

## Exploring metaverse-enabled innovation in banking: Leveraging NFTs, blockchain, and smart contracts for transformative business opportunities

Azza Mohamed<sup>a\*</sup> and Rouhi Faisal<sup>b</sup>

<sup>a</sup>Faculty of Information Technology, Liwa College, Al Ain, United Arab Emirates

<sup>b</sup>Faculty of Business, Liwa College, Al Ain, United Arab Emirates

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### ABSTRACT

Industries all throughout the world are preparing to understand the ramifications of the emerging metaverse, which is a merger of the virtual and physical worlds. Notably, the banking industry stands on the cusp of a monumental shift, with the metaverse offering unprecedented operational enhancements. While the potential transformations brought about by the metaverse are discussed in various sectors, there is a discernible gap in understanding its specific applications in banking, especially with respect to advanced technologies such as NFTs, blockchain, and smart contracts. The study adopts a comprehensive approach to bridge this knowledge gap, employing convenience non-probability sampling to engage 48 subject matter experts specializing in Metaverse-Enabled Innovation in Banking. Data was collected using both mailed and electronic questionnaires. The empirical analysis offers strong evidence supporting the pivotal role of technologies like Digital Twins, Artificial Intelligence, and Blockchain-Based Assets in the metaverse's preliminary stages. We discover a plethora of business potential for banks within the metaverse, including client communication, cross-border transactions, mortgages, digital assets, green loans, and data security.

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## 1. Introduction

The banking industry might profit substantially from the usage of Metaverse, a platform that provides safe transactions, improved client communication, and aids in the achievement of carbon net-zero targets. This gives a once-in-a-lifetime opportunity for banks to improve their operations and remain competitive by leveraging technology such as NFTs, blockchain, smart contracts, and digital identities. Banks, as innovators, must aggressively study Metaverse and cooperate with stakeholders to accelerate industry adoption. Continued investment and dedication might result in a banking sector transformation and expedite the adoption of circular economy principles for a more sustainable future (Allam et al., 2022; Banaeian Far & Imani Rad, 2022). Metaverse has enormous promise in the financial business, and its future is full of possibilities. Predicted trends from 2023 to 2028 indicate increased collaboration between banks and technology firms, regulatory frameworks that support innovation, and adoption from businesses other than financial services (Brik, 2022). Metaverse has the potential to improve compliance procedures, reduce fraud, and ease cross-border payments in the banking sector, particularly beginning in 2023. Metaverse can also generate digital assets that represent fiat currencies, bonds, or commodities. These assets are available for trading on Metaverse's decentralized exchange, which offers high levels of security and transparency. Although the usage of Metaverse in banking is still in its early phases, its benefits indicate that it will be widely used in the future. This would transform the way banks work, bringing considerable benefits to both clients and institutions (Allam et al., 2022).

\* Corresponding author.

E-mail address: [Azza.Basiouni@lc.ac.ae](mailto:Azza.Basiouni@lc.ac.ae) (A. Mohamed)

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The study is structured as follows. Section 2 is a survey of the literature on Metaverses and their features. Section 3 contains the research agenda. Section 4 of the paper contains the research methodology. Section 5 discusses the results and study findings. Section 6 presents the study's conclusion.

## 2. Literature review

### 2.1 *The Metaverse's Preliminaries*

What is the metaverse, exactly? The word “meta” is a Greek prefix that signifies “more comprehensive” or “transcending”. The term “-verse” is a shortened form of “universe”, which denotes a space/time continuum. The term “metaverse” is derived from the Greek words “meta” for comprehensive or surpassing and “-verse” for a space/time container. It refers to a new digital living area produced by mixing cutting-edge technology like virtual reality, blockchain, and digital twin. Everything in the real world is mapped to a parallel reality where people can work, live, and play with friends from anywhere. The notion of the metaverse was first proposed in Neal Stephenson's science fiction novel *Snow Crash*, in which people govern and compete via computer avatars. The metaverse, on the other hand, is still at its conceptual stage, with few real-world implementations available. Digital twins, which are digital representations of real-world objects, processes, or systems, are another enabling technology for the metaverse. They can be used to build a digital reproduction of the physical world in the metaverse, allowing users to interact with virtual twins (Tao et al., 2019). Blockchain technology is also a crucial component of the metaverse, enabling secure transactions and ownership of digital assets within the virtual world. It provides a trusted and transparent platform for digital assets and virtual currencies, as well as a decentralized infrastructure for the metaverse (Chang et al., 2021). Artificial intelligence (AI) is another key technology for the metaverse, providing intelligent agents, chatbots and virtual assistants to enhance user experience and interaction in the virtual environment. AI can assist in the creation of more realistic and engaging virtual environments, as well as in navigating and interacting with the metaverse (Duan et al., 2021).

