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Intelligent construction of financial risk management system based on an e-commerce platform under the background of the Internet of Things

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Abstract: This paper proposes an Intelligent Financial Risk Blockchain Management system under the Internet of Things (IFRBM-IoT) to address the challenges of financial risk management (FRM) in e-commerce. With the rise of IoT, e-commerce platforms have grown rapidly, but regulatory gaps and security concerns hinder FRM development. The IFRBM-IoT framework integrates Hyperledger blockchain technology with a Neuro-fuzzy decision method and control chart analysis to enhance data credibility, accountability, confidentiality, and integrity. It aims to improve service quality, standardise assurance processes, and optimise security and profitability. Empirical analysis demonstrates the model's high accuracy in financial risk evaluation and its effectiveness in ensuring data security within e-commerce operations. This approach provides a practical solution for managing financial risks and assessing data security measures.

Keywords: IoT; Internet of Things; FRM; financial risk management; E-commerce; panel data regression analysis; hyper ledger blockchain.

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1 Introduction

With the advent of the business ecosystem, e-commerce firms are experiencing explosive growth and are currently the norm in domestic and global commerce (Qiu, 2021). The time it takes to choose a trade may be drastically reduced when dealing with an e-commerce company, the speed and ease with which information can be exchanged, and the depth of the material information provided to both parties (Hameed et al., 2020). As a result, the success rate of operations is increased, and society benefits from this electronic commerce paradigm. As the e-commerce business platform is accessible and collaborative, it helps businesses and universities study customer behaviour and information management (Zhu and Liu, 2021; Odigbo et al., 2022). However, several issues have contributed to the business's slow growth, including a lack of laws and legislation that necessitates security, facilitating economic risk management systems and gaps. Thus, this era has tremendous theoretical and actual importance for investigating the financial risk management (FRM) method (Mahmood and Ahmed, 2022).

Different standards for data acquisition in business financial appropriate risk data management have been proposed in light of the widespread use of IoT technology in this area. However, the technology now available for processing corporate risk data is inadequate (Naim, 2022). Furthermore, after extensive research into IoT-based enterprise collection, analytics, and storage solutions, IoT support is needed for e-commerce incorporation and retrieval (Jin et al., 2022; Chiang et al., 2022). Despite the widespread use of data processing technologies in corporate processing analysis systems, reducing redundant data for real-time processing in the face of massive data flows and maintaining the security of monetary operations communicated online are two examples of the many problems that still need to be solved in the informational context and statistics measurements of real-world applications (Li et al., 2022; Abba et al., 2022).

However, the current technique needs more financial management and risk assessment resources to keep up with the new environment's fast evolution (Landi et al., 2022). Thus, there is substantial theoretical and practical importance in investigating the most appropriate financial management style (Landi et al., 2022). For the most part, prior studies of organisational financial risk must combine the neuro-fuzzy decision method, control chart approach, and IoT technologies based on e-commerce platforms. This study provides IFRBM-IoT to examine the financing risk management (FRM) in the e-commerce platform. The neuro-fuzzy decision approach is used to examine E-commerce risk assessment. The piecewise sample control chart method is utilised for statistical analysis and complete risk control decision-making. Still, conventional has many drawbacks, including weak oversight, a high chance of default, and marketplace confusion. Additionally, the system provides blockchain technology to business financial management; however, these efforts have been shown to reduce severe security and categorisation accuracy flaws (Lu et al., 2022; Shahbazi and Byun, 2022). The Hyperledger Blockchain secures financial data in the IFRBM-IoT system, preventing input tampering and harmful assaults. The Neuro-Fuzzy Decision System makes static flaws challenging to exploit by updating risk models depending on economic trends. Control Chart Methods also monitor risk assessment data for odd oscillations indicating malevolent intervention. Hyperledger Blockchain helps the IFRBM-IoT model comply with rules and make financial transactions visible and safe. Smart contracts ensure tax, AML, and KYC compliance. The Control Chart Method allows real-time compliance risk monitoring, and AI-driven risk classification adjusts policies dynamically to meet changing legal requirements.

The main contributions of the paper include

- The paper proposes an e-commerce platform-based Intelligent Financial Risk Blockchain Management under IoT (IFRBM-IoT) system to improve an enterprise FRM system that standardises quality assurance operations and equips businesses with optimal security and quality controls.
- The Neuro-Fuzzy decision method was used to classify hazards and financial risks in present data and adapt to new ways of learning. The control chart approach statistical process control subsystem module was used to develop a successful FRM system integrating hyper-ledger blockchain technology on an e-commerce platform.
- The stated framework develops a strategy for managing the risks associated with financing an e-commerce company in the modern day.

The following is the outline for this paper: In Section 2, review relevant works. In Section 3, FRM is based on an e-commerce platform using a systemic approach. Methodology and data collection are discussed in Section 4, system performance is evaluated in Section 5, and final results are summarised in Section 6.

2 Literature survey

Zhou et al. (2019) proposed a big data mining (BDM) strategy for managing financial risks in the banking industry with an IoT application: a particulate swarm optimisation based backpropagation (PSO-BP) neural net that uses Apache Spark and Hadoop Distributed File system (HDFS) techniques to build a variation concurrent optimisation method for a dataset that includes both on-balance-sheet and off-balance-sheet items. According to the experimental data, this contemporary risk management model has a high convergence speed and predicting ability and performs well in screening default behaviour. On the other hand, the dispersed execution on massive data clusters drastically cuts down on the time it takes to train and test models.

Qu et al. (2021) introduced empirical methods that examine the current state of the supply chain for small and medium scale enterprises (SME) online retailers. Initially, this study creates an edge-computing-based assessment methodology for e-commerce firms' supply chains. Second, this study establishes a supply chain financial risk assessment-fuzzy neural network (SCFRA-FNN) model with parameters including the member's specified quota, reputation, execution time, and other indications. The pricing strategy is then analysed based on this information and the regression analysis results. The findings reveal that the model's estimate of financing risk is quite close to the actual risk.

