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## Article

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# The Analysis of Impact of Metaverse on the FinTech Industry Based on Text Mining and Association Rules Mining

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## ABSTRACT

**Purpose:** The purpose of our study is to explore the influence of Metaverse on FinTech industry and identify the mediators between them.

**Design/methodology/approach:** To achieve the purpose, we conducted words frequency analysis, network analysis, and association rules analysis, based on 68,957 Metaverse-related and 23,902 FinTech-related news articles from January 1, 2021, to September 31, 2023.

**Findings:** The results from the analysis indicate that the five most frequently shown words are 'Metaverse', 'Fintech', 'Technology', 'Investment', and 'Platform'. Additionally, the outcomes of association rules analysis highlight relationships between the Metaverse and FinTech through terms like 'Service', 'Platform', 'Digital' and 'Information'.

**Research limitations/implications:** Our findings emphasize the crucial significance of Metaverse in FinTech Industry, providing insights for related investors or stakeholders. The reliance on news data only may have constrained the depth of insights on the dynamics between the Metaverse and FinTech, thereby future study could benefit from video content, industry reports or white papers.

**Originality/value:** While many studies on the Metaverse and FinTech focus on exploratory or theoretical discussions, this study performed an in-depth textual analysis of the collected text data on these topics. This study not only provides understanding of the relationship between the Metaverse and FinTech but also suggests future applications in other fields.

*Keywords: Metaverse, Fintech industry, Text mining, Association rules mining*

## I. Introduction

The COVID-19 pandemic has had a profound impact on a wide range of industries, both challenges and opportunities (Abushammala, 2022; Saturwa et al., 2021; Isa et al., 2022; Han & An, 2022). Notably,

its positive effects are primarily observed in the accelerated adoption of digital technologies. This acceleration has significantly advanced the digital transformation process, unveiling unprecedented opportunities for innovation across several sectors (Soto-Acosta, 2020; Almeida et al., 2020; Iivari et al., 2020; Dwivedi et al., 2020). This acceleration includes not only the widespread use of telework, online education, and virtual interactions, but also a growing interest in the Metaverse, which is a fusion of real and virtual worlds that transcends the limitations

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of space and time. This trend is found particularly among digital natives, such as Generation Z and Generation Alpha, who excel in digital communication (Buhalis, 2022; Mandal et al., 2024; Lee & Kwon, 2024; Kabilan, 2023). They actively interact with Metaverse, engaging in diverse interactive activities. Future scientist Roger Hamilton predicted that by 2024, we will spend more time in three-dimensional virtual worlds than we currently do in the two-dimensional spaces.

Research on the Metaverse covers a wide range of topics, categorized into several important areas. Firstly, it explores descriptions of foundational technologies such as blockchain, VR and AR (Gadekallu et al., 2022; Mozumder et al., 2022; Yang et al., 2022; Mystakidis, 2022; Ko & Rogers, 2021). The second focus area examines the behavioral patterns of users within the Metaverse, particularly their purchasing and decision-making (Han et al., 2023; Adams, 2022; Jenkins, 2022; Gai et al., 2023; Azmi et al., 2023). The third area of research investigates the applications of Metaverse across various fields, including education, finance, marketing and advertising, while addressing the challenges and opportunities within these sectors (Kye et al., 2021; Mozumder, 2023; Barrera & Shah, 2023; Buhalis et al., 2023; Kim, 2021; Hollensen et al., 2022). Furthermore, researches in Metaverse also includes discussions on data security technologies and relevant policies (Chen et al., 2022; Wang et al., 2022; Di Pietro et al., 2021). Dwivedi et al. (2022) categorize applications of Metaverse as tools to address real-world challenges in industries such as education, manufacturing, and virtual platforms where profits are generated such as virtual real estate investment.

Financial companies, using VR and AR technology, have transformed the customer engagement model for investment and trading services by providing a virtual environment that eliminates the need for visits of branch, significantly enhancing experience and convenience of service (Campbell et al., 2020; Oyewole et al., 2024; Bonelli & Hamelin, 2022; Dell'Erba, 2024; Anggara et al., 2022; Yoo, 2022).

Many studies have explored the convergence between Metaverse and Fintech. Al-Qudah (2024)

conducted a theoretical analysis on the potential effects of the Metaverse on the finance industry, utilizing global statistics and facts. Similarly, Bhavana et al. (2023) investigated the financial technology, clarifying its fundamental frameworks and the AI technologies that support it. They also highlighted the increasing need for cryptocurrencies, blockchain technology, mobile networks, and other crucial components within the FinTech industry. Sahiner (2023) examined the impact of the Metaverse on the global financial system, providing a detailed analysis of its innovative features and potential benefits, while aiming to comprehensively evaluate the economic pros and cons of establishing a blockchain-based decentralized Metaverse. Furthermore, Mohamed et al. (2024) interviewed 48 experts involved in Metaverse-related innovations in the banking industry, emphasizing the crucial role of digital twin technologies, AI, and blockchain assets during the initial phase of Metaverse development. Additionally, Şanlısoy & Çiloğlu (2023) analyzed the potential of the Metaverse to transform future financial institutions and analyzed its impact on the global economy, emphasizing both challenges and opportunities, along with relevant policy suggestions. Vakiti et al. (2023) performed a review of 454 papers from 2003 to 2023, to gain an understanding of the emergence and development of FinTech in Metaverse-based banking. Also, Mozumder et al. (2023) examined Metaverse applications in finance, challenges, and proposed solutions. Dubey et al. (2019) outlines the potential of the Metaverse to revolutionize the banking industry through innovations such as NFT, blockchain, and smart contracts.

