

The Role of Artificial Intelligence and the Metaverse in Improving Financial Reporting and Fraud Detection: An Empirical Approach Emphasizing the Reduction of Human Error



Abdolreza Ghonji¹, Seyed Hossein Naslmasavi^{2,*}, Aliakbar Ramezani³ and Alireza Modanlo Joibary⁴

¹ Ph.D. Student, Department of Accounting, Qa.S.C., Islamic Azad University, Qaemshahr, Iran; 

² Assistant Professor, Department of Accounting, Qa.S.C., Islamic Azad University, Qaemshahr, Iran; 

³ Assistant Professor, Department of Accounting, Qa.S.C., Islamic Azad University, Qaemshahr, Iran; 

⁴ Assistant Professor, Department of Management and Accounting, Beh.C., Islamic Azad University, Behshahr, Iran; 

* Correspondence: Nseyedhossein2@iau.ac.ir

Citation: Ghonji, A., Naslmasavi, S. H., Ramezani, A., & Modanlo Joibary, A. (2027). The Role of Artificial Intelligence and the Metaverse in Improving Financial Reporting and Fraud Detection: An Empirical Approach Emphasizing the Reduction of Human Error. *Business, Marketing, and Finance Open*, 4(10), 1-19.

Received: 05 July 2026

Revised: 01 October 2026

Accepted: 07 October 2026

Initial Publication: 30 October 2026

Final Publication: 01 October 2027



Copyright: © 2027 by the authors. Published under the terms and conditions of Creative Commons Attribution-NonCommercial 4.0 International (CC BY-NC 4.0) License.

Abstract: The present study aimed to investigate the role of emerging technologies, particularly artificial intelligence (AI) and the metaverse, in fraud detection and improving the accuracy of financial reporting. A mixed survey–library research method with a descriptive-correlational design was employed. The statistical population consisted of corporate managers, auditors, and financial supervisors, and data were collected using a structured questionnaire. The descriptive statistical results indicated that auditors demonstrated the highest level of familiarity with and the most positive attitudes toward the application of AI in reducing human error and detecting fraud, whereas attitudes toward the metaverse were more cautious and exhibited greater variability. Statistical analyses, including the one-sample t test and multiple linear regression, showed that familiarity with and application of AI, as well as familiarity with the metaverse, had positive and significant effects on reducing human error. The findings emphasize that developing knowledge and skills related to the use of intelligent technologies and applying such technologies in financial environments can play an effective role in enhancing transparency, accuracy, and trust in the financial reporting process. This study provides a scientific foundation for designing operational models based on intelligent technologies and reducing risks associated with human error.

Keywords: artificial intelligence, metaverse, financial reporting, fraud detection

1. Introduction

The digital transformation of accounting and financial management has accelerated markedly with the emergence of artificial intelligence (AI), machine learning, blockchain, immersive environments, and metaverse-based business ecosystems. These technologies are increasingly reshaping how financial information is generated, processed, analyzed, verified, communicated, and monitored. In contemporary organizations, financial reporting is no longer exclusively dependent on traditional accounting systems and manual professional judgment; instead, intelligent algorithms are increasingly used to process large volumes of structured and unstructured data, identify abnormal patterns, automate repetitive procedures, and support decision-making. In parallel, the metaverse is creating interactive and persistent digital environments in which economic transactions, organizational interactions, digital assets, and

financial activities may occur in real time. These developments have important implications for accounting because the expansion of digital economic activity introduces both opportunities for improving transparency and accuracy and new risks involving fraud, manipulation, cybersecurity, and regulatory oversight. The integration of AI with metaverse environments is therefore becoming particularly relevant for financial reporting and fraud detection, as intelligent systems can potentially analyze complex transactional patterns while immersive digital environments enable new forms of observation, interaction, monitoring, and simulation [1-3].

Artificial intelligence has already become one of the most influential technologies in accounting and finance because of its ability to automate analytical tasks and identify patterns that may not be readily observable through conventional procedures. Modern AI systems can assist with transaction classification, reconciliation, financial forecasting, anomaly detection, audit planning, risk assessment, and the identification of potentially fraudulent behavior. More recent generative AI technologies, including large language models and intelligent interfaces, further extend these capabilities by enabling automated interpretation of financial documents, extraction of information from complex reports, generation of summaries, and decision support across accounting and finance functions [4]. The significance of AI for financial reporting is particularly evident in contexts where human processing capacity is limited by the scale, velocity, and complexity of financial data. Evidence suggests that AI adoption can improve the quality of financial reports by increasing the consistency, timeliness, and analytical precision of financial information while reducing dependence on error-prone manual procedures [5]. Accordingly, AI should not be understood merely as a technological add-on to accounting systems, but as an increasingly important component of the financial information infrastructure of modern organizations.

One of the most important potential benefits of AI in financial reporting concerns the reduction of human error. Financial reporting processes remain vulnerable to unintentional mistakes resulting from information overload, fatigue, computational errors, inconsistent classification, cognitive bias, and limitations in professional judgment. These weaknesses can affect the reliability of financial statements even when no deliberate manipulation is involved. Automated and intelligent systems may reduce such errors by standardizing repetitive processes, continuously checking data consistency, identifying unusual observations, and generating alerts when reported information deviates from expected patterns. Machine-learning systems can also improve over time as they are exposed to larger datasets and new patterns of financial behavior. Nevertheless, AI does not entirely eliminate human involvement. Rather, it changes the nature of human participation by shifting accountants and auditors from routine data-processing activities toward interpretation, validation, professional judgment, and supervision of algorithmic outputs. The effectiveness of this transformation therefore depends on users' familiarity with AI, their ability to understand its analytical capabilities and limitations, and the actual integration of AI systems into financial workplaces [4-6].

The importance of AI is even greater in fraud detection because fraudulent financial behavior is typically characterized by concealment, irregularity, strategic adaptation, and attempts to imitate legitimate transactions. Traditional fraud detection procedures often depend on periodic reviews, predefined rules, sampling, and the professional skepticism of auditors. Although these methods remain essential, they may be insufficient when organizations generate massive volumes of transactions across digital platforms. AI and machine-learning techniques provide an alternative by analyzing entire datasets, identifying subtle nonlinear relationships, recognizing abnormal transaction sequences, and detecting deviations from established behavioral patterns. Anomaly detection has become especially important in digital finance and blockchain environments because fraudulent activity may appear not as an obviously prohibited transaction but as an unusual combination of

otherwise legitimate behaviors. Research on blockchain transactions within metaverse environments demonstrates the growing relevance of anomaly-detection methods for distinguishing suspicious transactions from normal activity [7]. Machine-learning approaches have similarly been applied to blockchain-based metaverse transactions to identify irregular financial behavior and improve the monitoring of decentralized economic activity [8]. More advanced applications combining Isolation Forest algorithms with autoencoder neural networks further illustrate how AI-based anomaly detection can identify complex transactional abnormalities within open metaverse ecosystems [9].

The metaverse adds a further dimension to this technological transformation because it expands financial activities into persistent, interactive, and immersive digital environments. In such environments, individuals and organizations may engage in transactions involving virtual assets, digital identities, financial services, decentralized platforms, smart contracts, and blockchain-based ownership structures. The financial industry may consequently experience significant changes in customer interaction, service delivery, payment processes, investment practices, and reporting requirements [2]. The metaverse may also transform financial management practices within smaller organizations by creating new possibilities for virtual collaboration, data visualization, remote management, customer engagement, and digital financial services [10]. However, the expansion of financial activity into virtual environments increases the complexity of accountability and reporting because transactions may involve multiple platforms, virtual identities, decentralized architectures, and assets that do not fit easily within traditional reporting frameworks. This emerging context requires new approaches to financial transparency, internal control, auditability, and regulatory monitoring.