Yue et al. (2021) introduce the use of information fusion tools for research into enterprise FRM through BDM and subsequent analysis of effective FRM strategies. Big data analytics, support vector machine (SVM), logistic regression, and information fusion are all tools used by analysts to investigate potential financial risks to the company. The choice of investment risk indices may affect the monitoring outcomes of the SVM-based FRM model. In contrast, the knowledge fusion-based FRM model uses a fusion algorithm to combine data from many sources, while the Logistic regression-based FRM model effectively categorises financial consequences. The findings show that the SVM-based FRM model and the Logistics regression-based FRM model are both effective in controlling and classifying business financial risks in reality; thus, the FRM based on information fusion is superior to the SVM and the Logistic regression models.

Rahmati et al. (2022) introduced failure modes and effect analysis (FMEA) as the basis for a decision-making strategy to determine which aspects of a company's financial management system pose the most significant risk. The proposed decision-making approach uses the Z theory-stepwise weight assessment ratio analysis (Z-SWARA) and Z theory-weighted addition sum product assessment (Z-WASPAS) methods with the FMEA method to address the limitations of the risk priority number (RPN) score in the tackle. According to the data, the most important aspects of a finance control system for management are expense guidelines and client happiness. In addition, the strategy planning and deviation analysis factors (rated 2.95 and 2.87, respectively) are at their lowest possible levels. In conclusion, according to FMEA methods and the views of three experts, market or sector shifts are the primary source of risk in companies.

Sun and Gu (2021) proposed a cross-border electronic commerce logistics supervision (CB-ELS) uses Internet of Things (IoT) technology and the evaluation indication system from the state's overall recommended framework to improve distribution network monitoring, threat oversight, and the system's sequence breadth. In addition, the security assessment and transaction supervisory component software ensure the transaction supervision system's integrity, control, and efficacy. Hence, the integral approach supervisory system is safe and controllable, and e-commerce operations protect the privacy of its users and their transactions, end the use of fraudulent papers and data, and turn these protections into an actual reality.

Luo et al. (2022) introduced four agricultural supply chain cases that require information credibility: product tracking, E-commerce platforms, farm insurance, and agricultural funding. Upstream vendors and downstream merchants are wary of sharing data out of concern for privacy or business secrets. Regulatory agencies may need help identifying accurate pollution sources if there is scant or wrongly reported information at any level of the food supply chain. The findings on innovative credibility applications focus on blockchain-related technologies that can provide information credibility, and we do so by analyzing current issues and relevant contexts.

Wang (2021) introduced the approach of analyzing the credit risk of SME financing via the lens of supply chain finance and using blockchain technology and fuzzy neural network algorithms. This paper details the use of blockchain technology in constructing a supply chain financial system and incorporating supply chain financial data into blocks. The supply chain's risk processing level is solved and enhanced by applying the fuzzy neural network technique for processing and assessing financial data. The simulations proved that blockchain and machine learning algorithms might benefit the financial supply chain.

Wang and Wang (2022) offer an in-depth examination of supply chain financing and blockchain technology based on the extensive theoretical investigation. The monitoring system, working capital of the supply chain, and risk control system are all examined alongside the contemporary context of blockchain in supply chain finance. As a result of everyone involved in supply chain finance working together to improve the supply chain FRM system, everyone's exposure to risk is considerably mitigated. In addition, commercial banks and businesses may benefit greatly from the shared data and enhanced data processing the blockchain IoT ecosystem provides.

Dashottar and Srivastava (2021) proposed the blockchain (a decentralised ledger-based computing) framework for credit risk assessment, prompt flag issuance, and hardening the regulatory structure, notwithstanding the benefits of blockchain technology in enhancing the performance of some corporate finance products. Regulatory technology (RegTech) is discussed in the paper to enable better supervisory and reporting architecture, which would aid in unifying data currently accessible inside the banking system. As a result, lenders can make better credit choices (data-driven finance) and keep better tabs on their borrowers. Capital allocated to credit risk will be optimised as a result.

Chen et al. (2021) proposed the random forest algorithm to assess and provide warnings about the security threat posed by substantial group activities. The approach for weighing the privacy risk score is integrated with the random forest method's design variables, and the parameters' importance is determined. With a maximum classification performance rate of 0.86, the random forest technique has significant predictive power in risk assessment of large-scale group activities thanks to optimisation investigation and a random forest prototype experiment. This paper provides more vital evidence for the practicability and efficacy of its claims.

Refer to the surveys to get an in-depth understanding of the essential technical features of the most widely used FRM strategies. This study focuses on neuro-fuzzy since it allows using blockchain and other advancements that do not need a current software or hardware redesign. Still, the suggested balancing approach can be used for the abovementioned things under the right circumstances. Provide a modelling framework, an innovative water balance optimisation method, and a simple-to-implement solution based on these concepts.

In contrast to conventional fixed-threshold statistical process control approaches, the weighted mean control limit approach continuously modifies risk thresholds according to past transaction patterns, improving financial risk identification (Song et al., 2024). This method makes fraud detection more accurate and less prone to false positives and negatives by considering real-time financial swings. Better still, this strategy can adjust to changing economic conditions and seasonal trends, making it more robust in the ever-changing world of online retail (Zhang et al., 2024; Zhao et al., 2024).