Finally, in today's world, a significant part of our routine activities take place online, such as working, higher education, healthcare appointments, and banking. The hybrid model has made it possible for many of these tasks to be done remotely, and now, with the emergence of Web3.0, there is a need for digital banking to step up its game and provide a more immersive experience. The Metaverse is an inevitable part of this evolution (Cho, 2023).

### 2.2 *Blockchain-Based Assets & Technology*

S. Nakamoto proposed the practical form of blockchain in 2009 (Roussou et al., 2019). Blockchain is a distributed and transparent ledger that stores immutable texts and codes. The blocks on the blockchain, including data strings, are linked to the prior block(s), and any changes or modifications made during the previous block(s) are reflected in the present or next block(s). As a result, the stored data is tamper-proof, and any alterations are immediately identified. To accept each contributed data on public blockchains, consensus from the majority of blockchain nodes is necessary (Bamakan et al., 2020). Otherwise, the blockchain recording procedure rejects the given data. Blockchain has been a cutting-edge technology in both industry and academics during the previous decade, with applications in a variety of technology disciplines.

This section introduces three major assets stored on public blockchains.

#### 2.2.1. *Cryptocurrency*

Cryptocurrency is the most well-known blockchain asset and the most widely used blockchain application. It is a digital money that makes use of distributed ledger technology and encryption techniques. S. Nakamoto created the first distributed cryptocurrency, Bitcoin, on its blockchain. Since then, other cryptocurrencies, known as altcoins, have been proposed in their specialized blockchains.

#### 2.2.2. *Token*

Tokens are altcoins that are launched on other blockchains and do not have their own specialized blockchains. They will lose access if their blockchain infrastructure is disrupted.

#### 2.2.3. *Non-Fungible Token (NFT)*

NFTs are blockchain-based immutable tokens/codes that certify uniqueness. They were first proposed in 2017 and deployed on the Ethereum blockchain thanks to ERC-721. They are distinguished by their singularity, immutability, and non-interchangeability. NFTs are employed in a variety of fields, including digital art, collecting cards, and Metaverse digital territories. OpenSea, Rarible, ZORA, Teia, and Marketplace, for example, offer NFT-related services such as creation, trading infrastructure, purchase, sell, and exchange.

### 2.3 *Banking Industries on the Metaverse*

Because of the multiple benefits it provides to financial institutions, the usage of the Metaverse in banking is becoming increasingly widespread. These advantages include enhanced communication with customers, simplified transactions, reduced expenses, and increased security. With the Metaverse, banks can effortlessly store and access customer account data, which can enable them to better comprehend customers' requirements and preferences, ultimately resulting in improved services and customized offerings. The Metaverse also enables banks to interact seamlessly with other financial systems and apps, lowering

costs and increasing efficiency. Overall, the Metaverse offers an appealing solution for banking applications, ranging from account transactions to cross-border payments and digital identity validation.

Another point of view is that we can conduct transactions with other users in the Metaverse, buying and selling a range of commodities and services, including NFTs like artwork, music, and video material, as well as avatars, virtual meeting passes, concert tickets, and even financial services. As more people purchase and sell online using digital assets, digital currency, which many institutions across the world are developing, will likely become the preferred means of payment. As a result, the combination of Central Bank Digital Currency with the Metaverse offers a number of advantages, as explained in the following sections.