The accounting implications of the metaverse have therefore become increasingly important. Financial reporting within metaverse environments may involve novel forms of digital assets, virtual transactions, decentralized records, and interactions that challenge conventional recognition, measurement, verification, and disclosure practices. Research examining financial reporting practices in metaverse-related contexts has highlighted the need to adapt accounting systems and institutional practices to the characteristics of digital environments [11]. The future of accounting in the metaverse is consequently not limited to the technical recording of virtual transactions; it also concerns how accounting professionals interpret economic substance, maintain accountability, ensure comparability, and establish confidence in financial information generated within increasingly complex digital systems [1]. As the metaverse becomes more closely connected with organizational and economic activities, its interaction with technologies such as AI, blockchain, digital twins, the Internet of Things, and extended reality may create integrated ecosystems in which financial information is continuously generated and analyzed rather than produced only through periodic reporting cycles [3, 12].

The relationship between AI and the metaverse is particularly significant because AI can provide the analytical and adaptive intelligence required to manage the complexity of immersive digital environments. AI algorithms may monitor transactions, authenticate patterns of behavior, recognize suspicious activities, evaluate cyber risks, and support automated decision-making within virtual ecosystems. At the same time, metaverse environments may provide rich behavioral and transactional data that allow AI systems to detect relationships that are difficult to observe in traditional financial records. The combination of generative AI and the metaverse has consequently been identified as a promising direction for financial analytics because the two technologies can create synergies in data interpretation, simulation, user interaction, and predictive analysis [6]. Such integration may allow financial actors to move beyond static financial datasets and examine behavior dynamically across simulated or digitally

mediated environments. This capability may be particularly valuable for identifying how fraud emerges, spreads, and adapts under changing incentives and competitive conditions.

The potential contribution of metaverse technology to fraud detection has also been increasingly recognized. Metaverse-based systems may improve fraud detection by enabling sophisticated simulations, creating interactive monitoring environments, and integrating multiple sources of behavioral and transactional information. Empirical research has demonstrated that metaverse technology can support the identification of financial fraud and provide new mechanisms for detecting suspicious financial behavior [13]. The combination of AI and metaverse techniques has also been discussed as a mechanism for reducing earnings management, suggesting that emerging technologies may influence not only the technical detection of anomalies but also the broader behavioral conditions under which financial manipulation occurs [14]. This perspective is important because financial fraud cannot be explained solely by data irregularities. It also involves managerial incentives, pressure, opportunity, competitive dynamics, and deliberate strategic choices. Technologies that improve transparency and increase the visibility of financial behavior may therefore discourage manipulation while simultaneously improving the probability of detecting it.

Despite these opportunities, financial activities within the metaverse create new categories of risk. The use of digital identities, blockchain transactions, virtual assets, immersive platforms, and interconnected systems increases the potential attack surface for cybercrime, identity manipulation, data theft, unauthorized transactions, and sophisticated fraud. AI is increasingly regarded as an important mechanism for addressing these risks because it can support continuous monitoring and rapid identification of abnormal behavior. However, malicious actors can also use AI to automate attacks, generate deceptive content, and adapt fraudulent strategies, creating a continuing technological competition between detection and evasion. Research on metaverse cybersecurity therefore emphasizes both the opportunities and challenges associated with AI-based security architectures [15]. Similar concerns have been raised regarding the role of AI in mitigating emerging metaverse threats across manufacturing and service industries, where security, authenticity, and reliable identity management are essential for maintaining confidence in digital transactions [16]. AI and machine-learning systems are consequently expected to play a central role in metaverse security, although their effectiveness depends on the quality of available data, algorithm design, system governance, and the ability to respond to continuously evolving threats [17].

Risk management within metaverse financial ecosystems also requires an understanding of transaction-level anomalies and regulatory implications. Financial transactions in immersive and decentralized environments may be difficult to supervise through traditional mechanisms because of their speed, cross-platform nature, technological complexity, and potential pseudonymity. Studies of financial transactions in the metaverse have therefore emphasized the importance of integrating risk analysis, anomaly detection, and regulatory approaches rather than treating them as independent functions [18]. This integrated perspective is particularly relevant for auditors and financial supervisors, whose responsibilities increasingly extend beyond verifying conventional financial records toward evaluating the reliability of technology-driven processes. As transaction environments become more automated, auditors may need to evaluate not only reported outputs but also the algorithms, digital infrastructures, and data-generation processes underlying those outputs. Financial supervisors may similarly require technological capabilities that enable them to identify abnormal activities before they develop into significant reporting failures or systemic risks.

An additional concern relates to privacy and personal data protection. AI-supported metaverse environments can generate and analyze extensive amounts of behavioral, biometric, transactional, and identity-related information. Although such data can improve fraud detection, their collection and processing also create legal and

ethical challenges. Financial systems must therefore balance the benefits of enhanced monitoring with requirements concerning confidentiality, data protection, consent, proportionality, and legitimate use. The application of AI within the metaverse has already been identified as a new challenge for personal data protection in financial systems, particularly because conventional privacy frameworks may not fully address the persistence, granularity, and interconnectedness of data generated in virtual environments [19]. These concerns are directly relevant to financial reporting because trust in digital financial systems depends not only on the accuracy of information but also on the legitimacy and security of the processes through which that information is produced.

The emergence of AI-enabled digital twins, Internet of Things systems, blockchain infrastructures, and extended-reality environments further suggests that future financial reporting may operate within highly interconnected technological ecosystems. In these environments, financial information may be linked directly to operational processes, digital representations of organizational assets, and continuous streams of machine-generated data. Such integration could improve reporting timeliness and reduce the delay between economic activity and its representation in financial systems. Digital twins and metaverse-based enterprise environments, for example, may enable organizations to simulate operational scenarios and connect financial consequences with real-time physical and digital processes [12]. Similarly, the convergence of generative AI, blockchain-based fintech management, the Internet of Things, and industrial metaverse technologies points toward a cognitive and algorithmic economy in which organizational decisions are increasingly supported by interconnected intelligent systems [3]. These developments create opportunities for greater transparency but also require higher levels of technological literacy among managers, auditors, and regulators.

Within this evolving technological environment, the attitudes and capabilities of professional users become critical. The effectiveness of AI and metaverse technologies depends not only on their technical performance but also on whether managers, auditors, and financial supervisors understand, accept, and apply them appropriately. Managers influence technology adoption, resource allocation, internal control design, and organizational reporting cultures. Auditors evaluate evidence, assess risk, and determine whether intelligent systems can be relied upon within assurance procedures. Financial supervisors and regulators establish standards, monitor compliance, and respond to emerging risks. Differences among these groups in technological familiarity may therefore influence the extent to which AI and the metaverse contribute to financial reporting quality. For example, users with greater familiarity with AI may be more capable of interpreting algorithmic outputs and integrating intelligent tools into professional judgment, whereas limited knowledge may result in either excessive distrust or inappropriate overreliance. Similarly, the relative novelty of metaverse technology may produce greater uncertainty and variation in attitudes than more established AI applications.

