Predictive Virtual Reality System for Corporate Financial Risk Based on the Metaverse

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Abstract. The current study addresses the issues in corporate financial risk prediction, such as the narrow analytical perspective on influencing factors, lack of complex network and global view analysis, delayed predictive feedback, and low efficiency. By employing Metaverse technologies, the approach integrates a dynamic data repository, financial risk predictive virtual space, risk prediction model virtual simulation experiments, and an intelligent early-warning decision system.This methodology offers a holistic view and complex network analysis, combined with multi-level and multi-angle influence factors for financial risk forecasting. Comparative tests of data processing capabilities between traditional risk prediction systems and the proposed system revealed that, under identical data volumes, traditional systems only analyzed partial modules with significantly lower data throughput compared to our system.

Keywords: Metaverse, Hybrid Reality, Financial Risk Forecasting

1 Introduction

As the epitome of next-generation information technologies, the Metaverse integrates advances such as artificial intelligence, blockchain, the Internet of Things, and virtual reality to forge a novel paradigm of financial management. The increasing complexity and unpredictability of corporate management risks necessitate a pivotal shift towards leveraging these technologies for financial risk identification and prediction from a complex network and global perspective. While early research focused on constructing univariate financial risk warning models using traditional statistical methods with limited samples and financial indices, recent studies by López Iturriaga et al. [1][2] and others have employed AI on larger datasets to develop more accurate multivariate models. However, there is a paucity of research that deeply explores financial risk prediction through a multifaceted approach involving complex networks. This paper introduces a Metaverse technology-supported system that incorporates a multi-layered and multi-angle perspective to enhance the precision and proactiveness of financial risk warnings, thus contributing to the sustainable growth of enterprises.

2 Metaverse corporate financial risk prediction vr system architecture

The Metaverse enterprise financial risk prediction virtual reality system architecture primarily

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consists of three components: Metaverse technology support space, financial risk prediction real space, and financial risk prediction virtual space. The first part leverages artificial intelligence, human-computer interaction, digital twins, IoT, and blockchain technologies to provide an interface for real-time synchronization of data and actions, as well as virtual-real consistency of scenarios and models, offering technical support for both the real and virtual risk prediction spaces. The second part handles real-time collection of corporate internal and external data, perceiving corporate behavior, and uses time series analysis and machine learning to capture the dynamics of financial risk based on a foundational database. It incorporates risk feedback from the virtual space into the dynamic risk prediction mechanism of the real space. The feedback and actual corporate needs from the virtual space are used to dynamically adjust the corporate risk prediction data and indicator repositories and synchronize the updated information back into the virtual space, ensuring the timeliness and accuracy of financial risk prediction methods. The third part, the financial risk prediction virtual space, includes intelligent integration of real-world scenario virtual simulation, financial risk intelligent prediction, and intelligent early warning decision-making. This integration builds complex corporate behavior virtual scenarios through Metaverse technologies, mapping and simulating external and internal corporate behaviors in real time for scenario simulation and visualization. [3] The intelligent integration of financial risk early warning monitors corporate behaviors in various simulated scenarios to support dynamic updates to the real space's data repositories and risk indicators. The intelligent early warning decision-making integration processes real-time data and synchronized behavior from the real space, identifies risks and issues early warnings, and feeds back the final results to the real space.[4]

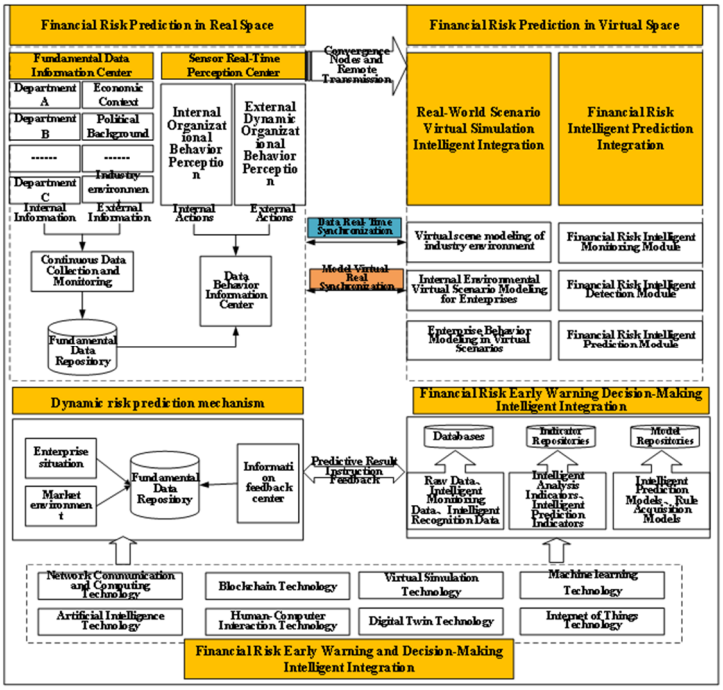

Figure 1. Architecture of the Metaverse Corporate Financial Risk Prediction Virtual Reality System.