Most studies on Metaverse and FinTech, however, are exploratory based, such as theoretical discussions. The purpose of this study is to find the impact of the Metaverse on FinTech through data driven analysis. A textual analysis is performed on the collected text data. The research has two primary objectives: it firstly discovers common themes in both the Metaverse and FinTech through word frequency analysis, identifying key topics of discussion and interest. Secondly, it identifies the mediating

factors and pathways through which the Metaverse exerts its influence on FinTech, with association analysis and mapping of the relationships between the Metaverse and FinTech.

## II. Literature Review

### A. Metaverse

The concept of the Metaverse is originated from Neal Stephenson's 1992 novel *Snow Crash*. With the introduction of Google's 3D mapping service, Google Earth, and the 3D virtual world Second Life, people's interest on the 3D network increased, and the discussion about the 'Metaverse' as a new area for future economic and social activities officially began. There are many suggested definitions regarding the Metaverse, nevertheless, there is still no specific definition. Ondrejka (2005) described it as an online environment, where users interact, socialize, conduct business, and entertain others, using the real world as a metaphor. Yang et al. (2006) defined Metaverse as a virtual world in which economic and social activities are carried out through avatars, which is closely related to the definition of Lyou & Ahn (2007), who defined the Metaverse as a virtual space where economic and social interactions take place in the same way as they do in real life.

ASF (Acceleration Studies Foundation) described the Metaverse as the convergence of 'virtually-enhanced physical reality' and 'physically persistent virtual space' in 2007 (ASF, 2007). This definition broadens the concept of the Metaverse, traditionally seen as a 3D virtual world, by incorporating 'reality' and proposing an evolutionary direction through the active interaction of the virtual and real world. Furthermore, ASF categorized the Metaverse into four types based on the dimensions of implementation space and information type: AR world, Lifelogging world, Mirror Worlds, and VR world. This framework has been detailed by subsequent scholars, shaping the foundational understanding of the Metaverse. For

instance, Facebook (Stassen, 2021) defined it as a new phase of connected virtual experiences using technologies like VR and AR, enabling users to engage in activities such as meeting friends, working, playing, learning, shopping, and creating. Ball (2022) described the Metaverse as 'a large-scale, interoperable, real-time, three-dimensional network of virtual worlds where users can synchronize and have continuous experiences with an unlimited number of other users, maintaining continuity of data such as identities, entitlements, objects, communications, and payments'. Park and Kim (2022) outlined the basic technologies for realizing the Metaverse with three dimensions (hardware, software, and content). They also show three approaches in Metaverse: user interactions, implementations, and applications, highlighting its focuses on the social values of Generation Z. The comparisons of the four types of Metaverse are shown in Table 1.

### B. Metaverse Technology

The Metaverse is a sophisticated fusion of advanced technologies, creating a comprehensive ecosystem that acts as a digital twin (DT) of the real world (Far & Rad, 2022; Aloqaily et al. 2023; Lv et al.2022). Digital twins offer a highly natural and realistic representation of virtual entities within the Metaverse, enhancing the sense of presence and interaction within this expansive virtual environment (Far and Rad, 2022). Central of this immersive universe are the integrations of blockchain, AR, VR, MR, the Internet of Things (IoT), sophisticated networking, computing, AI, and gaming, where each of these plays a crucial role in deepening the functionality and richness of the Metaverse experience.

The most crucial technologies of Metaverse are decentralized Web 3.0 technologies, AI, and interactive immersive computing (Cao, 2022). The base of Metaverse is Web3.0, which utilizes distributed ledger technology to establish and sustain a virtual environment that is actively shaped and managed by its users, in which cryptocurrencies, decentralized

**Table 1.** The comparisons of four types of Metaverse

	AR world	Life logging	Mirror Words	VR world
Definition	An interactive environment where virtual 2D or 3D objects are superimposed on real-world space.	Technology that captures, stores, and transmits everyday experiences and information about things and people.	A virtual world with expanded information that mirrors the real world.	Virtual worlds built with digital data
Value	Deliver immersive content that combines real-world, fantasy, and convenience	A wealth of real-world experience and information at your fingertips	Maximize utilization by integrating and extending external information into your virtual space	Provide a new, unrealistic virtual space where a variety of individuals can be active
Technology	- Unstructured data processing - 3D printing - 5G networks	- Online platforms - Ubiquitous sensors - 5G networks	- Blockchain - GIS systems - Data storage, 3D	- Graphics, 5G Networks, - AI, blockchain
Example	- Pokémon Go - SNOW app - Socializing via 3D avatars Activities - BMW's augmented reality smart factories	- S-health, Apple - Social media (Instagram, YouTube, Facebook, etc.)	- Google Earth - Airbnb - Zoom	- Fortnite - Roblox

financing (DeFi), non-fungible tokens (NFTs), digital identities, and decentralized autonomous organizations (DAOs) are combined. In addition, AI technologies such as NLP, DL, and ML play crucial roles in Metaverse. The techniques in data analysis also are used to understand user commands and optimize virtual environments. The core technologies of immersive computing are represented by XR such as VR, AR, or MR, which provides immersive experiences and enhanced interactivity for users. IoT technology extends virtual and real-world interactions and enriches the Metaverse experience (Li et al., 2022; Maksymyuk et al., 2022).