From a management perspective, reducing human error requires more than automating isolated accounting procedures. It requires the design of socio-technical systems in which human expertise and intelligent technologies complement one another. AI can perform computationally intensive monitoring and pattern recognition, while accounting and auditing professionals remain responsible for contextual interpretation, ethical judgment, validation, and accountability. Metaverse environments may further improve this interaction by enabling immersive training, collaborative review, scenario simulation, and visualization of complex financial relationships. At the same time, poorly designed technologies may create new forms of error through algorithmic bias, inappropriate model assumptions, weak data quality, cybersecurity failures, or excessive reliance on automated recommendations. For this reason, empirical assessment of users' familiarity, actual technology use, and

perceptions of error reduction is necessary for determining whether technological adoption translates into meaningful improvements in financial reporting.

Although the literature increasingly addresses AI in accounting, metaverse-based finance, blockchain anomaly detection, financial cybersecurity, and digital reporting, these topics are frequently examined separately. Research has established the potential of AI to improve financial reporting quality [5], demonstrated the use of anomaly-detection approaches in metaverse and blockchain transactions [7-9], examined financial and regulatory risks in metaverse transactions [18], and identified emerging accounting and financial reporting implications of virtual environments [1, 11]. Other studies have highlighted the financial applications of the metaverse [2, 10], the combined analytical potential of generative AI and metaverse technologies [6], and their possible role in mitigating manipulative financial behavior [14]. Nevertheless, comparatively less empirical attention has been given to the integrated relationship among AI familiarity, workplace application of intelligent systems, familiarity with the metaverse, and the reduction of human error in financial reporting across distinct professional stakeholder groups.

This gap is particularly important because the successful implementation of intelligent financial technologies requires evidence concerning how the professionals responsible for preparing, auditing, and supervising financial information perceive and use such technologies. A technology may possess substantial theoretical capability but produce limited practical benefits if its users lack familiarity, confidence, organizational support, or opportunities for application. Conversely, strong professional acceptance combined with effective implementation may allow AI and metaverse-based environments to improve transparency, support fraud detection, reduce manual errors, and strengthen confidence in financial information. Empirical comparison among corporate managers, auditors, and financial supervisors can therefore provide important insights into the degree of technological readiness across different dimensions of the financial reporting ecosystem and clarify whether technological familiarity is associated with perceived reductions in human error.

Accordingly, the aim of this study is to empirically examine the role of artificial intelligence and the metaverse in improving financial reporting and fraud detection, with particular emphasis on the effects of familiarity with and application of these technologies on reducing human error among corporate managers, auditors, and financial supervisors.

2. Methods and Materials

In terms of purpose, this study is classified as applied research because its findings can be directly utilized in the detection and prevention of financial fraud, particularly in digital environments and contexts based on emerging technologies such as artificial intelligence and the metaverse. In terms of the nature of the study and the examination of relationships among variables, the present research is descriptive-correlational; that is, its principal objective is to explain and model the relationships among the main research variables and examine their effects on fraudulent behavior in financial reporting. A combination of library-based and survey methods was used for data collection. In the library-based phase, a systematic review of the most recent scientific sources published during the preceding five years, including reputable articles, books, and research reports, was conducted to develop the theoretical framework of the study. Key concepts, including artificial intelligence, the metaverse, the Internet of Things, and data mining, were examined in relation to financial reporting and fraud detection. This stage provided the scientific foundation for developing the conceptual model of the study. In the survey phase, field data were collected using a standardized and structured questionnaire. The questionnaire consisted of two main sections: the first section addressed respondents' demographic characteristics, and the second included items measuring the

main research variables using a five-point Likert scale. The content validity of the questionnaire was confirmed by a group of university professors and financial experts.

According to Table 1, the reliability coefficients of the questionnaires, calculated using Cronbach's alpha, were reported for the three statistical populations of the study, namely corporate managers, auditors, and financial supervisors. As shown, Cronbach's alpha exceeded 0.80 in all groups, indicating satisfactory internal consistency and high reliability of the data collection instruments. For the corporate managers' questionnaire, Cronbach's alpha was 0.87. This level of reliability indicates that the items designed to measure variables associated with the role of managers in fraud and financial reporting possessed sufficient internal consistency and that the resulting data were highly reliable. In other words, the responses provided by corporate managers can serve as a valid basis for the statistical analyses conducted in this study. For the auditors' questionnaire, Cronbach's alpha was calculated as 0.85. This value also exceeds the minimum recommended threshold of 0.70, demonstrating that the items relating to this statistical group consistently measured the intended dimensions of the study. Therefore, the data collection instrument in the auditing domain possesses adequate reliability and stability and can provide dependable results for testing the research hypotheses.

Furthermore, the questionnaire administered to financial supervisors and regulators yielded the highest Cronbach's alpha coefficient, at 0.88. This indicates that this instrument demonstrated the greatest internal consistency among the three questionnaires and can measure variables associated with financial supervision and regulation with greater precision. Accordingly, the data collected from this group have a high degree of reliability and contribute to the robustness of the study findings. The statistical population consisted of financial managers, auditors, and capital market supervisors who are directly involved with emerging financial technologies and financial reporting. Cochran's formula was used to determine the sample size and suggested a minimum of 150 participants. Accordingly, a balanced and purposive sample comprising 50 financial managers, 50 auditors, and 50 supervisors was selected. A purposive-judgmental sampling method was employed, meaning that only individuals with sufficient experience and expertise in emerging technologies and financial reporting were included. The collected data were analyzed using inferential statistical methods. The statistical technique employed was multiple regression, which enabled the examination of relationships among the variables and assessment of the proposed research model. Thus, the combination of survey and library-based approaches enabled the study to develop, from both theoretical and empirical perspectives, a comprehensive model explaining the role of artificial intelligence and the metaverse in the detection and prevention of financial fraud.

The principal innovation of this study lies in addressing an important research gap. Most previous studies in the field of fraud detection have either focused exclusively on artificial intelligence and data-mining algorithms or examined the potential of the metaverse and digital environments; however, no study has simultaneously investigated the integrated role of these two technologies in enhancing financial reporting and reducing human error. For the first time, the present study proposes an integrated framework based on artificial intelligence and the metaverse that can analyze the behavior of financial actors within a simulated and dynamic environment. A second contribution concerns the gap in the literature regarding the reduction of human error in the fraud detection process. Most previous studies have focused solely on improving the predictive accuracy of models, whereas the present study demonstrates that integrating the metaverse and artificial intelligence not only improves algorithmic accuracy but also substantially reduces the likelihood of human error by increasing transparency in interactions and minimizing subjective intervention by auditors. Another innovation of this research is its empirical and data-driven approach. Unlike many previous studies that were primarily limited to theoretical analyses or static

modeling, the present research employs evolutionary game theory and machine-learning algorithms to simulate conditions close to real-world environments and enables the analysis of the dynamics of fraudulent behaviors in digital settings. By integrating the evolutionary game-theory framework with machine-learning tools, this study develops a dynamic model that not only analyzes past fraudulent behavior but also has the capacity to predict future changes. This innovation can address an existing gap in the accounting and financial reporting literature and provide a practical tool for auditors, regulatory institutions, and investors seeking to enhance transparency and trust in financial markets.