### 2.3.1 Banking Communication

The Metaverse is critical in consumer communication. Businesses must create a virtual place that encourages connection and participation to effectively engage with customers. This can be achieved through digital tools such as social media platforms and online forums that enable users to share information and connect with each other (Golf-Papez et al., 2022). The incorporation of the Metaverse into customer communication strategies offers numerous benefits. For starters, it enables organizations to collect valuable data about client preferences and behaviors, which can then be leveraged to successfully adapt marketing techniques and messaging (Banaeian Far & Imani Rad, 2022). Second, the Metaverse allows businesses to strengthen their relationships with customers by encouraging meaningful interactions and establishing a feeling of community around shared interests and values. By sponsoring brand promotions or offering customer support forums, businesses can deepen their connections with customers in significant ways (Buhalis et al., 2022). Ultimately, integrating the Metaverse into customer communication strategies can help businesses gather vital information about their target audience, leading to better-tailored marketing campaigns and messaging (Allam et al., 2022).

### 2.3.2 Cross-Border Transactions and Cryptocurrency

Blockchain technology is based on cryptography, peer-to-peer networking, and distributed ledger systems. It provides a decentralized database in which all network participants have equal rights, rendering middlemen or third parties unnecessary for conducting financial transactions. The traditional centralized paradigm of intermediaries is being replaced by a new system in which each transaction has its own smart contract that records asset ownership details. This ensures openness and accountability while removing the barriers to cross-border transactions caused by numerous currencies and complex banking networks (De Franceschi, 2022).

Let's look at a hypothetical situation in which Alice, who lives in China, wants to send money to Bob, who lives in Europe and wants to buy clothes from Zara's online store but doesn't have a credit card. With their Metaverse accounts, Alice and Bob can create an escrow contract that will remain locked until they both approve or terminate it. They can then use digital currency trading platforms to convert value from their Metaverse ETP accounts to euros (Dubey et al., 2022). Bob can then pay Zara with the Euros he got, authorizing payment and releasing the clothing. Furthermore, because different financial institutions in different countries employ different standards, the process of opening an account or complying with KYC regulations can be convoluted and time-consuming. Blockchain technology plays a significant role in enhancing the transparency of transactions while also reducing the risk of fraud or identity theft (Dwivedi et al., 2022).

### 2.3.3 Mortgages

A mortgage is a kind of financial product that allows people to utilize borrowed money to buy homes. Mortgages have traditionally been issued by banks and other financial institutions, which evaluate the risk of lending to specific borrowers to decide on the maximum amount, interest rate, and repayment schedule. But Metaverse technology promises to completely transform the mortgage industry. This cutting-edge platform will totally change the way that mortgages are traditionally thought of by utilizing blockchain technology (Melnyk et al., 2022). Lenders may swiftly assess a borrower's creditworthiness using Metaverse by looking at a number of variables, including their income history, stability of employment, credit score, and total assets. This removes the requirement for conventional techniques, such as documentation and drawn-out meetings with bank loan officers (Renduchintala et al., 2022). Furthermore, by utilizing smart contracts on Metaverse, the risk of fraud and loan default is reduced, and transparent terms and conditions are guaranteed. Because of this, Metaverse mortgages will be easier, faster, more secure, more efficient than they have ever been, giving people wider access to homeownership at a lower total cost (Mystakidis, 2022).

### 2.3.4 Utilizing of NFTs

The potential of NFTs is enormous for banks, since it offers more flexibility in financial transactions and new avenues for client engagement. Applying NFTs to a range of banking services, such as mortgages, credit cards, and bank accounts, may offer clients special advantages. NFTs, for example, can be used for credit cards. Banks can design branded NFTs associated with certain credit cards or credit lines, allowing users to handle their transactions more effectively. This can involve, among other things, tracking spending habits over time, setting spending restrictions on particular purchases, and setting up payment reminders (Belk et al., 2022).