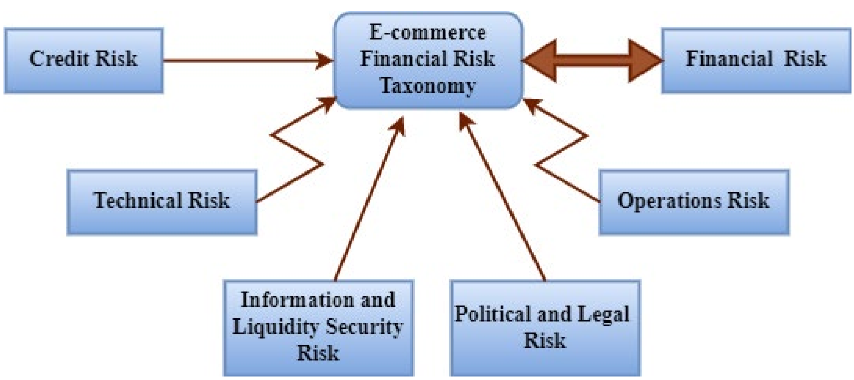
Edge computing analyses risk data closer to the source and minimises latency, making IFRBM-IoT more efficient than PSO-BP and SCFRA-FNN. IFRBM-IoT prioritises critical risk factors using fuzzy logic to optimise processing resources, unlike PSO-BP, which is computationally demanding. SCFRA-FNN models are not adaptable to changing financial risks, so IFRBM-IoT improves risk parameters using machine learning and blockchain-supported validation.

3 System methodology

3.1 Taxonomy of financial risk in E-commerce platform

Figure 1 shows the classification of financial risks that affect E-commerce business management. Regarding the financial sector, E-commerce FRM refers to using scientific methodologies to minimise or eliminate unfavourable risk outcomes, enhance the leadership of insured units, and foster sustainable economic growth. Inadequate management in many sectors of the online finance sector leaves the industry vulnerable to severe threats. As these threats emerge, they have devastating effects on civilisation. Information and Liquidity security risk due to the growth of information technology is the bedrock of potential for financial loss due to the actions of one or more participants in electronic financial transactions.

Figure 1 E-commerce financial risk taxonomy (see online version for colours)



Businesses may avoid operational risks with IFRBM-IoT because it incorporates real-time IoT-driven financial monitoring. This helps identify liquidity shortages, fraudulent efforts, and unusual transactions before they become serious. Businesses may optimise inventories, manage supplier relationships, and modify pricing depending on insights into financial health with the Neuro-Fuzzy Decision System's dynamic risk classification. Two outcomes of IFRBM-IoT's automated cash flow forecast process are improved liquidity management and avoided capital misallocations. Operational risks are due to Human error, such as carelessness on the job that leads to alterations at the firm and potential losses, or the malicious use of ways to infiltrate or exploit commercial systems unlawfully, which are common causes of high risks. One contributing factor is the lax oversight and flawed laws and regulations of online financial institutions. In addition, the business system's security cannot be assured owing to a lack of up-to-date technology, leaving it vulnerable to attacks by unwitting users. Next is financial risk, in which a broad client base, excellent flexibility in repayments, guaranteed sources of money, and a high degree of unpredictability increase the likelihood of liquidity concerns when Internet finance firms undertake fund-raising efforts.

3.2 IoT layer for E-commerce

Figure 2 illustrates the structure of IoT in E-commerce. Device communication, data gathering and strategic planning, identity connectivity, protection, confidentiality, cloud technology, and detecting and prompting technologies are some sophisticated technologies the IoT must harness. Edge computing helps the IFRBM-IoT platform make real-time decisions by processing financial risk data closer to its source, reducing latency. Decentralising data processing to edge devices allows the system to evaluate financial transactions, fraud, and liquidity. This removes bottlenecks in centralised cloud models. E-commerce finance operations are more efficient with real-time fraud detection, market reaction, and localised security. In addition, connecting physical and digital objects is essential for enhancing service delivery. The IFRBM-IoT model's Neuro-Fuzzy Decision System combines human-like reasoning with structured rule-based inference to assess risk. The Control Chart Method graphically depicts variances and their origins to validate risk choices statistically. The immutable audit trail of risk assessments on the Hyperledger Blockchain helps stakeholders trace decisions to data sources and justifications. This provides interpretable, accountable, and regulatory-compliant financial risk evaluations.

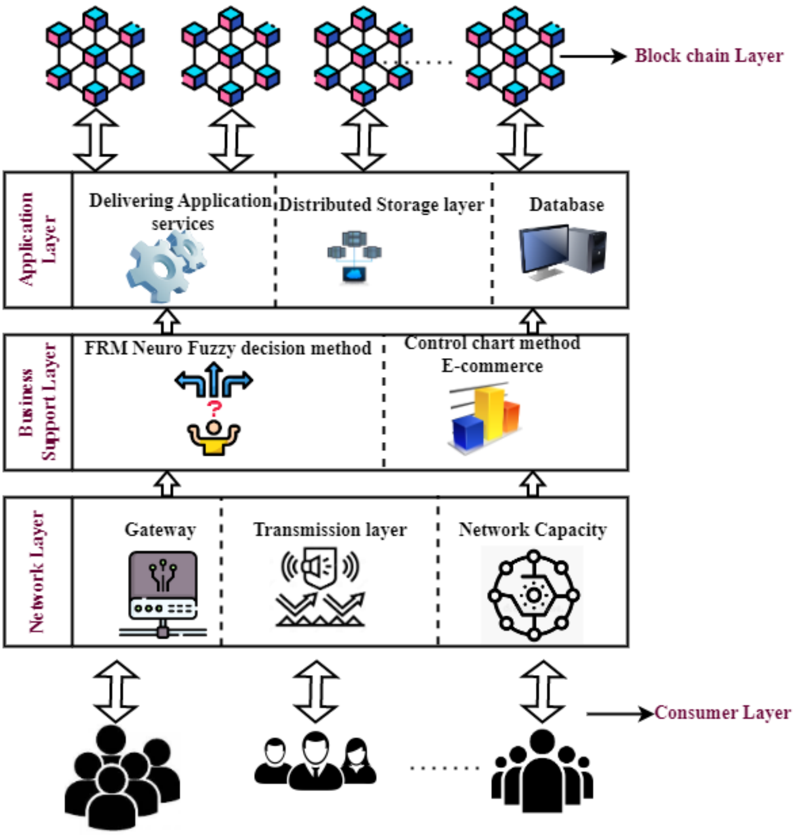
The core of the IoT reference model consists of the following layers: layers of abstraction (customer, network, business support, app, and blockchain). Moreover, it has security features and cross-layer administration capabilities in the E-commerce platform.