Table 1. Reliability Coefficients (Cronbach's Alpha) of the Questionnaires for the Three Statistical Populations

Statistical Population	Questionnaire	Cronbach's Alpha
Corporate managers	Managers' questionnaire	0.87
Managers and partners of auditing firms	Auditors' questionnaire	0.85
Financial supervisors and regulators	Supervisors' questionnaire	0.88

3. Findings and Results

Table 2 presents the demographic characteristics of the corporate managers, comprising 50 individuals. In terms of gender, the majority of the sample consisted of men, with 34 male and 16 female participants, indicating the predominance of men in managerial positions. Regarding age, the highest frequency was observed in the 30–40-year age group, with 26 participants, followed by those aged 40–50 years (14 participants) and those older than 50 years (6 participants); the group younger than 30 years had the smallest number of participants (4 individuals). This age distribution indicates that most managers were concentrated in midlife and the middle stages of their professional careers.

In terms of educational attainment, most managers held a master's degree (28 participants), whereas 12 held a bachelor's degree and 10 held a doctoral degree. This relatively high educational level may indicate sufficient academic preparedness for the adoption of emerging technologies such as artificial intelligence and the metaverse. Regarding academic discipline, most managers had backgrounds in accounting (22 participants) and finance (18 participants), while 10 came from other disciplines, which is consistent with the financial expertise required for addressing fraud in financial reporting. The type of organization also influenced the distribution of managers; 30 were employed in public-sector organizations and 20 worked in the private sector, indicating a slightly greater representation of the public sector in the sample. Finally, managers' work experience varied, with 14 having fewer than 5 years of experience, 20 having between 5 and 10 years, and 16 having more than 10 years of professional experience.

Table 2. Demographic Characteristics of Corporate Managers (Group 1)

Demographic Characteristic	Classification	Total
Gender	Male: 34 / Female: 16	50
Age	<30: 4 / 30–40: 26 / 40–50: 14 / >50: 6	50
Education	Bachelor's: 12 / Master's: 28 / Doctorate: 10	50
Organization type	Public: 30 / Private: 20	50
Work experience	<5 years: 14 / 5–10 years: 20 / >10 years: 16	50

Table 3 presents the descriptive statistics for the questionnaire administered to the auditor managers, corresponding to the second group. The mean scores indicate that respondents were highly familiar with the application of artificial intelligence in fraud detection, with a mean score of 4.2, while the standard deviation of 0.7

indicates relative convergence in respondents' opinions. Regarding the use of AI-based systems in the workplace, the mean of 3.8 and standard deviation of 0.9 indicate that although most respondents had experience using such systems, their views were somewhat more dispersed. Similarly, belief in the role of the metaverse in improving interoperability within the reporting process yielded a mean of 3.9 and a standard deviation of 0.8, suggesting that this technology was relatively well accepted, although respondents may not yet have had complete confidence in it. For items concerning the behavior of financial reporters under pressure and their tendency to engage in unhealthy competition, the mean scores were 3.5 and 3.6, respectively. These results indicate that respondents somewhat believed that financial reporters might engage in inappropriate competitive behaviors under competitive pressure and that financial managers may sometimes consciously engage in fraud. The greater dispersion of responses in these areas, reflected in standard deviations of 1.0 and 0.9, indicates differences in respondents' perspectives on these issues.

Table 3. Descriptive Statistics for the Auditor Managers' Questionnaire (Group 2)

Item	Mean	SD	Minimum	Maximum
I am familiar with the use of AI in fraud detection.	4.2	0.7	2	5
AI-based systems are used in my workplace.	3.8	0.9	1	5
The metaverse can improve interoperability in the reporting process.	3.9	0.8	2	5
Under pressure, a financial reporter may engage in unhealthy competition.	3.5	1.0	1	5
Financial managers knowingly choose fraud to maintain their competitive position.	3.6	0.9	1	5

Table 4 presents the demographic characteristics of the auditor managers, comprising 50 individuals. In terms of gender, 32 participants were men and 18 were women, corresponding to approximately 64% men and 36% women. This gender composition is similar to that of the corporate managers' group, although women had somewhat greater representation. Regarding age, the largest number of respondents belonged to the 30–40-year age group (24 participants), followed by those younger than 30 years (10 participants) and those aged 40–50 years (12 participants); the group older than 50 years had the fewest participants (4 individuals). This age distribution indicates a concentration among younger and middle-aged individuals, who are typically more familiar with emerging technologies.

In terms of education, most participants held a master's degree (28 individuals) or a doctoral degree (16 individuals), whereas fewer held a bachelor's degree (6 individuals). This educational level is slightly higher than that observed in the first group and indicates greater academic specialization in technology and machine learning. The participants' academic disciplines were primarily software engineering (16 participants), data science (12 participants), information technology (12 participants), and other disciplines (10 participants), all of which are closely related to technology and artificial intelligence and are therefore appropriate for the subject of the thesis. Participants also worked in diverse organizational settings: 16 were employed in startups, 24 in the private sector, and 10 in the public sector. This diversity reflects representation from both innovative and traditional organizations. Respondents' work experience was also varied: 18 had fewer than 5 years of experience, 15 had between 5 and 10 years, and 17 had more than 10 years of experience. This distribution indicates that individuals with varying levels of experience were included in the sample, which may increase the diversity of viewpoints.

Table 4. Demographic Characteristics of Auditor Managers (Group 2)

Demographic Characteristic	Classification	Total
Gender	Male: 32 / Female: 18	50
Age	<30: 10 / 30–40: 24 / 40–50: 12 / >50: 4	50
Education	Bachelor's: 6 / Master's: 28 / Doctorate: 16	50

Organization type	Startup: 16 / Private: 24 / Public: 10	50
Work experience	<5 years: 18 / 5–10 years: 15 / >10 years: 17	50

Table 5 presents the descriptive statistics for the auditor managers' questionnaire (Group 2), reflecting this group's views regarding the application of artificial intelligence and the metaverse in financial reporting. The mean scores for most items exceeded 3.7, indicating a high level of familiarity with and acceptance of emerging technologies in this group. The item "AI can reduce human error in financial reporting" received the highest level of agreement, with a mean of 4.3 and a standard deviation of 0.5, reflecting auditors' strong belief in the positive effect of artificial intelligence on reducing financial reporting errors. Familiarity with the application of AI in fraud detection, with a mean of 4.1, and familiarity with machine-learning methods in financial data analysis, with a mean of 4.0, also indicate that this group of auditors was highly familiar with intelligent technologies.

The mean of 3.9 for the use of AI-based systems in the workplace and the mean of 3.8 for the analysis of financial data using intelligent algorithms further indicate that the practical use of these technologies in respondents' work environments was considerable. Familiarity with basic metaverse concepts, with a mean of 3.7, indicates that although this technology is relatively new, it has received a reasonable degree of attention among this group. The relatively low standard deviations for most items, ranging from 0.5 to 0.8, demonstrate relative convergence of opinions; in other words, perspectives regarding the role of artificial intelligence and the metaverse were largely similar and positive. Overall, these findings indicate auditors' preparedness and acceptance of emerging technologies for combating fraud and improving financial reporting.