In the field of real estate loans, including mortgages, NFTs have still another possible application in banking. Banks might offer NFT-based loans linked to certain assets, like cars or real estate, to make it easier for customers to track ownership and

make any necessary adjustments. Furthermore, banks can use NFTs as a method to demonstrate their commitment to the environment. In order to win over customers and draw in socially conscious investors, they could offer "green" loans or assets associated with eco-friendly projects. NFTs are revolutionizing banking for the benefit of both customers and businesses. Banks can use them creatively to demonstrate their corporate responsibility and social impact, improve customer engagement with credit cards and other financial products, or provide more transactional flexibility (Smith, 2022).

### 2.3.5 Data Privacy and Security

For banks, the regulation of financial services in the metaverse poses a serious difficulty. It will be difficult to bring the strict laws that govern the banking sector in the actual world into the metaverse. Moreover, the traditional banking model, which functions in closed, regulated contexts, is at odds with the decentralized nature of the metaverse. Consequently, banks will have to adjust to this new setting and figure out how to maintain client confidentiality and privacy in a decentralized system (Katterbauer et al., 2022). Similarly, it might get harder to hold people responsible for money transactions made in the metaverse (Mogaji & Nguyen, 2021). Individuals' activities have real-world repercussions, which can be challenging to control and govern in a virtual environment. Additionally, virtual reality environments can give rise to other types of online harm, such as cyberbullying. According to Katterbauer, financial cybercrime in the metaverse is a serious issue that needs to be addressed with creative cybersecurity solutions in addition to new legal and regulatory frameworks. The selling of dubious NFTs and the theft of cryptocurrency from exchanges are the main causes of the rise in financial cybercrime in the metaverse (Leukfeldt et al., 2016).

Due to its vulnerability to fraud and market manipulation, NFT price volatility presents a serious challenge for banks. One problem is that smart contracts might be made to take tokens out of customers' wallets during the NFT minting process, which could result in loss. Furthermore, the secondary market pricing of NFTs can be manipulated by engaging in wash trading, which is the exchange of NFTs between wallets owned by the same person or group. As to the Defi protocols (Huang et al., 2023), there is a possibility of money laundering with cryptocurrencies due to these behaviors.

When it comes to NFTs, banks have a variety of difficulties, such as price volatility and the possibility of fraud and market manipulation. In addition to taking tokens out of buyers' wallets during the NFT minting process, smart contracts may also be used to artificially inflate secondary market prices through wash trading. This raises the possibility of money laundering, and doing "know your customer" (KYC) checks may be difficult for banks. The use of cryptocurrencies in metaverse financial transactions is especially problematic since proof-of-work consensus processes have a large carbon footprint, which raises questions regarding climate change (Nicholls et al., 2021). The rising cost of cryptocurrencies may potentially encourage more energy-intensive mining, raising the possibility of conflicts with Net Zero objectives and energy security issues. The use of cryptocurrency makes it possible for ransomware attacks, and the immutability of Blockchain makes it challenging to remove instances of doxing and other types of online harassment. These factors raise concerns about cybersecurity and online safety. It is also possible to employ airdropping NFTs into cryptocurrency wallets maliciously to give people ownership of illicit photos or films against their will (Trozze et al., 2022; Wilson et al., 2022).

## 3. Research Direction

Immersion-based technologies such as the metaverse are still in their infancy, and little is known about their potential and challenges. Future research on this could benefit from understanding how it impacts financial services in the real world as well as the metaverse. The following are potential study areas for the metaverse and banking sector:

What is the definition of the metaverse and how can it be integrated into the banking industry to enhance their operations?

What are the practical implementation possibilities of the metaverse in the banking sector, specifically with technologies like NFTs, blockchain, and smart contracts?

How can banks leverage the metaverse to improve customer communication, cross-border transactions, mortgages, digital assets, green loans, and data privacy and security?

What is the role of innovation leaders in driving the adoption of metaverse technology in the banking industry?

What are the challenges and barriers that banks may face when adopting metaverse technology, and how can these be overcome?

What regulatory frameworks and policies should be in place to ensure the safe and effective use of metaverse technology in the banking industry?

What are the potential ethical considerations associated with the use of metaverse technology in the banking industry, and how can these be addressed?