Consumer layer: The programs that consumers may interact with are known as the consumer layer. The Consumer Layer interfaces the Customer-Centric Architecture and its users. It allows a service-oriented architecture to handle information accessed and delivered independently by different clients over different channels.

Network layer: Networking and data transfer abilities fall under the network layer. Transmission infrastructure may provide functionalities for network connection management through a gateway. Data transport management and control information capacity are made available through the transmission capability, which connects IoT services and applications. The terminal has direct contact with the data support system.

Business support layer: The business support layer comprises standard and advanced features, such as the neuro-fuzzy decision and control chart methods. The support layer for the public network is equivalent to general support, whereas support for private networks within an industry is equivalent to specialised assistance.

Figure 2 IoT platform (see online version for colours)



Application layer: The application layer provides the distributed database, which stores all the information. It guarantees a program to communicate with others on various networked devices.

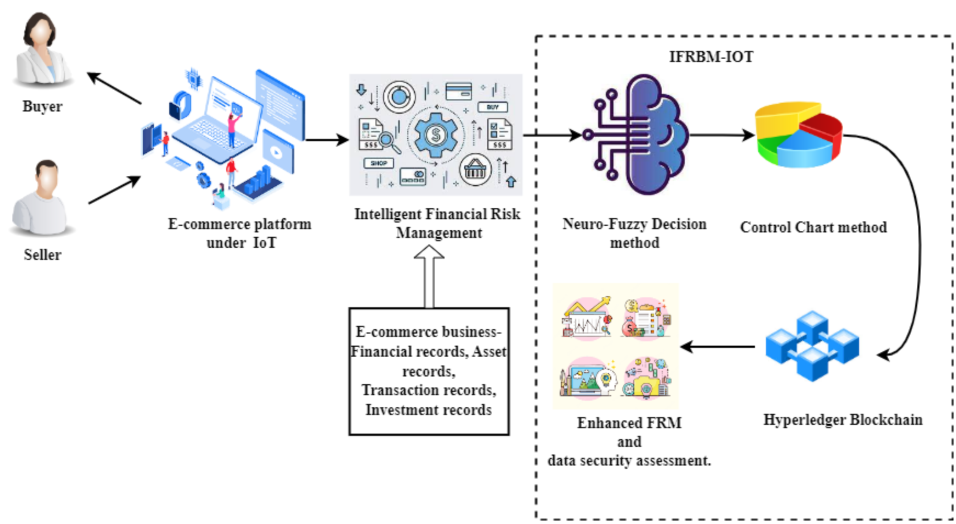
Blockchain layer: The blockchain layer is the organisation that interacts with the data-secure communications system through the gateway.

Although facing significant obstacles to making IoT a reality, it manages to run and build various applications and services. The IoT requires expertise in several fields, including pervasive computing, network connectivity, object detection, and specialised data processing. IoT design is chosen and implemented based on anomalies uncovered by extensive data analysis.

3.3 Structure of IFRBM-IoT based on E-commerce

Figure 3 illustrates the overall structure of intelligent FRM in online businesses under IoT. It is essential to consider the budgetary control of building a realistic e-commerce and IoT collaboration platform for efficient electronic business monitoring between seller and buyer. IoT is a global network of interconnected computing, electronic, and mobile devices that gather and share data in real-time. Allowing machines to communicate in real-time paves the way for authentic surveillance, tracking, and financial planning, which shortens the time required to transfer money and increases its overall efficiency. E-commerce businesses may benefit from real-time product monitoring and more efficient financial management with IoT's application to e-financial commerce's optimisation. Each financial sector node business may be immediately necessary thanks to the e-commerce interoperability and sharing platform's standardized, interoperable, seamless docking, incorporation, assessment, and sharing of inside and outside data. E-commerce enterprises can foresee future trends or the risk of accidents by analyzing and forecasting goods data across different stages in the supply chain, enabling executives to take precautionary actions or offer early warnings. This can significantly enhance the responsiveness of e-commerce businesses to the marketplace and the firm's management features.

Figure 3 E-commerce-based IFRBM-IoT structure (see online version for colours)



In intelligent finance, risk management sees potential threats, weighs the pros and cons of accepting them, and then decides to invest. Financial managers are responsible for protecting their companies against many types of risk, both quantitative and qualitative, by using a variety of financial instruments. The term 'financial risk' describes the potential for economic losses or gains for an entity due to many uncontrolled and unexpected events in various financial operations. A company's finances are constantly in motion as it goes about its business. There might be dangers in things like raising money, establishing long and short-term investments, and sharing earnings. Managing financial risk is an essential and often difficult task for businesses. Broad-based financial operations, a dynamic and long-term view, creating sensitive economic indicators and observing their changes, and monitoring and forecasting financial risks the organisation may or will encounter are the foundation of financial risk indicators. The suggested method places a premium on hybrid Neuro-fuzzy decision logic and chart method. Risks may need to be modelled accurately or thoroughly in project risk management. The available data and information must be more accurate, imprecise, and uncertain.

- The fuzzy decision logic method provides a more honest representation of the decision-making logic a non-expert investor might use in the actual market. The purchase and sale signals result from an indicator that uses general market information like efficiency and instability of asset values as input.
- The statistical process control subsystem module and surveys primarily use the control chart approach. It aids in avoiding faulty goods by establishing that quality performance is typical.
- The information is aggregated and given to the distributed blockchain approach, which is the primary source for managing the financial threats in E-commerce. Hyperledger is an open-sourced initiative designed to facilitate the growth of distributed ledgers based on the blockchain.

