braud, T., Zhou, P. Y., Wang, L., Xu, D., Lin, Z., ... & Hui, P. (2024). All one needs to know about metaverse: A complete survey on technological singularity, virtual ecosystem, and research agenda. *Foundations and trends®in human-computer interaction*, *18*(2--3), 100–337. https://www.nowpublishers.com/article/Details/HCI-095

[28] Mozumder, M. A. I., Sheeraz, M. M., Athar, A., Aich, S., & Kim, H. C. (2022). Overview: Technology roadmap of the future trend of metaverse based on iot, blockchain, AI technique, and medical domain metaverse activity. *2022 24th international conference on advanced communication technology (ICACT)* (pp. 256–261). IEEE. https://doi.org/10.23919/ICACT53585.2022.9728808

[29] Zawish, M., Dharejo, F. A., Khowaja, S. A., Raza, S., Davy, S., Dev, K., & Bellavista, P. (2024). AI and 6G into the metaverse: Fundamentals, challenges and future research trends. *IEEE open journal of the communications society*, *5*, 730–778. https://doi.org/10.1109/OJCOMS.2024.3349465

[30] Gadekallu, T. R., Huynh-The, T., Wang, W., Yenduri, G., Ranaweera, P., Pham, Q. V., … & Liyanage, M. (2022). *Blockchain for the metaverse: A review*. https://arxiv.org/abs/2203.09738

[31] Park, D. (2021). *Major South Korean banks plan virtual branches in the metaverse*. https://forkast.news/metaverse-banks-ibk-kb-kookmin-nh-nonghyup/

[32] Birch, K. (2022). *JP Morgan is first leading bank to launch in the metaverse*. https://fintechmagazine.com/banking/jp-morgan-becomes-the-first-bank-to-launch-in-the-metaverse

[33] Reuters. (2022). *HSBC launches metaverse portfolio for wealthy Asian clients*. https://www.reuters.com/technology/hsbc-launches-metaverse-portfolio-wealthy-asian-clients-2022-04-06/

[34] Fintecg Global. (2022). *Standard chartered bank latest bank in the metaverse*. https://fintech.global/2022/04/25/standard-chartered-bank-latest-bank-in-the-metaverse/

[35] Ooi, K. B., Tan, G. W. H., Aw, E. C. X., Cham, T. H., Dwivedi, Y. K., Dwivedi, R., ... & Sharma, A. (2023). Banking in the metaverse: A new frontier for financial institutions. *International journal of bank marketing*, *41*(7), 1829–1846. https://doi.org/10.1108/IJBM-03-2023-0168

[36] Kandpal, V., Ozili, P. K., Jeyanthi, P. M., Ranjan, D., & Chandra, D. (2025). Applications of metaverse technology on banking services: Opportunities and challenges. In *Digital finance and metaverse in banking: decoding a virtual reality towards financial inclusion and sustainable development* (pp. 69–86). Emerald Publishing Limited. https://doi.org/10.1108/978-1-83662-088-420251003

[37] Lee, P. (2022). *The coming battle over banking in the metaverse*. https://www.euromoney.com/article/29mm3kud7jxztutnyrhmo/fintech/the-coming-battle-over-banking-in-the-metaverse/

[38] Lee, U. K. (2022). Tourism using virtual reality: Media richness and information system successes. *Sustainability*, *14*(7), 3975. https://doi.org/10.3390/su14073975

[39] Makarov, I., & Schoar, A. (2022). Cryptocurrencies and decentralized finance (DeFi). *Brookings papers on economic activity*, *2022*(1), 141–215. https://doi.org/10.1353/eca.2022.0014

[40] Harvey, C. R., Ramachandran, A., & Santoro, J. (2021). *DeFi and the future of finance*. John Wiley & Sons. https://www.wiley.com/en-us/DeFi+and+the+Future+of+Finance-p-9781119836025

[41] Su, C. W., Qin, M., Tao, R., & Umar, M. (2020). Financial implications of fourth industrial revolution: Can bitcoin improve prospects of energy investment? *Technological forecasting and social change*, *158*, 120178. https://doi.org/10.1016/j.techfore.2020.120178

[42] Tao, R., Su, C. W., Xiao, Y., Dai, K., & Khalid, F. (2021). Robo advisors, algorithmic trading and investment management: Wonders of fourth industrial revolution in financial markets. *Technological forecasting and social change*, *163*, 120421. https://doi.org/10.1016/j.techfore.2020.120421

[43] Birch, D. G. W., & Richardson, V. J. (2023). Metamoney: Payments in the metaverse. *Journal of payments strategy & systems*, *17*(2), 130–141. https://www.ingentaconnect.com/content/hsp/jpss/2023/00000017/00000002/art00003

[44] Aysan, A. F., Gozgor, G., & Nanaeva, Z. (2024). Technological perspectives of metaverse for financial service providers. *Technological forecasting and social change*, *202*, 123323. https://doi.org/10.1016/j.techfore.2024.123323

[45] Rahman, J., Rahman, H., Islam, N., Tanchangya, T., Ridwan, M., & Ali, M. (2025). Regulatory landscape of blockchain assets: Analyzing the drivers of NFT and cryptocurrency regulation. *BenchCouncil transactions on benchmarks, standards and evaluations*, *5*(1), 100214. https://doi.org/10.1016/j.tbench.2025.100214

[46] Kotte, K. R., Attaluri, V., & Selvakumar, P. (2025). Revolutionising retail banking with AI and virtual technologies AI-driven financial training. In *Intersecting natural language processing and fintech innovations in service marketing* (pp. 421–440). IGI Global Scientific Publishing. https://doi.org/10.4018/979-8-3693-9944-6.ch020

[47] Kim, S. (2021). *South Korea's approach to the metaverse*. The Diplomat. https://thediplomat.com/2021/11/south-koreas-approach-to-the-metaverse/

[48] Vogel, S. (2021). How virtual reality can help accountants with CPD. *Institute of chartered accountants in England and wales*. https://charteredaccountantsworldwide.com/institute/the-institute-of-chartered-accountants-in-england-and-wales-icaew/