## 4. Conceptual Framework and Research Hypothesis

### 4.1 Customers' satisfaction (Hypothesis)

**H<sub>1</sub>:** *Digital Twins has sufficient influence on Metaverse as a Preliminaries.*

**H<sub>2</sub>:** *Artificial Intelligence has sufficient influence on Metaverse as a Preliminaries.*

**H3:** Blockchain-Based Assets & Technology has sufficient influence on Metaverse as a Preliminaries.

**H4:** There is a significant correlation between Metaverse and Banking Communication.

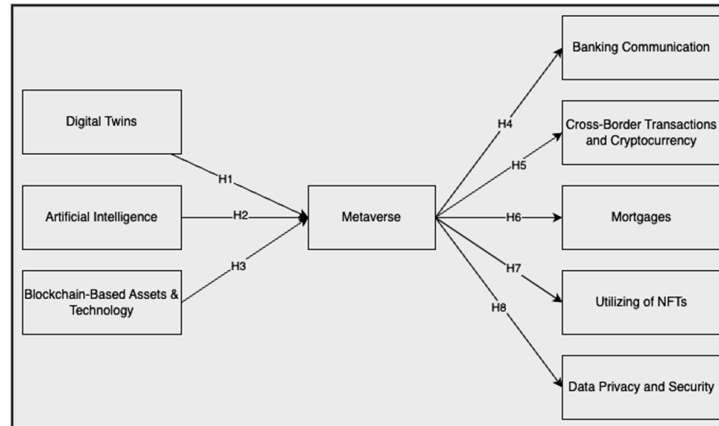
**H5:** There is a significant correlation between Metaverse and Cross-Border Transactions and Cryptocurrency.

**H6:** There is a significant correlation between Metaverse and Mortgage.

**H7:** There is a significant correlation between Metaverse and Utilizing NFTs.

**H8:** There is a significant correlation between Metaverse and Data Privacy and Security.

Fig. 1 presents the structure of the proposed study of this paper.



**Fig. 1.** The structure of the proposed study

## 5. Methodology

The author starts to read a lot of books in order to research the demand for banks to be proactive in embracing web 3.0 technologies to support the developing trend of the metaverse. Academic publications, case studies, and government reports are some of these literatures. The findings indicate that numerous sorts of procedures were employed by the researchers to collect data for their research, according to an overview of the techniques used in this literature. To assess the research findings and conclusions, the data will be split into secondary data and primary data. The secondary data came from case studies, government statistics reports, the journals of earlier scholars, and other sources. The survey and quantitative data used in the primary data collection were obtained during the research. In order to conduct the research and determine the main goal of the study, the deductive approach will be used in a survey method with structured questions. This method is used because it gives researchers a simple, organized way to assess and recognize prior theoretical research. The Positivist Approach (experimental and manipulative methods) is the research methodology used in this paper. This implies that studies of human behavior should be performed in the same manner as research of natural sciences.

The study's combined meanings already reveal the nature of this scientific investigation: it is an anonymous call for information that can be helpful to researchers in their field of study, and it explores and asks questions about information that is gathered to determine what is necessary to remove from the study that is not relevant. The study's positivist design allowed for the cross-examination of the hypotheses, which is necessary in order to meet the requirements curriculum that gives subordination to the laws of phenomena can be detected because it revealed a relative approach rather than scientific laws. This curriculum is based on observation and reporting the nature of things as they are, as well as studying the partial truths and elements of phenomena in search of the direct causes.

The questionnaire, which consists of a series of questions or written statements and answers, is obviously merely a tool for gathering information. As a result, the purpose of the questionnaire in this study is to collect information, and the only people who can do so without knowing the data and facts by using another instrument are those who are directly affected by the subject of the questionnaire.

### 5.1 Data Collection

Convenience non-probability sampling will be used for this study's survey. This type of sampling was chosen because it allows for quick and easy sample selection, allows for the categorization of the study population into groups, and allows for the selection of the number of participants in each group that is proportionate to the size of that group. While stratified random sampling and this sample are comparable, the latter allows the researcher to make independent decisions, while the former does not. 48 subject matter experts who work with Metaverse-Enabled Innovation in Banking, the research's focal area, make up the sample size for this study. The rationale is that researchers are more confident in their ability to obtain reliable data from respondents when the sample size is larger. The questionnaire will be sent by regular mail, electronic mail, and in-person administration whenever feasible as part of the survey.