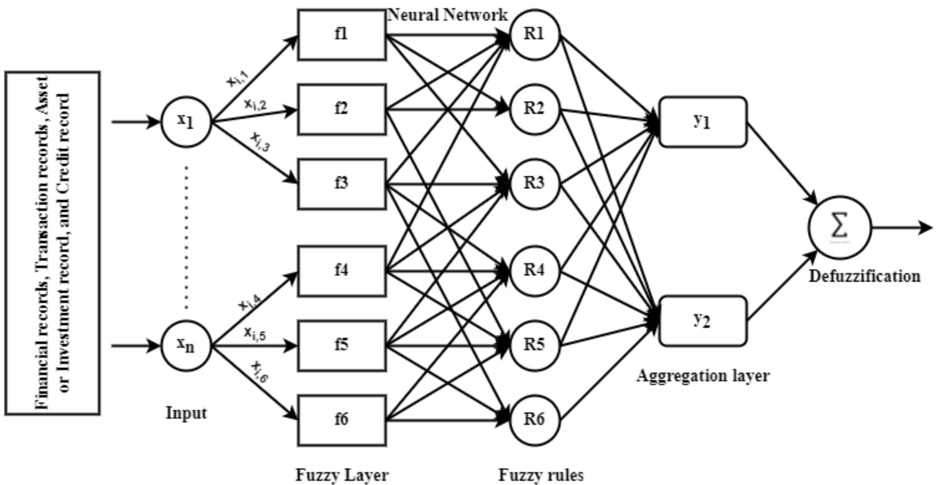
Hyperledger is a community-driven initiative developing a common blockchain app infrastructure. Membership to the Hyperledger system is limited to a select group of people established in advance. More and more nations are investing in distributed ledger blockchain development and research in the private sector in recent years. Since the next phase of E-commerce and IoT technology is being rolled out in different nations, the permissioned blockchain has emerged as a crucial competitiveness connection. The output of the IFRBM system is the enhanced FRM and practical data security assessment in the E-commerce platform.

3.4 Neuro-fuzzy decision system in E-commerce platform

Figure 4 depicts a simplified version of the Neuro-Fuzzy decision system put into place to classify hazards and financial risks based on historical and present data and to adapt to new ways of learning when required information is modified. The input of the neuro-fuzzy decision system includes financial records, transaction records, asset records, and credit records on which the decision system analyses all the factors is an effective risk management system that represents the four learning modalities that comprise the complete system. Input and output layers and three hidden levels representing classifiers and fuzzy rules include the system design shown in Figure 4. Neuro-fuzzy systems provide an umbrella for both fuzzy logic and ANNs. With a neuro-fuzzy decision system with partial or imprecise data, the capabilities of artificial neural networks, such as learning, adaptation, and generalisation, are astounding.

Fuzzy logic, on the other hand, offers approximative inference and lacks an automatic adjustment mechanism. The neuro-fuzzy approach combines fuzzy modelling and set-based learning to make adjustments in response to input. The membership modules' variables are chosen so that the neuro-fuzzy system represents the input-output pairings with the slightest inaccuracy. This approach to learning is analogous to neural networks acquiring knowledge. Algorithms are applied to a predetermined input/output dataset to build a system in which the parameters of the membership functions are determined. The modelled data then serves as the basis for the system's learning. In finance, risk management sees potential threats, weighs the pros and cons of embracing them, and then decides to invest. The phrase 'fuzzy inference' describes a group of single- or multi-criteria approaches to choose the best option when data is scarce or inaccurate. The business risk in various scenarios, including default risk, financial leverage, investment risk, overseas investment risk, equity risk, and currency fluctuations. In project risk management, the modelling process of hazards may need to be carried out adequately and precisely due to the nature of the relevant information and facts needing to be more accurate, ambiguous, inexact, and imprecise.

Figure 4 Neuro-fuzzy decision system



There are four stages in developing a neuro-fuzzy system.

Step 1: Establishing Standards (input layer). The selection factors ($x1...xn$) are specified at this stage. The criteria are defined using a Delphi-style poll and interview procedure with subject-matter experts. Next, neurons in the input layer are connected to those in layer 2 in three ways (fuzzification layer). First, values from the previous layer are translated into their translational fuzzy set equivalents in this layer.

Step 2: Establishing Neuro-Fuzzy Foundational Parameters. Defining the main rules is the most challenging component of creating the essential parameters of a fuzzy system. Each fuzzy system's management, including the fundamental laws of a neuro-fuzzy system, is defined in unique ways. Experts analyse the notoriously difficult records using the most common Delphi technique.

Step 3: The input-output pairs are the basis for a set of fuzzy rules, which can be generated using neural circuits' decision-making techniques. In a neuro-fuzzy system, the input parameters (X_i) are linked to the target value (Y) by a set of rules. The function of the input-output variables of the proposed model is given by equation (1)

$$f:\left(x_{1,}x_2\ldots x_n\right)-\rightarrow Y \tag{1}$$

Finding the input variables' weight coefficients in the neural network. The actual words are specified before establishing the connection weights of input variables. The neuro-fuzzy model in IFRBM-IoT excels in subjective risk evaluations such as creditworthiness and fraud detection. Using fuzzy logic, it handles uncertainties by evaluating incomplete, inaccurate, or confusing financial data. Since it employs fuzzy rules set by professionals, it cannot adapt to unanticipated market developments. Fuzzy models need a lot of adjusting to be accurate with high-dimensional data. The Zupac technique yields the source variable's weight coefficient (X_{iw}). After the coefficients of the fuzzy input variables' weights (X_{iw}) have been calculated, the classifiers of the input (X_i) and output (Y) variables may be classified as either continuous or discrete. The weight coefficients (W_{xi}) based on the fuzzy rules are calculated using equation (2):

$$\sum_{j=1}^{1} w_{xi} = x_{iw} \tag{2}$$

Input data weight coefficient distributions should be as realistic as feasible. It may be both smooth and bumpy. Producing a starting rule set with as many possible input-output permutations as possible. Equation (3) calculates the maximal number of constraints, dependent on the total number of attribute values.

$$R_n = \prod_{i=1}^{n} Q_{xi} \tag{3}$$

Rn represents the number of fuzzy rules that examine the financial data records to remove unknown weights, and Q_{xi} denotes the membership function of each variable.