Table 5. Descriptive Statistics for the Auditor Managers' Questionnaire (Group 2)

Item	Mean	SD	Minimum	Maximum
I am familiar with the use of AI in fraud detection.	4.1	0.6	3	5
AI-based systems are used in my workplace.	3.9	0.7	2	5
AI can reduce human error in financial reporting.	4.3	0.5	3	5
I am familiar with basic metaverse concepts.	3.7	0.8	2	5
I am familiar with machine-learning methods for financial data analysis.	4.0	0.6	3	5
In our company, financial data are analyzed using intelligent algorithms.	3.8	0.7	2	5

Table 6 presents the demographic characteristics of the financial supervisors' questionnaire respondents (Group 3), comprising 50 individuals. In terms of gender, 36 participants were men and 14 were women, representing approximately 72% men and 28% women and indicating the predominance of men in this group. Regarding age, most participants were in the 30–40-year (20 participants) and 40–50-year (17 participants) age groups; additionally, 10 participants were older than 50 years and only 3 were younger than 30 years. This age distribution represents a combination of professional experience and maturity among financial supervisors. The educational attainment of this group was predominantly at the doctoral level; 35 participants held doctoral degrees, 10 were doctoral students, and 5 held master's degrees, indicating a very high level of education. This may reflect substantial academic expertise and the ability to analyze complex financial issues. Regarding academic disciplines, most participants had backgrounds in accounting (20 individuals), management (12 individuals), and computer science (10 individuals), while 8 came from other disciplines. This disciplinary composition provides appropriate diversity for addressing issues related to finance and technology.

Most financial supervisors taught at public universities (28 participants), while 12 were affiliated with Islamic Azad University, 6 with Payame Noor University, and 4 with non-profit higher education institutions. This diversity in academic affiliation may contribute a broad range of theoretical and practical perspectives. Financial

supervisors' work experience was also diverse: 8 participants had fewer than 5 years of experience, 20 had between 5 and 10 years, and 22 had more than 10 years of professional experience. This distribution reflects an appropriate combination of relatively younger and highly experienced participants, which may contribute to a more precise analysis of fraud- and technology-related issues.

Table 6. Demographic Characteristics of Financial Supervisors (Group 3)

Demographic Characteristic	Classification	Total
Gender	Male: 36 / Female: 14	50
Age	<30: 3 / 30–40: 20 / 40–50: 17 / >50: 10	50
Education	Doctorate: 35 / Doctoral student: 10 / Master's: 5	50
University affiliation	Public: 28 / Islamic Azad University: 12 / Payame Noor University: 6 / Non-profit: 4	50
Work experience	<5 years: 8 / 5–10 years: 20 / >10 years: 22	50

Table 7 presents the descriptive statistics for the financial supervisors' questionnaire (Group 3), reflecting this group's views regarding the application of artificial intelligence and the metaverse in financial reporting and fraud-related issues. The mean responses indicate that financial supervisors were highly familiar with the use of AI in fraud detection ($M = 4.0$) and believed in its role in reducing human error ($M = 4.2$). These values indicate a high level of acceptance of artificial intelligence technology within this group.

Familiarity with basic metaverse concepts had a mean of 3.6, which was slightly lower than the mean scores for the other items. This may be attributable to the emerging nature of metaverse technology and its slower rate of adoption. Furthermore, the use of intelligent algorithms in financial data analysis yielded a mean of 3.7, indicating that supervisors had a moderate degree of awareness of the operational application of these technologies in their professional environments.

The items relating to financial reporters' behavior under pressure indicate that supervisors believed that, under such conditions, financial reporters may engage in unhealthy competition ($M = 3.4$) and that financial managers may sometimes knowingly commit fraud to preserve their competitive position ($M = 3.5$). These items had higher standard deviations of 1.0 and 0.9, respectively, indicating greater dispersion and diversity of views in this area. The minimum and maximum scores demonstrate that respondents' views ranged from complete disagreement to complete agreement. Overall, these findings indicate that although financial supervisors accept emerging technologies, they remain concerned about inappropriate financial behaviors, which may provide a useful basis for more in-depth analyses in the thesis.

Table 7. Descriptive Statistics for the Financial Supervisors' Questionnaire (Group 3)

Item	Mean	SD	Minimum	Maximum
I am familiar with the use of AI in fraud detection.	4.0	0.7	2	5
AI can reduce human error in financial reporting.	4.2	0.6	3	5
I am familiar with basic metaverse concepts.	3.6	0.9	1	5
In our company, financial data are analyzed using intelligent algorithms.	3.7	0.8	2	5
Under pressure, a financial reporter may engage in unhealthy competition.	3.4	1.0	1	5
Financial managers knowingly choose fraud to maintain their competitive position.	3.5	0.9	1	5

A comparison of the levels of understanding and attitudes among the three groups—corporate managers, auditors, and financial supervisors—toward emerging artificial intelligence (AI) and metaverse technologies indicates that all three groups were generally receptive to emerging technologies, although differences were observed in their levels of familiarity and attitudes. Regarding artificial intelligence, auditors demonstrated the highest level of understanding and the most positive attitudes toward the use of AI in fraud detection and the

reduction of human error. Their high mean scores on the relevant items indicate that this group not only possessed theoretical familiarity but also had considerable practical experience in using AI-based systems. Auditors were followed by financial supervisors and then corporate managers in this regard, although all three groups demonstrated relatively high levels of acceptance and awareness.

In contrast, attitudes toward the metaverse were somewhat more cautious and more heterogeneous across all three groups. Corporate managers expressed comparatively more positive attitudes toward the metaverse and its application in improving interoperability in reporting. Auditors and financial supervisors ranked next, respectively. This may be attributable to the emerging nature of metaverse technology and differences in the level of familiarity with and practical application of this technology in the work environments of these groups. It was also observed that attitudes in this area were less homogeneous and more dispersed than attitudes toward AI. Therefore, these data provide a basis for proceeding to the parameter calibration and game-theoretical modeling stage.

A one-sample t test was conducted to examine the level of familiarity with and acceptance of emerging technologies in financial reporting. The results indicated that the mean scores for all components exceeded the midpoint of the scale and were statistically significant, demonstrating respondents' positive tendency toward the use of intelligent technologies in financial environments. In particular, familiarity with artificial intelligence for fraud detection, with a mean of 4.1 and $t = 11.2$, demonstrated a high level of acceptance. Moreover, belief in the role of AI in reducing human error, with a mean of 4.3 and $t = 13.6$, received the highest level of agreement among respondents. These findings indicate that respondents regarded artificial intelligence as an effective tool for reducing errors and improving the accuracy of financial reporting. Other components were also evaluated significantly positively, including the use of AI-based systems ($M = 3.9$), familiarity with machine-learning methods in financial data analysis ($M = 4.0$), and the analysis of financial data using intelligent algorithms ($M = 3.8$). Familiarity with metaverse concepts, with a mean of 3.7, also indicates respondents' attention to emerging technologies and their willingness to apply them in financial reporting processes.

Multiple linear regression analysis was performed to examine the effects of predictor variables on the reduction of human error in financial reporting. The results showed that all predictor variables had positive and statistically significant effects on reducing human error. Familiarity with AI demonstrated the strongest effect, with $\beta = 0.42$ and $t = 5.12$, indicating the importance of knowledge and proficiency in artificial intelligence within financial environments. The use of AI in the workplace also had a substantial effect, with $\beta = 0.35$ and $t = 4.27$, demonstrating the role of the practical application of artificial intelligence in improving reporting accuracy. In addition, familiarity with the metaverse had a positive and statistically significant effect on reducing human error, with $\beta = 0.21$ and $t = 2.58$, indicating the importance of attending to emerging technologies in improving the quality of financial processes. Overall, these findings demonstrate that greater familiarity with and application of emerging technologies, particularly artificial intelligence and the metaverse, can play an effective role in reducing human error and improving the accuracy of financial reporting. The convergence of the findings from the one-sample t test and regression analysis emphasizes that the acceptance and application of intelligent technologies not only increase awareness but can also directly influence professional performance and reduce associated risks.