5.2 Study Instruments

There are three sections altogether in the questionnaire. Ten questions about the demographics of the respondents were in Section A. In order to ascertain the respondent's familiarity and experience with the Metaverse application and supporting industries, Section B covered the Metaverse Usage. To test the hypothesis based on three independent variables, these sets of questions are constructed. Like the preceding section, Section 4.1 consists of eight questions that examine the study indicators intended to evaluate the hypothesis pertaining to three dependent variables.

6. Results and Findings

In this work, SPSS is used to evaluate research models based on different classifiers. The current study uses the hybrid technique to validate the research hypotheses, in contrast to earlier research that used a one-stage analysis of SPSS. The hybrid model has two phases. Using correlation matrices to evaluate the research model is a part of the initial rest periods. The method is appropriate because there is no related literature, and the theoretical model is exploratory. The most popular technique for measuring consistency in the study is Cronbach's Alpha, which is based on internal consistency and offers an overall picture of how consistent the questions are with one another and with all questions in general.

6.1 Statistical Results on Independent and Dependent Variables

6.1.2 Variables Frequencies

**Table 1**  
Overall Statistics on Digital Twins (Independent Variable)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	10	6.6	6.6	6.6
	Disagree	8	11.9	11.9	18.5
	Slightly Agree	10	19.2	19.2	37.7
	Agree	10	28.5	28.5	66.2
	Strongly Agree	10	33.8	33.8	100.0
	Total	48	100.0	100.0	

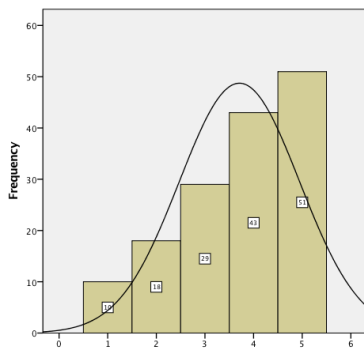


Fig. 1. Digital Twins (Independent Variable)

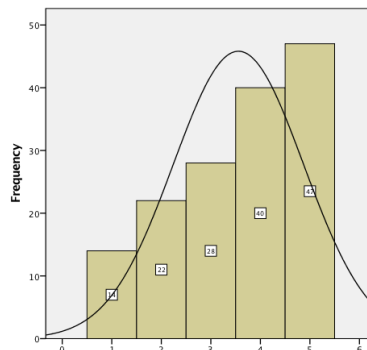


Fig. 2. Artificial Intelligence (Independent Variable)

Fig. 1 and Fig. 2 present the frequency of Digital Twins and Artificial Intelligence as two independent variables.

**Table 2**  
Overall Statistics on Artificial Intelligence (Independent Variable)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	4	9.3	9.3	9.3
	Disagree	10	14.6	14.6	23.8
	Slightly Agree	10	18.5	18.5	42.4
	Agree	10	26.5	26.5	68.9
	Strongly Agree	14	31.1	31.1	100
	Total	48	100	100	

**Table 3**  
Overall Statistics on Blockchain-Based Assets & Technology (Independent Variable)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	0	0	0	0
	Disagree	0	0	0	0
	Slightly Agree	0	0	0	0
	Agree	0	0	0	0
	Strongly Agree	48	100	100	100
	Total	48	100	100	

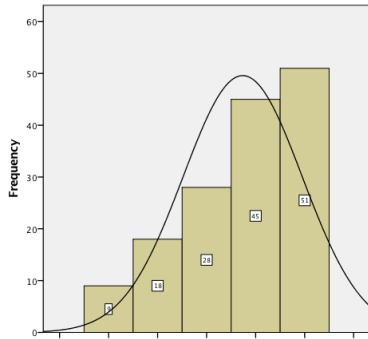


Fig. 3. Blockchain-Based Assets & Technology (Independent Variable)