Reducing the number of regulations (or unnecessary records) helps to enhance E-financial commerce's risk management. Each set of input parameters has a corresponding weighting factor of the output variable determined during rule development. The redundant rules are removed when two or more rules have the same or comparable membership values of the input/output parameters. The government is retained if its similarity measure has the most significant sum of weight coefficients represented in equation (4):

$$FR = \max\left(\sum w_{iFR}{}^{i}\right) \tag{4}$$

w_{iFR} denotes the weight coefficient of the output variable included in FR. While developing a neuro-fuzzy model, it is common practice to auto the rules that most accurately capture the connections between inputs and outputs.

Step 4: Neuro-fuzzy model training validation phase 4. At this step, verify the accuracy of the modelled system's judgements. If the results are subpar, the initial neuro-fuzzy decision settings are adjusted or reset, and the training procedure is started again from the beginning.

In the first stage, the impact of input parameters on output is examined, or it is checked to see whether the values of input variables result in irrational choice preferences. The research showed that the output variable did not suddenly and unexpectedly decline in response to relatively small changes in the input parameters. This stage involves comparing the trained network's output and the neuro-fuzzy decision model's output, both acquired by feeding the input data used to train the model into the model. With this method, the average deviation after training only includes minor discrepancies. Finally, experts apply the constructed model to the stated set of possibilities, and the outcomes are analysed for financial risks in the records.

3.5 Control chart method

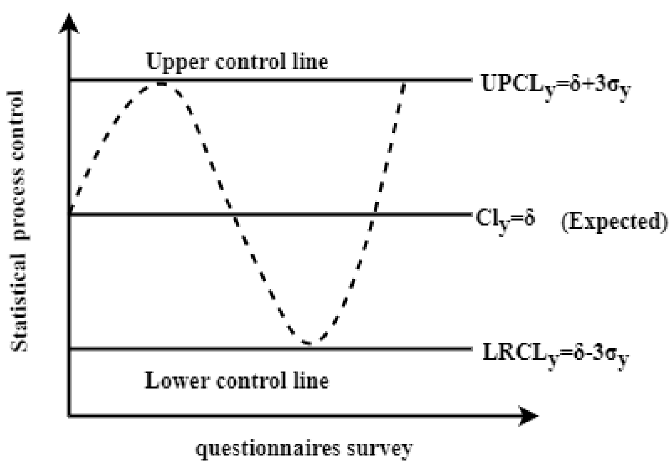
The statistical process oversight subsystems module extensively uses control charts and questionnaires. In addition to helping ensure that no faulty goods make it out of the distribution chain, it may confirm that the neuro-fuzzy decision control mechanism is operating as intended. Several variables cause unexpected and unusual variations in the procedure's quality. Figure 5 illustrates the control chart, which includes the upper, central, and lower control lines. When the range of variation is low, process quality is high, and vice versa. The financial management risks are minimised by using online surveys, which can poll more people in less time. Hence, this research employs online surveys, delivers them to residents, gathers their completed forms, discards those that do not conform to the original study specifications, combines and analyses the remaining legitimate data collected, and then derives a conclusion. Taking the weighted mean control limits as an example, below is the idea behind the chart's three control lines are calculated using mean and standard deviation is given in equations (5) and (6):

$$\mu = e(\delta) \tag{5}$$

$$\sigma = \frac{r}{D_2\sqrt{N}} \tag{6}$$

where δ is the variable data output, r is the average value across a set of values, D2 is the customary inquiry, and N is the number of mean value samples

Figure 5 Control chart method



Expressions illustrate the precise methodology used in the calculations. The study's findings are affected by variables, including the sample size, reliability and validity, and degree of variation is given in equation (7):

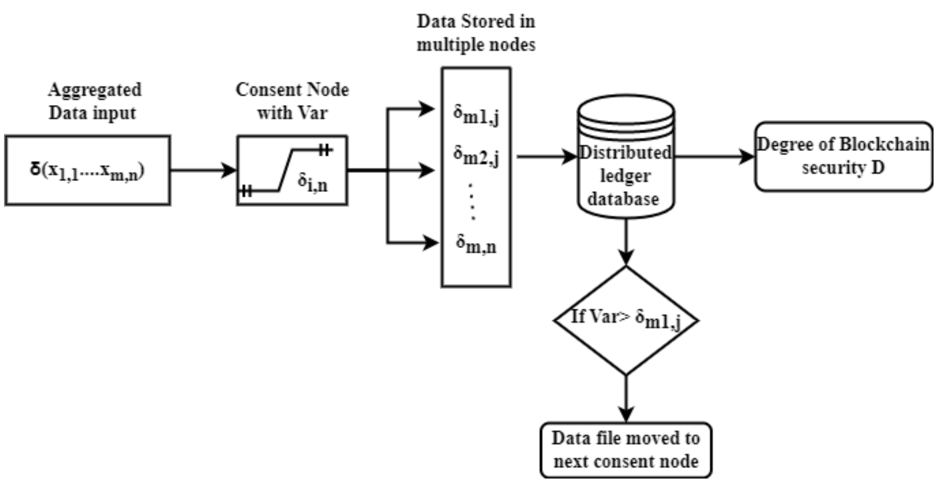
$$\delta = \frac{\alpha}{\beta} \tag{7}$$

α denotes the response rate, and β represents the variance degree. Risk perceptions among the general public, students, and professionals in various fields were studied by compiling survey data. The next step is to consult with veterans in the sector to examine pertinent KPIs and risk levels.