Table 8. One-Sample t Test for Questionnaire Components

Component	Mean	SD	t	p
Familiarity with AI in fraud detection	4.1	0.6	11.2	< .001
Use of AI-based systems	3.9	0.7	8.9	< .001

AI can reduce human error	4.3	0.5	13.6	< .001
Familiarity with the metaverse	3.7	0.8	6.8	< .001
Familiarity with machine learning in financial analysis	4.0	0.6	10.2	< .001
Financial data are analyzed using intelligent algorithms	3.8	0.7	8.2	< .001

Table 9. Multiple Linear Regression of the Research Variables

Predictor Variable	β	t	p
Familiarity with AI	0.42	5.12	< .001
Use of AI in the workplace	0.35	4.27	< .001
Familiarity with the metaverse	0.21	2.58	.011

4. Discussion and Conclusion

The present study examined the role of artificial intelligence and the metaverse in improving financial reporting and fraud detection, with particular emphasis on reducing human error. The findings provide empirical evidence that respondents generally held positive attitudes toward the adoption of intelligent technologies in financial environments and that familiarity with and practical use of AI were particularly important in explaining perceived reductions in human error. The descriptive results showed that auditors demonstrated the highest level of familiarity with AI applications and the strongest belief in the capacity of AI to reduce human error in financial reporting. Financial supervisors also reported relatively high levels of familiarity and acceptance, whereas corporate managers showed positive but somewhat lower levels of engagement with AI-related applications. In contrast, attitudes toward the metaverse were more cautious and more dispersed across the three groups. The inferential results further demonstrated that the mean scores for all technology-related components were significantly above the midpoint of the measurement scale. Multiple regression analysis indicated that familiarity with AI had the strongest positive effect on reducing human error, followed by the practical use of AI in the workplace and familiarity with the metaverse. Taken together, these findings suggest that both technological knowledge and actual organizational implementation play important roles in improving the quality and reliability of financial reporting.

One of the most important findings was the comparatively high level of familiarity with AI for fraud detection. The one-sample t test showed that familiarity with AI in fraud detection had a mean of 4.1 and was significantly above the scale midpoint, indicating that respondents generally recognized AI as an important component of contemporary fraud detection. This result is consistent with the growing use of AI and machine-learning techniques for identifying unusual patterns, anomalies, and potentially fraudulent financial transactions. Previous research has demonstrated that machine-learning methods can effectively identify anomalous blockchain transactions and suspicious patterns that may otherwise remain unnoticed in large and complex datasets [7, 8]. Similar evidence has been reported for more sophisticated techniques such as Isolation Forest and autoencoder neural networks, which can improve the detection of unusual transaction behavior in open metaverse environments [9]. These studies support the present finding by showing that familiarity with AI is increasingly important because fraud detection is moving from rule-based and manually intensive procedures toward data-driven models capable of continuously identifying abnormal behavior.

The finding that respondents strongly believed AI can reduce human error in financial reporting is also particularly important. This component received the highest mean score, at 4.3, and the highest t value among the measured variables. The result indicates that participants viewed AI not merely as a fraud detection tool but as a

mechanism for improving reporting accuracy more broadly. This finding is consistent with evidence that AI adoption can enhance the quality of financial reporting by improving the consistency, timeliness, and precision of data processing [5]. AI systems can automate repetitive accounting procedures, reduce computational mistakes, standardize classifications, detect inconsistencies, and flag unusual entries for professional review. Generative AI can further support accounting and finance functions by assisting in document processing, financial analysis, information extraction, and decision support [4]. Accordingly, the strong agreement observed in the present study may reflect recognition among financial professionals that intelligent systems can reduce the frequency of errors arising from fatigue, information overload, routine processing, and inconsistent human judgment.

The regression findings strengthen this interpretation. Familiarity with AI had the strongest standardized regression coefficient, with $\beta = 0.42$ and $t = 5.12$, demonstrating that greater knowledge of AI was associated with greater perceived reduction in human error. This finding suggests that the benefits of AI are not determined exclusively by the availability of technology but also by the knowledge and competence of the professionals who interact with it. AI systems require users who understand how to interpret outputs, recognize limitations, validate unusual findings, and combine algorithmic results with professional judgment. The importance of human familiarity is especially relevant as financial processes increasingly incorporate generative AI, machine learning, blockchain, digital twins, and other intelligent systems [3, 4]. In this context, AI literacy becomes part of professional competence. Financial professionals who understand the capabilities and limitations of intelligent systems are more likely to use them effectively and less likely to either disregard useful algorithmic signals or rely on them uncritically.

Practical use of AI in the workplace also significantly predicted reductions in human error, with $\beta = 0.35$ and $t = 4.27$. This result is noteworthy because it distinguishes theoretical familiarity from actual organizational application. Knowledge alone may increase awareness of technological capabilities, but direct exposure to AI-based systems provides users with opportunities to integrate those tools into everyday financial processes. The finding therefore suggests that institutional adoption is necessary if the potential benefits of AI are to translate into improved reporting outcomes. Previous research on the use of advanced technologies in financial analytics similarly emphasizes the operational advantages of integrating AI into routine financial activities rather than treating it merely as an experimental or conceptual technology [6]. Evidence on AI adoption in financial reporting also indicates that actual implementation can contribute to improvements in the quality of reported information [5]. Thus, the present result supports the argument that organizations seeking to reduce human error should focus not only on training employees but also on embedding intelligent systems into financial workflows.

The comparatively strong positive attitudes among auditors are another important finding. Auditors displayed the highest levels of familiarity with AI and the strongest belief in its error-reduction capacity. This may reflect the increasing relevance of AI to contemporary auditing activities, including risk assessment, transaction screening, anomaly detection, audit sampling, continuous monitoring, and fraud identification. Auditing involves the examination of large quantities of financial evidence, and the growing complexity of digital transactions makes purely manual inspection increasingly impractical. AI can assist auditors by highlighting transactions or patterns that warrant further investigation and by supporting more comprehensive analysis of financial datasets. This result aligns with research showing the usefulness of AI-supported anomaly detection in complex digital and blockchain-based environments [8, 9]. It also corresponds with the broader transformation of accounting and finance processes through advanced AI interfaces and automated analytical systems [4]. The greater acceptance observed among

auditors may therefore be explained by the direct relevance of these capabilities to assurance and fraud-related responsibilities.

The findings concerning financial supervisors were also generally positive. Financial supervisors reported high familiarity with AI in fraud detection and strong agreement that AI can reduce human error. This result is significant because regulators and supervisors are responsible for monitoring the integrity of financial systems and evaluating whether organizations comply with reporting requirements. As financial activity becomes more technologically complex, supervisory institutions increasingly require analytical capabilities that allow them to examine large-scale transaction networks and identify abnormal patterns. Research on metaverse financial transactions has emphasized that effective oversight requires the integration of risk analysis, anomaly detection, and regulatory mechanisms [18]. The present findings suggest that financial supervisors recognize the importance of such technologies and may be increasingly prepared to incorporate AI-assisted monitoring into supervisory activities. This is particularly relevant as digital ecosystems become more decentralized and traditional forms of periodic oversight may become insufficient.