The architecture of the Metaverse-based corporate financial risk prediction VR system is illustrated in Figure 1.

3. Design of the metaverse corporate financial risk prediction vr system

3.1 Metaverse vr system technology model

The Metaverse virtual reality system technology model comprises four layers: the foundational technology layer, the real space risk prediction engine layer, the virtual space risk prediction engine layer, and the intelligent feedback decision layer. The model aggregates basic data and scenario behavior information into the real space for risk prediction, using time series analysis and machine learning to capture the dynamics of financial risk and then dynamically adjusts the corporate risk prediction data and indicators based on feedback from the virtual space. It monitors financial risks in real-time and synchronizes real behavior and scenario data into the virtual space using IoT and human-computer interaction technologies. In the virtual space, different scenarios are built using digital twin, AI, and virtual simulation technologies to simulate industry and corporate behavior, constructing corresponding risk prediction models based on deep machine learning and AI for different behavior feedbacks. The model loads real-time dynamic data feedback from the real space into the established early warning decision-making intelligent integration system. When the real space corporate behavior data reaches the monitoring threshold, the model uses risk level assessment methods to evaluate abnormal data, ultimately outputting financial risk prediction results for the enterprise.

3.2 Metaverse-based risk prediction methodology

The Metaverse-based risk prediction method utilizes an integrated risk prediction model combined with risk level assessment techniques to forecast corporate financial risks.

Risk assessments are performed on real-space data anomalies processed by the Metaverse-based risk prediction model using these assessment techniques. Initial data processing is reflected through an intelligent indicator system. During dynamic risk assessments, five scoring levels are set: no risk, low risk, moderate risk, increased risk, and severe risk. Based on the efficacy coefficient method, the standard coefficients for these five levels are set at 1, 0.8, 0.6, 0.4, and 0.2, respectively. Assuming the baseline score for the first level is A, for the second level is B, and the actual score is V, the efficacy coefficient D can be calculated as follows:[5]

$$D= (V - B)/ (A - B) \tag{1}$$

From Equation (1), the adjusted score T for the level can be determined as follows:

$$T=D* (A - B) \tag{2}$$

The composite score for a level is the sum of the individual indicator scores, which are the sum of the baseline and adjusted scores. Hence, the formula for level scoring is:

$$W = \frac{D^* \sum T}{\sum T^* J} \tag{3}$$

In formula (3), J is set as the indicator weight. The risk level of financial dynamic data is calculated using formula (3), and the level details are presented in tabular form, as shown in Table 1.

Table 1. Details of Information Risk Levels.

Evaluation Metric Interval	Risk Status	Incident Report
0.85~1.0	No Risk	No Incident
0.7~0.85	Monitor Potential Risks	Minor Incident
0.5~0.7	Minimal Risk	Moderate Incident
0.3~0.5	Significant Risk	Major Incident
0~0.3	Critical Risk	Severe Incident

The financial information risks in real space are classified based on the information risk levels from the table above. Appropriate response measures are then selected from the intelligent integrated system for early warning and decision-making through the use of deep learning, cloud computing, and artificial intelligence technologies.

3.3 System technical approach

The technical route for a metaverse-based corporate financial risk prediction VR study centers around the main content of the system, arranged in the order of "information input—information processing—scenario simulation—model construction—intelligent decision-making," ensuring cohesion and continuity between sections. The entire system practice is divided into six steps:

Step 1: Data mining and collection. Utilize AI technology to deeply extract and organize internal and external corporate information, importing the data into the VR system for financial risk prediction.

Step 2: Construct a dynamic data repository. Utilize deep learning and cloud computing technologies to organize data activities and employ control scripts for mapping information across narrative space elements. Implement time series analysis and machine learning techniques to build a dynamic database of corporate foundational information.

Step 3: Construct a financial risk prediction VR space. Use human-computer interaction, IoT, and blockchain technologies to map data from real space to virtual space in real-time, achieving synchronization between virtual and actual realities.

Step 4: Risk prediction model VR simulation experiments. Conduct VR simulation experiments using AI and deep learning based on foundational information, simulate corporate behavior under different scenarios, and develop corresponding financial risk prediction models and risk thresholds.

Step 5:Establish a dynamic risk prediction mechanism. Integrate real-time risk feedback from virtual space with actual corporate needs into the dynamic risk prediction mechanism, dynamically adjust the data and indicator repository, and synchronize the updated information

back into the virtual space in real-time.

Step 6: Implement an intelligent early warning decision-making system. Utilize Metaverse technologies to monitor real-time feedback from the dynamic risk prediction mechanism, including data and indicators. Initiate the intelligent financial risk early warning process when data is within the threshold detection range, facilitating corporate financial risk alerts.