### C. FinTech

FinTech, a word that combines the concepts of finance and technology, which breaks down the boundaries of traditional finance by utilizing advanced technologies such as mobile platforms, social networks, and big data to deliver personalized service and value to customers (Hoffman et al., 2020; Gomber et al., 2017, Go et al., 2020). For example, remittance services like Easy Pay provide individuals and businesses with a fast, cost-effective way to transfer funds globally (Chishti & Barberis, 2016). In addition, FinTech has used AI and big data analytics

**Table 2.** Summary of applications of FinTech

	Definition	Key service
Remittance Payment	Convenient, low-fee payment services	Easy Pay/Money Transfer, International remittance/Currency exchange
Financial data analysis	Create new value-added through financial data analytics	AI and big data-based credit scoring and FDS, InsurTech, Asset management
Financial software	Improve the efficiency of existing financial operations	RPA, RegTech, Authentication and security
Financial platform	Provide a platform where various financial transactions can be carried out seamlessly	P2P Lending, Crowdfunding

\*FDS: Fraud Detection System, a system that detects abnormal financial transaction patterns

\*RPA: Short for Robotic Process Automation, a computer program that replaces simple repetitive tasks

to revolutionize financial services by improving the efficiency of credit scoring and fraud detection. It also improved the services in the areas of InsurTech and asset management through innovative and data-driven services (Sailusha et al., 2020; Amer et al., 2015). While software innovation such as robotic process automation (RPA) is crucial in increasing operational efficiency and minimizing errors, RegTech utilizes technologies in FinTech to help financial institutions in regulatory compliance, streamlining the compliance process and reinforcing the financial industry's integrity (Haddad & Hornuf, 2019, Arner et al., 2015). With numerous definitions of FinTech, it can be simply defined as an industry that utilizes advanced technologies to improve the efficiency of the existing financial system (Puschmann, 2017). Mosteanu and Faccia (2021) further defined the goals of FinTech companies as providing the most innovative financial services that bring new benefits to end users such as large companies or SMEs.

The FinTech industry has gone through three major stages of development (Leong & Sung, 2018): the FinTech 1.0 era, dominated by efficiency gains from the reversal of computer technology; the FinTech 2.0 era, centered on digitization and mobile devices, which loosened the traditional financial services value chain; and the FinTech 3.0 era, in which financial services were re-bundled through integrated financial platforms, a trend that was accelerated by the COVID-19 pandemic. These platforms offer seamless venues for executing a variety of financial transactions, including innovative financial service models from P2P lending to crowdfunding.

The FinTech industry is segmented into BankTech, PayTech, Market Provisioning, WealthTech, InsurTech, and Digital Asset, along with FinTech Enabler that enable the delivery of financial services (Alt et al., 2018). BankTech involves banks that provide financial services through digital channels rather than traditional off-line bank branches or offline infrastructure, contributing to cost savings for customers, offering lower fees or higher interest rates and innovating the user experience. Examples include Kakao Bank in South Korea, Revolut in the UK, and Chimee

in the US. PayTech is related to driving the diversification of payment methods beyond credit and debit cards, with simple payment services like Apple Pay and Alipay. With the surge in demand for buy now pay later (BNPL) services, payments are now expanding beyond simple payments into the realm of lending and credit. Market Provisioning is an innovative model for directly connecting financial activities between individuals and businesses, like crowdfunding and peer-to-peer (P2P) lending. WealthTech points out the emergence of innovative services that leverage digital-based tools, such as rob advisors such as Betterment and Wealthfront, which provide investors with personalized portfolio management. Additionally, Insurtech is the application of technology to the insurance industry to provide personalized insurance products and improve risk management capabilities, while digital asset management covers the entire process of issuing, trading, storing, managing, and scaling digital assets.

#### D. Metaverse Technologies Applied in FinTech

With the rapid development of Metaverse technology in the FinTech industry, its profound impact on consumer experiences, the innovation of financial institutions' business models, and the industry's long-term trends is undeniable. This new digital revolution combines cutting-edge technologies, redefining not only the way users interact with financial services, but also offering unprecedented opportunities for financial institutions to innovate and expand their business. From providing more personalized and immersive customer experiences to driving fundamental changes in business models and operational efficiencies and shaping the future trends of the FinTech industry, Metaverse technologies are emerging new forces for progress in the financial industry (Seth et al., 2022; Rane et al., 2023; Dubey et al., 2022; Allam et al., 2022).

From the perspective of consumers, the Metaverse is revolutionizing accessibility, convenience, and customer experience in financial services. Immersive

banking experiences, enabled by VR and AR technologies, offer users a new dimension of interaction with their financial service (Yathiraju & Dash, 2023; Nguyen et al., 2023; Seth et al., 2022). This shift towards immersive banking not only enhances customer engagement, but also introduces a novel approach to managing finances in a virtual environment (Zainurin et al., 2023; Yoon, 2021). Personalized financial solutions can be developed with techniques such as big data and AI. Data analytics has the capability to offer consumers with investment advice and financial planning services that are customized to align with their individual financial goals and requirements (Kaur et al., 2023; Yathiraju & Dash, 2023; Shin et al., 2022). Furthermore, Metaverse offers a simulation platform that facilitates financial education by allowing users to engage in the investigation and experimentation of investment strategies inside simulated market scenarios, facilitating consumers in making more precise financial judgments (Vakiti & SL, 2023). CBM Bank in the United States has created a comprehensive virtual world experience for its customers. Similarly, Bank of America has employed VR for employee training, creating programs that simulate real-world customer interactions for employees to prepare customer services more effectively and ensure a higher quality of services (Mlbye 2023; Vakiti & SL, 2023; Brich, 2022). Furthermore, the decentralized nature of blockchain technology, combined with the 3D interactive experience provided within the virtual platform, allows consumers to understand, operate, and customize financial products in a secure, intuitive, and completely virtual environment. This strengthens the relationship of trust between financial institutions and their customers (Garcia Bringas et al., 2020; Truong et al., 2023).