In contrast to the strongly positive results concerning AI, familiarity with the metaverse was comparatively lower. The mean score for metaverse familiarity was 3.7 in the one-sample t test, and descriptive results showed somewhat greater variability in responses. This pattern is understandable because the metaverse remains less established in financial practice than AI. While AI has already been integrated into many analytical and reporting processes, metaverse applications in finance are still developing. Existing research has nevertheless identified substantial potential for metaverse technology in financial services, including virtual customer interactions, digital transactions, immersive financial management, and new forms of organizational collaboration [2, 10]. The more cautious attitudes observed in the present study may therefore reflect differences between technological potential and current practical exposure. Professionals may be aware of metaverse concepts while still lacking extensive experience with their application to routine financial reporting.

Despite this relatively cautious orientation, familiarity with the metaverse still had a significant positive effect on reducing human error, with $\beta = 0.21$ and $t = 2.58$. Although this effect was weaker than those associated with AI familiarity and workplace AI use, it remains theoretically important. The result suggests that the metaverse may contribute to financial reporting quality by providing new environments for visualization, interaction, simulation, and monitoring. Previous research has suggested that metaverse-based technologies can support the detection of financial fraud and provide new mechanisms for revealing suspicious behavior [13]. The combined use of AI and metaverse technologies has also been proposed as a means of reducing earnings management and improving the transparency of financial activities [14]. These findings support the present result by indicating that immersive and digitally mediated environments may improve the visibility of financial interactions and reduce some of the information-processing limitations associated with conventional reporting systems.

The study also found that respondents had favorable attitudes toward the use of machine-learning methods in financial data analysis. Familiarity with machine learning had a mean of 4.0, and the use of intelligent algorithms for financial data analysis also received a positive evaluation. These results are consistent with the increasing reliance on machine learning to process complex, high-volume, and nonlinear financial information. In fraud detection, machine-learning systems are particularly valuable because they can identify relationships that may not be captured by conventional statistical or rule-based systems. Research on anomaly detection in metaverse and blockchain transactions demonstrates that intelligent algorithms can distinguish irregular financial behaviors by learning patterns from large datasets [7, 8]. The positive attitudes reported in the present study therefore reflect

broader developments in financial analytics, where machine learning is becoming an increasingly important complement to human expertise.

The findings relating to metaverse-based financial reporting can also be interpreted in light of the changing nature of financial ecosystems. Previous research has emphasized that the metaverse may create new challenges for accounting recognition, disclosure, verification, and financial communication [11]. Scholars have also argued that financial reporting and accounting practices will need to evolve in response to virtual transactions, digital assets, and immersive environments [1]. The present finding that respondents were moderately familiar with the metaverse suggests that professional awareness is emerging, although the technology has not yet achieved the same level of normalization as AI. As organizations increasingly combine the metaverse with blockchain, the Internet of Things, digital twins, and generative AI, financial reporting may become part of a broader interconnected digital infrastructure [3, 12]. Consequently, the current moderate level of familiarity may represent an early stage of professional adaptation rather than resistance to the technology.

The study's findings also need to be considered in relation to cybersecurity and data protection. Greater reliance on AI and metaverse technologies can improve monitoring and fraud detection, but it can also create new technological vulnerabilities. Metaverse environments may expose organizations to cybersecurity risks involving digital identities, virtual assets, unauthorized access, manipulated transactions, and adversarial use of AI. Research has emphasized the central role of AI in securing metaverse environments while simultaneously highlighting the evolving nature of cyber threats [15, 16]. Similarly, AI and machine learning are expected to become important components of metaverse security infrastructures because of their capacity to identify suspicious behavior in real time [17]. At the same time, the collection and analysis of extensive behavioral and financial data create important concerns regarding privacy and personal data protection [19]. Therefore, although the present study demonstrates strong professional acceptance of intelligent technologies, their implementation should be accompanied by appropriate governance, cybersecurity controls, and data protection mechanisms.

Another important result concerns the respondents' perceptions of fraudulent behavior under competitive and organizational pressure. The descriptive findings showed moderate agreement that financial reporters may engage in unhealthy competitive behavior under pressure and that financial managers may knowingly engage in fraud to preserve competitive positions. The relatively higher standard deviations for these items indicate that respondents differed considerably in their assessments. These findings highlight the fact that technology alone cannot fully explain or eliminate financial fraud. Fraudulent behavior remains influenced by managerial incentives, organizational pressures, opportunity structures, and strategic decision-making. Nevertheless, AI and metaverse technologies may reduce opportunities for manipulation by increasing transparency, strengthening monitoring, and identifying unusual behavior more rapidly. The potential of metaverse technologies to reveal fraud and of AI-supported systems to reduce earnings management reinforces the idea that technological systems can function as complementary control mechanisms within broader governance structures [13, 14].

Overall, the convergence of the descriptive, one-sample *t*-test, and regression results indicates that intelligent technologies can contribute to the reduction of human error and improvement of financial reporting quality. The strongest results were associated with AI, particularly knowledge of AI and practical workplace use, while the metaverse showed a smaller but still significant contribution. These findings are consistent with the broader literature demonstrating the growing importance of AI in financial reporting quality, fraud detection, anomaly identification, and financial analytics [4-6]. At the same time, the results extend this literature by demonstrating that familiarity with the metaverse is also associated with perceived reductions in human error. This finding is

consistent with emerging research emphasizing the role of immersive financial environments, blockchain-based metaverse transactions, and integrated digital ecosystems in improving transparency and monitoring [2, 11, 18]. The findings therefore support the view that future financial reporting systems are likely to depend increasingly on the integration of human expertise with AI-driven analytical tools and technologically advanced digital environments.

The present study is subject to several limitations that should be considered when interpreting the findings. First, the study relied on self-reported questionnaire data, and respondents' assessments of their technological familiarity, workplace practices, and perceptions of human error may be influenced by social desirability, subjective judgment, or differences in interpretation of the questionnaire items. Second, the sample consisted of 150 participants divided equally among corporate managers, auditors, and financial supervisors, which provided balanced group representation but may limit the generalizability of the findings to broader professional populations. Third, the cross-sectional design captured respondents' perceptions at one point in time and therefore does not allow definitive conclusions regarding causal relationships or changes in technology adoption over time. Fourth, the metaverse remains an emerging technology, and respondents may have had substantially different levels of practical exposure to metaverse-based financial environments. Finally, the study focused primarily on familiarity and technology use and did not directly measure additional organizational factors such as digital infrastructure, technology investment, cybersecurity maturity, organizational culture, professional training quality, or regulatory readiness, all of which may influence the effectiveness of AI and metaverse technologies in financial reporting.

Future studies should extend the present research through larger and more diverse samples drawn from different industries, financial institutions, regulatory environments, and national contexts. Longitudinal designs would be particularly valuable for examining how familiarity with AI and the metaverse evolves as these technologies become more widely adopted and whether increased technological use produces measurable improvements in reporting accuracy over time. Future research should also incorporate objective indicators of human error, fraud detection performance, reporting accuracy, and audit quality rather than relying exclusively on self-reported perceptions. Experimental studies could compare traditional reporting procedures with AI-assisted and metaverse-supported environments to assess differences in error rates, decision quality, response time, and fraud detection accuracy. Additional variables such as digital literacy, trust in AI, perceived technological risk, cybersecurity awareness, organizational readiness, professional skepticism, and resistance to technological change should also be incorporated into future models. Researchers may further examine mediating and moderating mechanisms, including whether professional training strengthens the relationship between AI adoption and reporting quality or whether organizational culture affects the effective use of intelligent financial systems.