3.6 Hyperledger blockchain for security measures

The distributed nature of Hyperledger blockchains distinguishes them. In an ideal scenario, no one entity or collection of organisations could destroy the whole blockchain network. According to recent research, the expense may be utilised as a proxy for centralised blockchain networks. The operable unit count of each subsystem is summed, and the component with the lowest count is used as the system's dispersion index. When the value rises, so does the quantity of distribution. Timely equity and strategy investment, the development of intelligent contract expertise and skills in entrepreneurs and research institutions, the acceleration of the remodelling of blockchain norms, and the acquirement of the ability to speak and authority altitudes in the progress of the hyper ledger blockchain are all required to maintain its position as one of the most forward-thinking countries in the world and capitalise on the opportunity. The blockchain's development has been a line-by-line and parallel process from a single digital currency to the financial industries. Figure 6 depicts the hyper ledger blockchain data security, which improves the FRM in the E-commerce business.

Figure 6 Hyperledger blockchain in intelligent FRM system



First, the data input from the fuzzy decision and control chart is aggregated and represented as δ. A consent node information is stored in a common database throughout the decision cycle and is given in equation (8).

$$\delta = \begin{bmatrix} x_{1,1} & x_{1,n} \\ x_{2,1} & x_{2,n} \\ x_{m,1} & x_{m,n} \end{bmatrix} \tag{8}$$

The total amount of data files that should be recorded in the consent node of the consent node i is represented in equation (9)

$$\delta_{i,n} = x_{i,1} + x_{i,2} + \ldots + x_{i,n} \tag{9}$$

The total data files should be recorded in the consent node i of the blockchain technology. For risk management in E-commerce, it is possible to keep many copies of the data file on different nodes j to safeguard against data loss in the online platform, which is represented by equation (10)

$$\delta_{m,j} = x_{1,j} + x_{2,j} + \ldots . . x_{m,n} \tag{10}$$

The VaR of the consent node's (n_c) data file storage variance measures the dissimilarity between the quantity of data that each node stores. The bigger the VaR, the more data the consensus node stores differently than the other nodes. VaR may be expressed in equation (11)

$$varience = \frac{\sum \delta_{i,n} - \frac{x_{i,j}}{n_c}}{n_c - 1} \tag{11}$$

Consensus nodes in Hyperledger blockchains establish a blockchain system, which has allowed it to improve. This technique is superior when it comes to doing business online. This proposed system is more effective. Many users are involved in risk management, and financial risks must be managed. The system functions business efficiency, costs, and risk management capabilities of the E-commerce platform under IoT business have vastly increased.

Hyper-ledger Blockchain and quantum-resistant cryptographic approaches, including zero-knowledge proofs, hash-based signatures, and lattice-based encryption, reduce the influence of quantum computing in the IFRBM-IoT paradigm. Due to these advanced cryptographic methods, quantum computers cannot crack encryption and access financial risk data. Blockchain sharding and multi-signature verification may distribute security concerns. It's less vulnerable to quantum attacks since no one can access critical financial data.

Budgeting, financial management, costing, planning, resource allocation, and revenue generation are some core activities the FRM system supports. The organisation's financial management system has the following properties:

1 it can display the flows of cashflow

2 it can display the entity's economic means and liquid assets and contrast and compare them

3 it allows the enterprise's FRM personnel and financial reporting personnel to realise the evaluation and calculation of various data contained in the accounting system

4 it can provide a wide variety of banking services to the organisation.

APIs and middleware interfaces allow businesses to integrate IFRBM-IoT with their ERP systems to synchronise financial transactions, supply chain data, and risk management analytics. IoT devices provide real-time transaction analytics, while Hyperledger Blockchain smart contracts improve ERP financial processes. AI-driven predictive analytics modules in ERP dashboards can improve enterprise risk forecasting and compliance monitoring.

4 Results and discussion

The suggested technique employs a dataset from credit analysis risk (CRA) (https://www.kaggle.com/datasets/ranadeep/credit-risk-dataset) With 212,922 page views and 2786 downloads, it is quite popular. Customers' credit records at a certain bank are shown here. The plan is to identify potential loan defaulters in advance and assist financial institutions in taking preventative measures. This sets the stage for developing a reliable database. The first basic configuration of a database specifies that the data table must have a primary key, that there must be no duplicate entries, and that each field must be atomic, meaning that it cannot be further subdivided. The next standard version of the database is based on the previous normal form. The performance metrics calculated for the proposed work include financial risk analysis, Accuracy rate, performance rate, and error measurement of IFRBM-IoT.

IFRBM-IoT reduces network congestion and cloud dependence by optimising computing efficiency for localised data processing via edge computing. The Neuro-Fuzzy Decision System optimises resource allocation by screening and evaluating risk data before blockchain confirmation. Data compression approaches based on artificial intelligence and parallel processing simplify real-time risk assessments and ensure efficient processing of large amounts of data. Adaptive computing frameworks allow the model to dynamically alter processing capacity based on transaction volume, eliminating performance bottlenecks.

4.1 Financial risk distribution analysis

The primary analytical tool of Qualitative Risk Management is a financial Risk Distribution analysis is shown in Figure 7. The mathematical definition of risk is a Randomised Variable with an arbitrary posterior distribution. There are four phases to the risk evaluation method: hazard recognition, hazard description, sensitivity analysis, and risk evaluation. Experts and seasoned professionals in the financial sector first assess the potential danger posed by each preliminary indicator. Then aggregate all of these estimates into a comprehensive risk assessment. The risk score was analysed by multiplying the Risk Impact Rating by the Risk Probability. The quantifiable statistic allows essential decision-makers to make risk-related decisions quickly and confidently. The operational risk, credit risk, platform operation risk, financial risk, and reputation risk ratios in high-risk E-commerce, according to the experts and experienced financial industry professionals. The risk chances of these first-level indications are critical and must be avoided as effectively as possible to limit IoT financial risks.