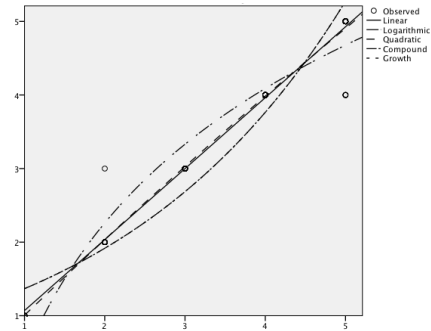


Fig. 4. Curvilinear Regression between Digital Twins and Metaverse

6.1.3 Correlation Matrixes

**Table 4**  
Correlation Analysis between Digital Twins and Metaverse

		Digital wins	Metaverse
Digital Twins	Pearson Correlation	1	.987**
	Sig. (2-tailed)		.000
	N	48	48
Metaverse	Pearson Correlation	.987**	1
	Sig. (2-tailed)	.000	
	N	48	48

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The Sample correlation coefficient  $r = 0.987$

The p-value category for this decision is  $p = 0.000 < 0.001$  [refer to Table 4]. There is sufficient evidence from the sample to support the research hypothesis **(H1)** The Digital Twins has sufficient influence on Metaverse as a Preliminaries.

**Table 5**  
Correlation Analysis between Artificial Intelligence and Metaverse

		Artificial Intelligence	Metaverse
Artificial Intelligence	Pearson Correlation	1	.965**
	Sig. (2-tailed)		0
	N	48	48
Metaverse	Pearson Correlation	.965**	1
	Sig. (2-tailed)	0	
	N	48	48

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The Sample correlation coefficient  $r = 0.965$

The p-value category for this decision is  $p = 0.000 < 0.001$  [refer to Table 5]. There is sufficient evidence from the sample to support the research hypothesis **(H2)** The Artificial Intelligence has sufficient influence on Metaverse as a Preliminaries.

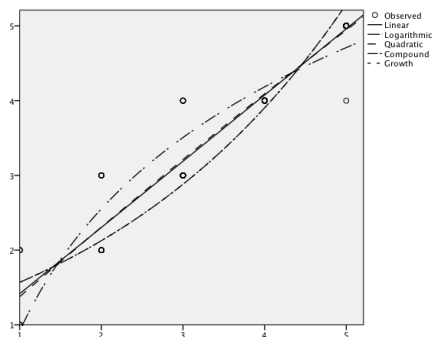


Fig. 5. Curvilinear Regression between Artificial Intelligence and Metaverse

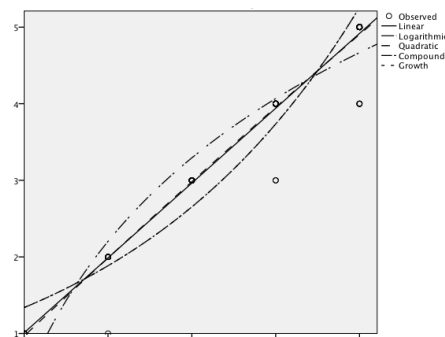


Fig. 6. Curvilinear Regression between Blockchain-Based Assets & Technology and Metaverse

**Table 6**  
Correlation Analysis between Blockchain-Based Assets & Technology and Metaverse

	Blockchain-Based Assets & Technology	Metaverse
Blockchain-Based Assets & Technology	Pearson Correlation	1
	Sig. (2-tailed)	.983**
	N	48
Metaverse	Pearson Correlation	.983**
	Sig. (2-tailed)	0
	N	48

\*\* . Correlation is significant at the 0.01 level (2-tailed).

The Sample correlation coefficient  $r = 0.983$

The p-value category for this decision is  $p = 0.000 < 0.001$  [refer to Table 6]. There is sufficient evidence from the sample to support the research hypothesis (**H3**) The Blockchain-Based Assets & Technology has sufficient influence on Metaverse as a Preliminaries. Table 7 summarizes the results of the survey.