4 System simulation testing

This study's system, utilizing a metaverse technology cluster as the carrier and corporate internal and external data as the core, constructs a financial risk early warning platform that is synchronized with both virtual and real worlds. The system applies to various aspects including data detection, regulation, simulation, management, and assistance, with a focus on implementing real-time data risk monitoring, virtual-real synchronization simulation, real-time data transmission with intelligent alerts, and the practical application of the virtual reality system.

To effectively validate the practical performance of the system in financial risk prediction, the study uses both the proposed system and traditional systems for comparison, setting multiple groups of abnormal financial data as test cases. The financial risk levels under both systems are then compared with the original data risk levels, with the test results presented in Table 2.[6]

Table 2. Practical Application Test of Metaverse Corporate Financial Risk Prediction VR System.

Test Cases	Original Information Risk Level Prediction	Prediction of Information Risk Levels Based on Traditional Systems	Information Risk Level Prediction Using the System Described Herein
001	Evaluation Index: 0.51 Risk Status: Minimal	Evaluation Index: 0.74 Risk Status: Attention Needed	Evaluation Index: 0.89 Risk Status: None
002	Evaluation Index: 0.32 Risk Status: Significant	Evaluation Index: 0.63 Risk Status: Minimal	Evaluation Index: 0.78 Risk Status: Attention Needed
003	Evaluation Index: 0.75 Risk Status: Attention Needed	Evaluation Index: 0.88 Risk Status: None	Evaluation Index: 0.93 Risk Status: None
004	Evaluation Index: 0.53 Risk Status: Minimal	Evaluation Index: 0.75 Risk Status: Attention Needed	Evaluation Index: 0.88 Risk Status: None
005	Evaluation Index: 0.43 Risk Status: Significant	Evaluation Index: 0.63 Risk Status: Minimal	Evaluation Index: 0.78 Risk Status: Attention Needed

Comparison of each evaluation index and risk status in Table 2 indicates that the information risk levels of the test cases decreased after risk prediction using both traditional and the proposed systems. However, the reduction in information risk levels was significantly greater when using the proposed system. It can be inferred that the proposed system outperforms the traditional system in practical application effectiveness for financial risk prediction.

After combining the various modules designed within the metaverse-based corporate financial risk prediction VR system, the data handling capabilities of both the traditional and proposed systems were tested with massive datasets. Data behavior information for the years 2021 and 2023 was selected, with sizes of 444GB and 517.5GB, respectively. The 2021 data set was labeled as Group A1, and the 2023 data set as Group A2. This information was inputted into both systems for risk testing simulation experiments. System risk indicators and basic data information are shown in Table 3, and the results of the data throughput comparisons, obtained by running the systems, are presented in Figure 2.

Table 3. Risk Indicators and Basic Data Information for Both Systems Testing.

	Module1		Module2		Module3		Module4		Module5		Module6	
	T/F	Data/RI	T/F	Data/RI	T/F	Data/RI	T/F	Data/RI	T/F	Data/RI	T/F	Data/RI
The System in This Study	T	300/0.9	T	350/0.84	T	400/0.8	T	450/0.76	T	500/0.71	T	550/0.68

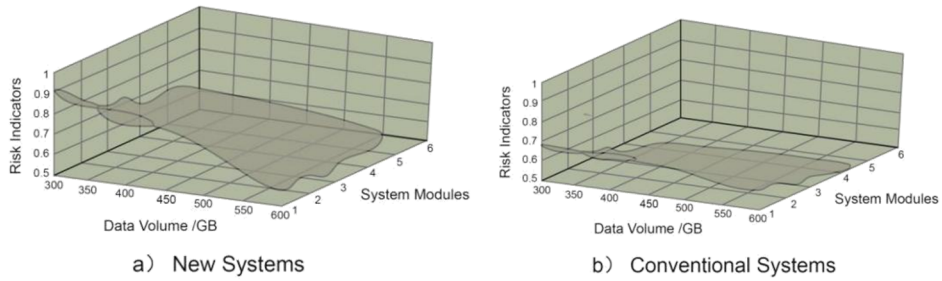

Figure 2. Metaverse Corporate Financial Risk Prediction VR System Test Simulation Results.

The test results indicate that the proposed system evaluated data across six modules, handling greater data throughput and producing a broader range of risk indicators. In contrast, the traditional system analyzed only a subset of modules with significantly lower data throughput, resulting in a limited range of risk indices and overlooking other levels of system risks.

5 Conclusion

The construction of the Metaverse Corporate Financial Risk Prediction VR System has achieved intelligent processing of data across multiple dimensions and layers by establishing an integrated virtual-real risk prediction platform. It has facilitated complex virtual scenario processing and intelligent risk prediction, providing technical support and case references for big data processing applications and digital governance innovation in enterprises. Furthermore, it contributes ideas to the development of the Metaverse economic system and innovation in Metaverse enterprise scenarios. The system represents an avant-garde development in the new era, driving enterprises towards an intelligent, virtualized, and decentralized future. The

successful construction of the Metaverse Corporate Financial Risk Prediction VR System will advance intelligent strategic decision-making for enterprises and urban development.

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