From the perspective of financial institutions, Metaverse technologies opened a new era for them with business model innovation, enhanced risk management, stricter compliance, and broader market expansion, which signals the transformation of financial industry from traditional model to a digital one (Ooi et al., 2023). The use of blockchain and Distributed Ledger Technology (DLT) within the

Metaverse not only enhances security, decentralization, and interoperability, but it also supports the creation of secure digital assets and decentralized governance systems, ensuring transparent decision-making and fairness (Gadekallu et al., 2022; Yang et al., 2022). Technologies in blockchain and DLT are bolstering cybersecurity, simplifying financial reporting, and boosting compliance (Gadekallu et al., 2022; Yang et al., 2022). For example, Visa is exploring the use of blockchain technology, while KB Kookmin Bank has developed a DLT-based funds transfer solution. Consequently, financial institutions can now offer services that are more efficient and overcome the constraints of traditional centralized banking systems, thereby granting customers greater control over their financial transactions.

### III. Research Methodology

#### A. Data Collection and Research Process

A total of 68,957 Metaverse-related news articles and 23,902 FinTech-related news articles were collected from January 1, 2021, to September 31, 2023, from Naver News, utilizing keywords 'Metaverse' and 'FinTech'. Python programs were employed for pre-processing the collected data, followed by frequency analysis, network analysis and association analysis. The process of our study as illustrated in Figure 1, begins with the application of both TF-IDF and frequency analyses to find the key discussed keywords of the Metaverse and FinTech, pinpointing areas of thematic overlap. We proceeded to calculate both degree of centrality and eigenvector for centrality to identify important or influential nodes within the network. Association rules were then applied to delineate the influences exerted by the Metaverse on FinTech. Finally, the relationship between these two fields were visualized.

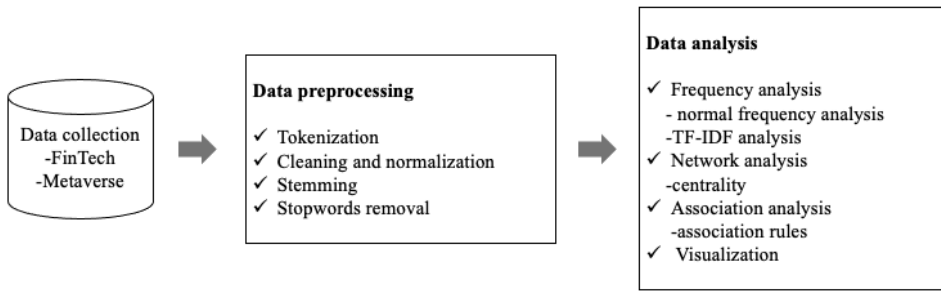


Figure 1. Research process

## IV. Results and Discussions

### A. TF-IDF Results

TF-IDF is a metric that used to clarify how important a word is to a document in a collection or corpus. It is calculated by two-step processes, which first involve calculating the term frequency (TF) to measure how often a word appears in a document. Following this, calculating the inverse document frequency (IDF) to emphasize words that are significant within that document. The top 10 keywords in Table 3 are the important words in Metaverse and FinTech fields. Words like 'Metaverse', 'finance', 'technology', 'investment', 'platform' are shown as common words, signifying their reference across both Metaverse and FinTech areas. However, words such as 'bank', 'service', 'data', 'start-up', and 'loan' are exclusive to FinTech, highlighting their unique importance within FinTech sector. Conversely, 'game' and 'contents' are notable and significant in Metaverse, indicating their importance in Metaverse.

In addition, we conducted a words frequency analysis, and the results of each Top 15 are visualized in Figure 2. It reveals that the terms 'economy', 'technology', 'platform', 'investment', 'digital', 'innovation', and 'industry' are aligned with those from our TF-IDF analysis. This suggests that these words are crucial to understanding both the Metaverse and FinTech sectors, indicating their central role in the intersection of Metaverse and FinTech.

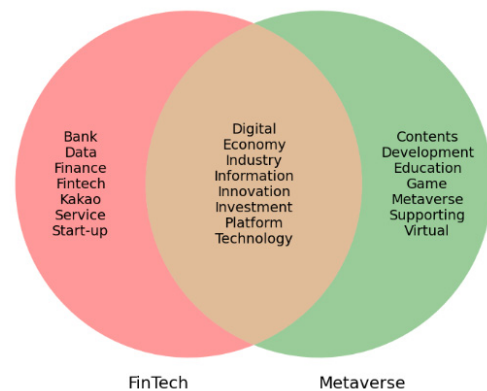
### B. Results from Network Analysis

Centrality analysis has been used to identify the most significant nodes in a network (Borgatti, 2005; Bloch et al., 2023). There are several types of centrality measures, such as degree centrality, closeness centrality, betweenness centrality and eigenvector centrality. we only focused on degree centrality and eigenvector centrality in our study. Degree centrality quantifies the number of direct connections a node has, reflecting the popularity and influence of that node (Zhang & Luo, 2017). Its normalizes value ranges from 0 (no connections) to 1 (the maximum possible number of connections). Unlike degree centrality, which simply counts the number of direct connections a node has, eigenvector centrality considers not only the quantity of connections, but also the quality of those connections, emphasizing the value of being connected to well-connected nodes (Ruhnau, 2000). A high eigenvector centrality score means that a node is connected to many other nodes that are themselves important or central within the network.