**Table 7**  
The summary of testing the hypotheses

Hypothesis No and Name	Result
<b>H1:</b> The Digital Twins has sufficient influence on Metaverse as a Preliminaries.	Accepted
<b>H2:</b> The Artificial Intelligence has sufficient influence on Metaverse as a Preliminaries.	Accepted
<b>H3:</b> The Blockchain-Based Assets & Technology has sufficient influence on Metaverse as a Preliminaries.	Accepted
<b>H4:</b> There is a significant correlation between Metaverse and Banking Communication.	Accepted
<b>H5:</b> There is a significant correlation between Metaverse and Cross-Border Transactions and Cryptocurrency.	Accepted
<b>H6:</b> There is a significant correlation between Metaverse and Mortgage.	Accepted
<b>H7:</b> There is a significant correlation between Metaverse and Utilizing NFTs.	Accepted
<b>H8:</b> There is a significant correlation between Metaverse and Data Privacy and Security.	Accepted

## 7. Discussion and Conclusion

The ascendance of the metaverse represents a transformative moment for industries worldwide. For the banking sector, this virtual integration with reality promises an array of operational enhancements and new business opportunities. The potential of the metaverse in banking is enormous, encompassing digital assets, green loans, mortgages, cross-border transactions, customer communication, data privacy, and security, as this paper explains. Our research underscores the paramount role of technologies like NFTs, blockchain, and smart contracts in this impending evolution. The empirical findings from our study provide robust support for the various hypotheses posed at the inception of this research. Digital Twins, Artificial Intelligence, and Blockchain-Based Assets & Technology have all exhibited a marked influence on the metaverse as preliminaries. This is evident from the overwhelmingly significant p-values obtained in our analyses (all  $p = 0.000$ ), reinforcing the integral nature of these technologies in the metaverse's fabric. Furthermore, our research established significant correlations between the metaverse and several banking aspects. This includes banking communication, cross-border transactions with cryptocurrency implications, mortgages, the utilization of NFTs, and the critical domain of data privacy and security. These correlations not only substantiate the immense potential of the metaverse in revolutionizing banking but also delineate the areas where its impact is poised to be most profound. Innovation leaders in the banking sector must recognize the tidal wave of change that the metaverse is set to usher. By harnessing the opportunities, it offers, they can drive sustainable practices, particularly supporting the circular economy, which is essential in today's climate of environmental awareness. The importance of proactive adoption of web3.0 technology cannot be overstated, as it's pivotal for banks to remain at the forefront of this burgeoning trend.

The implications of our research findings are multifaceted. For banking professionals, the evident correlations between the metaverse and its various aspects signify the importance of early adaptation and investment in this space. Institutions that proactively integrate metaverse technologies stand to gain a competitive advantage, both in terms of operational efficiency and in delivering unparalleled customer experiences. Additionally, with the increasing emphasis on sustainability, banks that leverage the metaverse in alignment with circular economy practices can position themselves as leaders in both technological innovation and environmental stewardship. Furthermore, the validated significance of Digital Twins, AI, and Blockchain-Based Assets & Technology in the metaverse framework suggests that these technologies should be the cornerstone of any bank's metaverse strategy. This emphasis ensures that banks don't merely use the metaverse as an add-on, but rather integrate it deeply into their operational DNA. Like all studies, ours is not without limitations. Firstly, our research is cross-sectional, meaning it captures the situation at a specific point in time. The rapid evolution of technology means that the metaverse landscape might look very different in a few years. Secondly, while our sample provides robust statistical evidence, it might not be wholly representative of all banking institutions worldwide. Different regions and sizes of banks may experience



varying degrees of metaverse integration challenges and opportunities. Given the dynamic nature of the metaverse and its nascent integration in the banking sector, there is a vast expanse for future research. Longitudinal studies tracking the evolution of metaverse implementations over time can provide insights into its lasting impacts and the challenges that emerge as the novelty wears off. Additionally, research focused on the potential risks and mitigation strategies in the banking metaverse would be invaluable. Exploratory studies could delve deeper into the nuances of customer behavior in banking metaverses or the role of regulators in this new dimension. Another avenue of inquiry could be the development of frameworks or models to guide banks in their metaverse integration journeys, ensuring optimal ROI and alignment with broader strategic goals.

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