Organizations should prioritize both technological investment and professional capability development when implementing AI and metaverse-related financial systems. Financial managers, auditors, and supervisors should receive structured training in AI-assisted analysis, machine-learning outputs, anomaly detection, and the interpretation of algorithmic results so that technological tools complement rather than replace professional judgment. Organizations should integrate AI systems into routine financial workflows, particularly in transaction monitoring, reconciliation, risk assessment, fraud screening, and reporting-quality control. Metaverse applications should initially be introduced in areas where immersive visualization, simulation, collaborative review, or training can provide clear operational value. Financial institutions and regulatory bodies should also establish governance frameworks defining accountability for automated decisions, validation procedures for algorithmic outputs,

cybersecurity controls, data protection requirements, and mechanisms for human oversight. Finally, organizations should regularly evaluate whether intelligent systems are actually reducing error rates and improving reporting quality rather than assuming that technological adoption alone guarantees better outcomes.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

Acknowledgments

Authors thank all participants who participate in this study.

Conflict of Interest

The authors report no conflict of interest.

Funding/Financial Support

According to the authors, this article has no financial support.

References

- [1] A. M. Musleh Alsartawi and K. Hussainey, "Guest Editorial: The Future of Financial Reporting and Accounting in the Metaverse," *Journal of Financial Reporting and Accounting*, vol. 22, no. 2, pp. 205-210, 2024, doi: 10.1108/JFRA-05-2024-747.
- [2] M. A. I. Mozumder, A. T. P. Theodore, A. Athar, and H. C. Kim, "The Metaverse Applications for the Finance Industry, Its Challenges, and an Approach for the Metaverse Finance Industry," presented at the 2023 25th International Conference on Advanced Communication Technology (ICACT), 2023. [Online]. Available: <https://doi.org/10.23919/ICACT56868.2023.10079695>.
- [3] T. Kliestik *et al.*, "Enterprise Generative Artificial Intelligence Technologies, Internet of Things and Blockchain-Based Fintech Management, and Digital Twin Industrial Metaverse in the Cognitive Algorithmic Economy," *Oeconomia Copernicana*, vol. 15, no. 4, 2024, doi: 10.24136/oc.3109.
- [4] P. R. Chelliah, P. K. Dutta, A. Kumar, E. D. S. Gonzalez, M. Mittal, and S. K. Gupta, *Generative Artificial Intelligence in Finance: Large Language Models, Interfaces, and Industry Use Cases to Transform Accounting and Finance Processes*. John Wiley & Sons, 2025.
- [5] A. H. J. Alhazmi, S. M. Islam, and M. Prokofieva, "The Impact of Artificial Intelligence Adoption on the Quality of Financial Reports on the Saudi Stock Exchange," *International Journal of Financial Studies*, vol. 13, no. 1, p. 21, 2025, doi: 10.3390/ijfs13010021.
- [6] R. Saivasan and M. Lokhande, "Exploring Use Cases of Generative AI and Metaverse in Financial Analytics: Unveiling the Synergies of Advanced Technologies," *International Journal of Global Business and Competitiveness*, vol. 18, no. Suppl 1, pp. 77-86, 2023, doi: 10.1007/s42943-023-00082-2.
- [7] Q. Siddique, "Anomaly Detection in Blockchain Transactions within the Metaverse Using Anomaly Detection Techniques," *Journal of Current Research in Blockchain*, vol. 1, no. 2, pp. 155-165, 2024, doi: 10.47738/jcrb.v1i2.17.
- [8] G. Airlangga, "Anomaly Detection in Blockchain Transactions: A Machine Learning Approach within the Open Metaverse," *Jurnal Informatika Ekonomi Bisnis*, pp. 308-312, 2024, doi: 10.37034/infec.v6i2.864.
- [9] A. D. Buchdadi and A. S. M. Al-Rawahna, "Anomaly Detection in Open Metaverse Blockchain Transactions Using Isolation Forest and Autoencoder Neural Networks," *International Journal Research on Metaverse*, vol. 2, no. 1, pp. 24-51, 2025, doi: 10.47738/ijrm.v2i1.20.
- [10] A. Qadeer, R. Sultan, M. A. Erri, and A. Waheed, "The Role of the Metaverse in Transforming Financial Management Practices for SMEs," in *Metaverse and Sustainable Business Models in SMEs*: IGI Global Scientific Publishing, 2025, pp. 339-356.

- [11] Z. Sanad, "Insights into Financial Reporting Practices in the Metaverse: Evidence from Islamic Financial Institutions in Bahrain," *Journal of Islamic Marketing*, 2024, doi: 10.1108/JIMA-01-2024-0029.
- [12] G. Lăzăroiu *et al.*, "Digital Twin-Based Cyber-Physical Manufacturing Systems, Extended Reality Metaverse Enterprise and Production Management Algorithms, and Internet of Things Financial and Labor Market Technologies in Generative Artificial Intelligence Economics," *Oeconomia Copernicana*, vol. 15, no. 3, 2024, doi: 10.24136/oc.3183.
- [13] C. Xu, X. Liang, Y. Sun, and X. He, "Fraudsters Beware: Unleashing the Power of Metaverse Technology to Uncover Financial Fraud," *International Journal of Human-Computer Interaction*, vol. 40, no. 18, pp. 4987-5002, 2024, doi: 10.1080/10447318.2023.2238367.
- [14] Y. A. Kadhim and S. A. M. Al Ani, "Using Artificial Intelligence and Metaverse Techniques to Reduce Earning Management," presented at the International Multi-Disciplinary Conference-Integrated Sciences and Technologies, Cham, 2023. [Online]. Available: https://doi.org/10.1007/978-3-031-51716-7_12.
- [15] A. Awadallah *et al.*, "Artificial Intelligence-Based Cybersecurity for the Metaverse: Research Challenges and Opportunities," *IEEE Communications Surveys & Tutorials*, vol. 27, no. 2, pp. 1008-1052, 2024, doi: 10.1109/COMST.2024.3442475.
- [16] A. J. Nair, S. Manohar, and R. Chaudhry, "Securing the Metaverse: Exploring the Role of Artificial Intelligence in Mitigating Emerging Threats in Manufacturing and Service Industries," in *Augmenting Retail Reality, Part B: Blockchain, AR, VR, and AI*: Emerald Publishing Limited, 2024, pp. 67-84.
- [17] H. Thakar, D. Thakar, and V. Pradhan, "Artificial Intelligence and Machine Learning in Metaverse Security," in *Defending the Metaverse*: CRC Press, 2025, pp. 115-143.
- [18] B. Srinivasan and T. Wahyuningsih, "Navigating Financial Transactions in the Metaverse: Risk Analysis, Anomaly Detection, and Regulatory Implications," *International Journal Research on Metaverse*, vol. 1, no. 1, pp. 59-76, 2024, doi: 10.47738/ijrm.v1i1.5.
- [19] L. Sautunnida, N. R. M. Zain, I. M. M. Zakri, and A. Yahya, "The Application of Artificial Intelligence in Metaverse: A New Challenge on Personal Data Protection in the Financial System," in *Islamic Sustainable Finance, Law and Innovation: Opportunities and Challenges*. Cham: Springer Nature Switzerland, 2023, pp. 117-126.