The analysis of network centrality on the text data from 2021 to 2023 reveals that Metaverse consistently emerges as the most crucial concept, with the highest degree centrality scores at 0.7489, 0.8910, and 0.7511, respectively (shown in Table 4). In 2021, top 5 core nodes contain 'service', 'platform', 'industry', and 'digital' closely followed by 'Metaverse'. These terms with strong degree centrality are also have strong eigenvector centrality, highlighting their individual importance and their influential capacity within the network. Specifically, the strong presence of 'service'



and 'platform' particularly illustrates the shift towards more integrated and customer demand-based financial solutions, such as comprehensive digital banking platforms that offer seamless customer experiences. The node 'service' reflects a trend towards service diversification and customization in FinTech. Companies are leveraging technology to offer a broader array of services that are more tailored to individual needs, improving accessibility and convenience. For example, the integration of AI into customer service, such as chatbots and automated advisors, enables more personalized and efficient customer interactions. The focus on services enhances



**Figure 2.** Word frequency in FinTech and Metaverse

**Table 3.** Results of TF-IDF

	Metaverse-based TF-IDF		FinTech-based TF-IDF		Common Word
	Word	TF-IDF	Word	TF-IDF	
1	Metaverse	0.0365	Finance	0.0555	Metaverse
2	Technology	0.0221	FinTech	0.0316	Finance
3	Digital	0.0174	Investment	0.0263	Technology
4	Platform	0.0173	Bank	0.0242	Investment
5	Industry	0.0164	Service	0.0188	Platform
6	Education	0.0157	Platform	0.0186	Digital
7	Investment	0.0142	Data	0.0182	Industry
8	Contents	0.0138	Start-up	0.0179	Education
9	Information	0.0127	Loan	0.0178	FinTech
10	Game	0.0122	Digital	0.0173	Information

**Table 4.** Results of network centrality

	2021			2022			2023		
	Keyword	D.C.	E.C.	Keyword	D.C.	E.C.	Keyword	D.C.	E.C.
1	Metaverse	0.7489	0.0282	Metaverse	0.8910	0.0294	Metaverse	0.7511	0.030
2	Service	0.6667	0.0279	Platform	0.6365	0.0266	Supporting	0.5914	0.0287
3	Platform	0.5985	0.0270	Service	0.5709	0.0260	Service	0.5829	0.0286
4	Industry	0.5568	0.0264	Supporting	0.5701	0.0258	Platform	0.5809	0.0283
5	Digital	0.5444	0.0262	Industry	0.5589	0.0258	Industry	0.5604	0.0284
6	Covid-19	0.5392	0.0261	Digital	0.5565	0.0256	Digital	0.5471	0.0279
7	Growth	0.5262	0.0260	Growth	0.5156	0.0253	Growth	0.5168	0.0278
8	Supporting	0.5244	0.0257	Investment	0.4800	0.0245	AI	0.5136	0.0273
9	Investment	0.5222	0.0256	Environment	0.4664	0.0244	Investment	0.4912	0.0271
10	Online	0.5142	0.0256	Information	0.4500	0.0240	Innovation	0.4591	0.0264

*D.C.: Degree Centrality; E.C.: Eigenvector Centrality*

customer engagement and retention by providing a more responsive and user-centric experience. The node 'Platform' centralizes diverse financial services such as digital wallets, payment systems, or comprehensive banking apps, making them accessible from anywhere, which is crucial for modern consumers who favor digital solutions. They facilitate seamless interactions between financial institutions and their customers, and among customers themselves, fostering an ecosystem that supports transactions, investments, and information exchange. The node 'Digital' means everything from digital payments to online banking and digital asset management. The digital transformation in FinTech has led to the development of digital-only banks and the widespread adoption of blockchain and cryptocurrency, enhancing the speed and security of financial transactions and enables the handling of big data for improved analytics and service offerings. Additionally, digital technologies have allowed FinTech firms to innovate rapidly, scale globally, and reduce operational costs significantly.

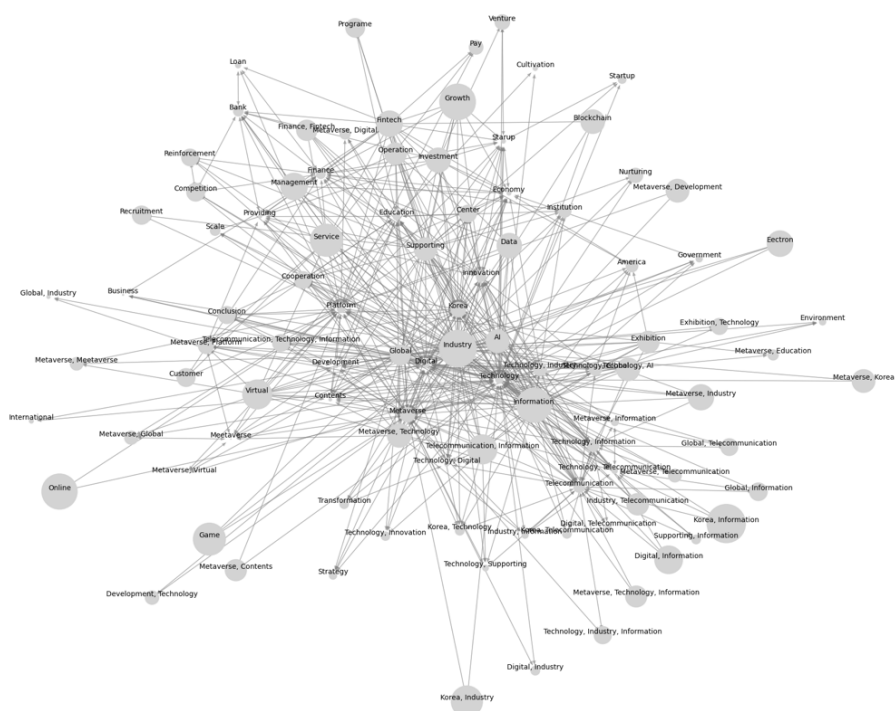
In 2022, the emergence of 'supporting', 'environment', and 'information' as key nodes signaled a trend towards sustainability and enhanced information security in FinTech. The 'supporting' node encapsulates not only the development of policies that facilitate technological innovation, but also reflects the increased focus that financial companies are placing on leveraging FinTech to advance their operations. The 'environment' node shows a growing emphasis on sustainable financial practices, driven by consumer demand for green finance and investments that consider environmental impact. FinTech firms or platforms like Clim8 Invest are incorporating ESG (Environmental, Social, and Governance) criteria into their investment products, promoting green bonds, and supporting sustainable business practices through eco-friendly loans and services. Moreover, digital platforms are increasingly used to facilitate investments in renewable energy projects and carbon credit trading, thus aligning financial growth with environmental sustainability. Meanwhile, the node of 'information' underscores the critical importance of data management and protection, which are fundamental to the trust and

efficiency of financial services. With the proliferation of digital technologies in finance, protecting consumer data has become a top priority. Furthermore, effective information management helps FinTech firms leverage big data analytics to offer personalized services, optimize operations, and comply with stringent regulatory requirements regarding data privacy and security.

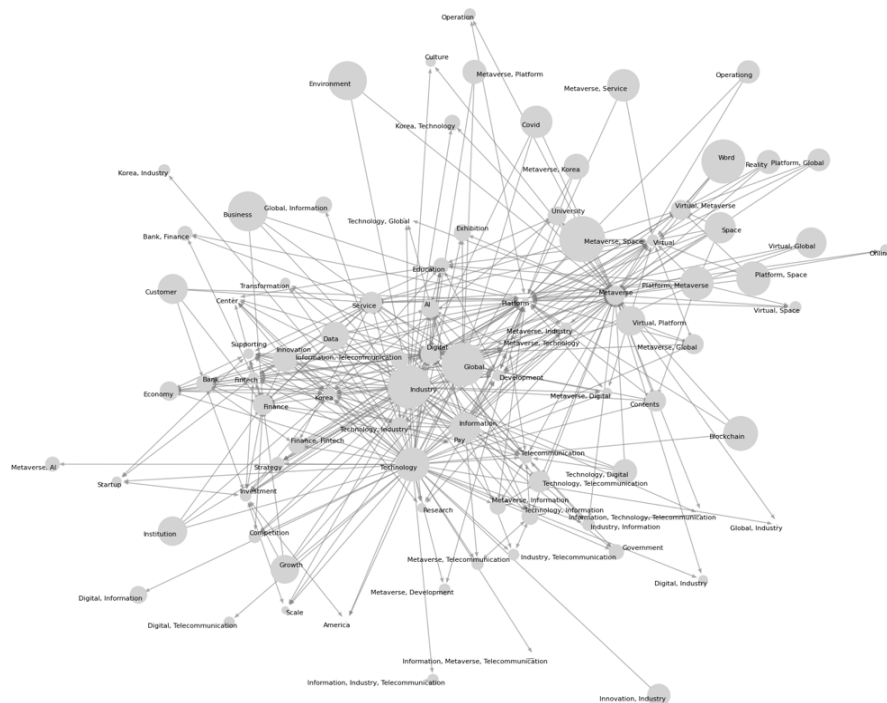
In 2023, 'AI' and 'Innovation' had become central nodes, indicating a decisive shift towards leveraging AI to drive financial innovations. AI customizes banking services for individual users by analyzing their behaviors, preferences, and financial histories. This personalization significantly enhances customer engagement and satisfaction, which in turn boosts retention rates across financial platforms. Additionally, AI has also been used in risk assessment and monitor of transactional data for signs of fraudulent activity to reduce financial losses and increase trust among customers. The focus on innovation has accelerated the adoption and integration of emerging technologies such as blockchain, quantum computing, and the Internet of Things (IoT). Innovation drives the development of creative new financial products and services. For instance, many FinTech startups are now exploring decentralized finance (DeFi) applications, which utilize blockchain technology to offer financial services that are transparent, secure, and accessible without the need for traditional intermediaries. These features enhance user autonomy by allowing more direct control over personal finances and they also increase efficiency and reduce costs associated with financial transactions. Notably, 'Covid-19' and 'Online', which were prevalent in 2021, are replaced by these forward-looking terms, demonstrating a shift from pandemic-related concerns.

This study visualized and quantified the interactions between terms associated with the Metaverse and FinTech, as presented in the network graphs of Figure 3 (for 2021, 29,805 news), Figure 4 (for 2022, 40,083 news), and Figure 5 (for 2023, 22,971 news). And Figure 6 presents the network graphs of data from 2021 to 2023. Network analysis extends frequency analysis, which similarly shows these keywords as

102



**Figure 5.** Visualization of 2023



**Figure 6.** Visualization of 2021-2023

recurring in discussions on the Metaverse and FinTech.

### C. Results from Association Rule Analysis

Association Rule Mining is a data mining technique that utilizes an association algorithm such as an Apriori to generate 'If... Then...' rules, discovering significant relationships and extracting valuable information on association from data sets (Zhang, C., & Zhang, S., 2002). For example, in the retail industry, merchants utilize association rule mining to identify patterns in customer shopping behaviors, such as finding that 'If a customer purchases bread (A), then it is likely they will also purchase milk (B)'. The strength of association rule is measured by three main parameters: support, confidence, and lift. Similarly, when this technique is applied to the analysis of word occurrences in articles, one could say, 'If the term 'innovation' (A) appears in an article, then it is likely that the term 'performance' (B) will also appear'.

Support indicates the frequency with which a particular item set appears in the database, and the higher the support, the more common the item set is within the dataset. Confidence is the conditional probability of the occurrence of the consequent Y given the antecedent X and is usually recognized as a reliability indicator of rules. The association rules with higher support values and confidence values are statistically more reliable. The value of support and confidence ranges from 0 to 1. Lift measures the ratio of the probability of Y occurring when X is present in the transaction to the probability of Y occurring in all transactions, accounting for the popularity of item sets. A lift greater than 1 indicates that a higher positive association between X and Y. Support, Confidence and lift criteria are described as follows:

$$\begin{aligned} \text{Support}(X \rightarrow Y) &= P(X \cap Y) / P(X) \\ \text{Confidence}(X \rightarrow Y) &= P(X \cap Y) / P(X) \\ \text{Lift}(X \rightarrow Y) &= \frac{P(X \cap Y)}{P(X) * P(Y)} \end{aligned}$$

Association rule analysis in this study is to show how the Metaverse impacts the FinTech sector and identify the mediating words facilitating this influence. Given that 'FinTech' is a combination of finance and technology, we expanded our analysis beyond the general concept of FinTech by specifically leveraging the top five keywords identified through the frequency analysis on FinTech. The reason for this is that by focusing on these keywords, we can more accurately trace the pathways through which the Metaverse influences on FinTech, offering a clearer view of the mediators involved. Table 5 shows the direct relationships between the Metaverse and these keywords, using the lift value as a metric for analysis.

Table 5 shows the multifaceted impact of the Metaverse on Finance, illustrating various pathways and mediators with a primary connection through 'service', 'platform', 'digital', and 'information' (Metaverse → Service → Finance; Metaverse → Platform → Finance; Metaverse → Digital → Finance; Metaverse → Information → Finance). However, in the pathway from the Metaverse to Fintech, 'industry' substitutes 'information' (Metaverse → Industry → Fintech). Notably, the only direct link between the Metaverse and 'investment' is established exclusively through 'platform' (Metaverse → Platform → Investment). And 'platform' and 'service' together mediate the link between Metaverse and FinTech (Metaverse → Platform → Fintech; Metaverse → Service → Fintech). The relationship between the Metaverse and services is affected by 'platform', 'information', 'technology', and 'digital' serving as critical intermediaries (Metaverse → Platform → Service; Metaverse → Information → Service; Metaverse → Technology → Fintech; Metaverse → Technology → Service; Metaverse → Digital → Service). In the specific case of data within the Metaverse, 'AI' plays an important mediating role, alongside 'technology', 'platform', and 'digital' (Metaverse → AI → Data; Metaverse → Information → Data; Metaverse → Service → Data; Metaverse → Digital → Data). When examining the Metaverse's connection to startups, 'platform' and 'technology' emerge as the sole direct paths of association

**Table 5.** Results of association rules

Antecedents	Path(<2)	Consequents	Lift
Metaverse →	Service		3.128
	Platform	→ Finance	3.092
	Digital		2.561
	Information		2.265
	Service		3.389
	Platform	→ FinTech	3.146
	Digital		2.268
	Industry		2.260
	Platform	→ Investment	3.075
	Platform	→ Bank	3.174
	Service		3.130
	Platform		3.692
	Information	→ Service	2.585
	Technology		2.336
	Digital		2.333
	AI		4.931
	Information		3.868
	Service	→ Data	3.496
	Platform		3.314
	Digital		2.936
	Technology		2.787
	Platform	→ Start-up	3.153
	Technology		2.591
	Industry, Technology		3.429
	Technology, Information		3.208
	platform		3.186
	AI	→ Digital	3.183
	Contents		2.930
	Education		3.784
	R&D		2.525
	Service		2.187
	Zepeto		7.677
	Virtual		3.525
	Contents		3.136
	Game		3.108
	Blockchain	→ Platform	2.986
	Online		2.973
	R&D		2.816
	Service		2.776
	Education		2.447
	Digital		2.406
Antecedents	Path(<3)	Consequents	Lift
Metaverse →	Service		7.853
	Platform	→ Finance	7.817
	Digital		7.286
	Information		6.990

(Metaverse → Platform → Start-up; Metaverse → Technology → Start-up). The emphasis on digital shows two predominant pathways: 'Industry', 'Technology' and 'Technology', 'Information', which have significant lift values (Metaverse → Technology, Information → Digital; Metaverse → Industry, Technology → Digital). Significant mediators in the relationship include 'content', 'education', and 'R&D', although 'platform' and 'service' continue to play influential roles (Metaverse → Content → Digital; Metaverse → Education → Digital; Metaverse → R&D → Digital; Metaverse → Platform → Digital; Metaverse → Service → Digital). As for platform, 'Zepeto' stands out with the highest lift value, followed by other mediators such as 'virtual', 'contents', 'games', 'blockchain', 'online', 'R&D', 'service', 'education', and 'digital' (Metaverse → Zepeto → Platform; Metaverse → Virtual → Platform; Metaverse → Contents → Platform; Metaverse → Game → Platform; Metaverse → Blockchain → Platform; Metaverse → Online → Platform; Metaverse → Service → Platform; Metaverse → Education → Platform; Metaverse → Digital → Platform). Regarding the Metaverse's linkage to loans, this analysis does not identify direct paths. However, this study illuminates relevant pathways with path lengths shorter than three words, demonstrating how 'service', 'platform', 'digital', 'information', indirectly affect Metaverse by the role of 'finance' to 'loans' (Metaverse → Service → Finance → Loan; Metaverse → Platform → Finance → Loan; Metaverse → Digital → Finance → Loan; Metaverse → Information → Finance → Loan).

## V. Conclusion

The purpose of our research is to find the shared thematic domains between Metaverse and FinTech sectors, as well as to show how Metaverse influences FinTech. With text mining techniques, specifically TF-IDF, words network analysis and association rule mining, this study has identified key words, which

represent thematic intersections and the paths through which the Metaverse impacts on the FinTech. Our findings underscore the crucial roles played by terms such as 'service', 'platform', 'digital', and 'information'. These keywords serve as essential channels through which the Metaverse's influence on finance is mediated.

The significant overlap and interactions between these terms provide insights into how Metaverse technologies are integrated with financial services and enhance it. They serve as crucial mediators, facilitating deeper integration between the technological advances within the Metaverse and foundational financial operations. This relationship shows the potential of Metaverse technologies in reshaping the financial sector by leveraging digital platforms to enhance service delivery and customer engagement.

Theoretical implication of this paper is to find future influences of a technology to an industry in the future using technologies such as text mining and data mining, specifically text mining, association rule analysis and words network analysis in this study. While most study focuses on direct relationship between A (technology) and B(industry), this study finds direct and also indirect relationships between them by considering multiple mediating factors linking them.

Potential applications of approaches suggested in this study can be finding major key factors influencing FinTech areas by Metaverse, along with positive and negative influences shown in words network graphs. Rules from association rule analysis on texts regarding Metaverse and FinTech can also be used to identify possible path of influences in the future. Butterfly Effect can be an example of this. There can , however, be many possible effects from Metaverse to FinTech in the future in this approach.

The integration of Metaverse technologies such as VR and AR presents significant opportunities for FinTech companies to revolutionize their customer interactions and operational structures. For example, the development of immersive customer experiences, such as virtual financial advisory services where individuals interact with digital advisors in 3D

environments, targets younger generations, aligning with their preferences for digital-first interactions, in not only enhancing convenience and hedonic in financial engagement, but also altering marketing strategies by leveraging targeted advertisements in Metaverse platforms. Moreover, the use of these virtual environments extends to employee training, where complex financial products can be demonstrated and explored interactively, potentially reducing training costs and enhancing service delivery effectiveness. Additionally, the adoption of virtual branches within the Metaverse allows customers to perform consultations and transactions remotely, significantly boosting accessibility and satisfaction by providing services that are not constrained by geographical boundaries.

The integration of technologies like AI and blockchain within finance sectors needs regulatory. Policymakers are thus called upon to establish comprehensive financial regulations specifically tailored to the Metaverse to ensure the integrity of these transactions. The Metaverse needs to ensure the integrity of these transactions. This includes the implementation of advanced fraud detection systems that leverage AI to monitor transactions in real time, preventing suspicious activities. Ensuring the security and privacy of customer data in these virtual spaces is paramount; thus, the development of stringent encryption technologies, secure user authentication methods, and standardized data protection protocols is essential to build trust and safeguard user information.

This study, while comprehensive in its exploration of the Metaverse and FinTech sectors through textual analysis of news articles from 2021 to 2023, acknowledges certain limitations that open avenues for future research. Primarily, the reliance on news sources as the sole form of data collection may have constrained the depth of insights into understanding dynamics between the Metaverse and FinTech. Future studies could benefit from incorporating a wider array of unstructured data, including but not limited to video content like YouTube, which often contain rich discussions and presentations on the latest technological advancements, as well as industry reports, white papers, and social media discourse

from platforms such as Twitter, blogs, or LinkedIn. For this, data extraction can be gained by using tools like YouTube API for automatic downloading of video captions or transcripts. Expanding the data sources will not only enrich the analysis but also provide a more nuanced understanding across different media and platforms. Moreover, while this study has identified direct connections between the Metaverse and FinTech, along with their top associative words, it does not show the indirect connections that underpin this relationship. Future investigations could focus on unraveling these complex interdependencies, shedding light on the multifaceted role of digital platforms in bolstering financial services, the transformative potential of service delivery within immersive virtual environments, and the far-reaching effects of digital transformation on traditional and emerging financial models. Future studies should consider employing case study methodologies. This involves conducting in-depth interviews with industry experts and participants in the Metaverse and FinTech sectors, as well as collecting and analyzing real-world data on user engagement and financial performance metrics from companies that have integrated these technologies. Such qualitative insights, combined with quantitative data analysis, will provide a richer, deeper understanding of how digital innovations are reshaping financial models and customer experiences.

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