4.2 Accuracy of the neuro-fuzzy decision system

Figure 8 shows the accuracy of the neural fuzzy approach, which executes activities in the E-commerce platform's FRM. The confusion matrix plays a vital role in calculating accuracy. IFRBM-IoT's oversupply of fraud detection false positives may create customer dissatisfaction, transaction bottlenecks, and financial losses from rejected genuine transactions. The model adjusts its fraud detection thresholds using adaptive machine learning to accommodate changing transaction patterns. Control chart analysis monitors mistake rates to re-calibrate fraud detection parameters in real time. High-risk transactions can use human-in-the-loop verification to reduce false positives and maintain security. The neuro-fuzzy systems combine the intelligence of ANNs with the flexibility of a fuzzy inference engine. In the first stage, the impact of financial risk-based input variables on output is analysed, or if the input parameters' values generate unreasonable choice preferences for efficient risk management is checked. The research showed that the output variable did not suddenly and unexpectedly decline in response to relatively small changes in the input parameters. The suggested model is compared to PSO-BP, SCFRA-FNN, FRM-BDM, and CB-ELS methods. It uses a neuro-fuzzy decision system to eliminate the hazards produced by other elements, hence lowering the financial risks. Figure 8 clearly shows that the suggested strategy had better performance in terms of accuracy.

Figure 7 Financial risk distribution analysis (see online version for colours)

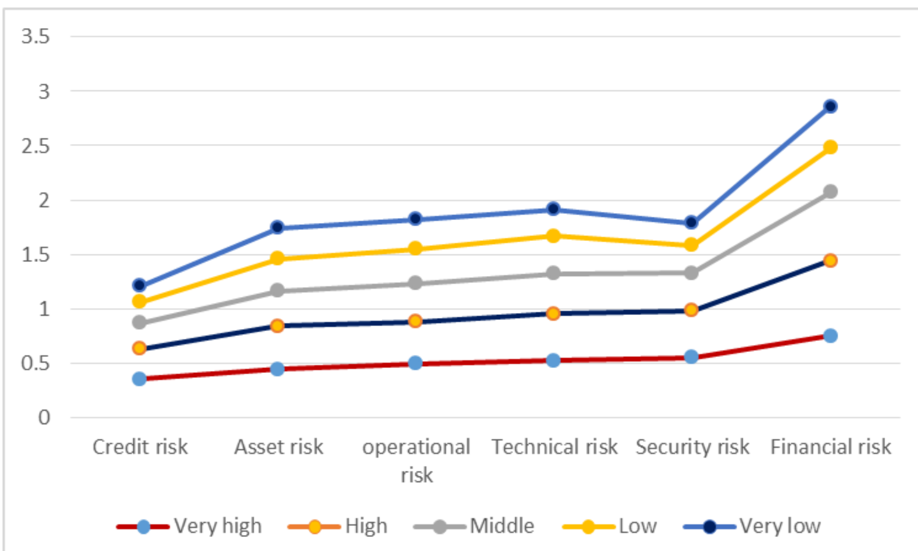
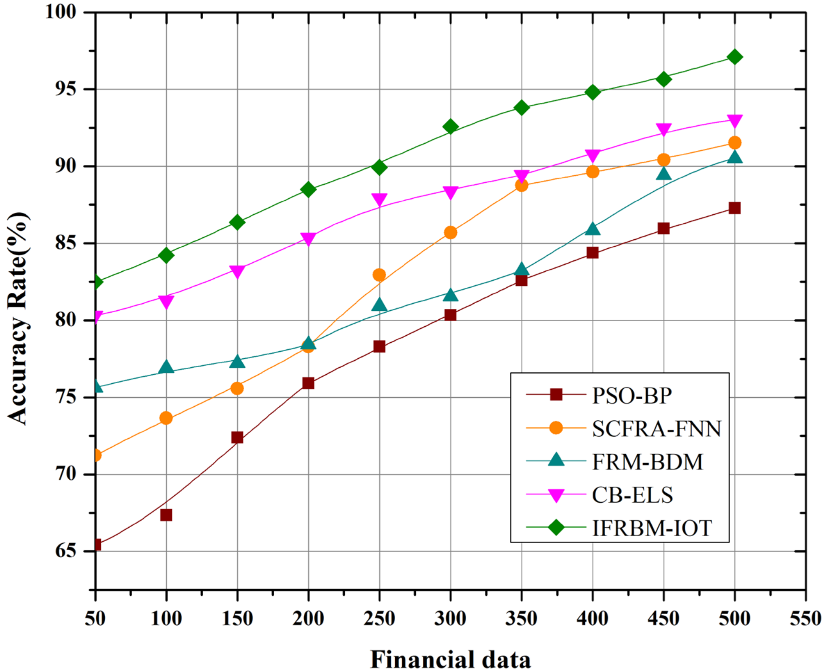


Figure 8 depicts how the Neuro-Fuzzy Decision System in IFRBM-IoT improves due to its adaptive learning, real-time financial risk classification, and blockchain connection to assure data integrity. The neuro-fuzzy system dynamically updates risk parameters using neural networks for pattern recognition and fuzzy logic for uncertainty management. This contrasts with static training dataset-based machine learning models. This combination strategy improves monetary risk assessment accuracy by reducing false positives and negatives. The IFRBM-IoT Neuro-Fuzzy model is more resilient and interpretable for e-commerce FRM than typical ANNs or SVMs, which have overfitting issues. Rule-based decision-making and real-time transaction monitoring yield 90%+ accuracy.

Figure 8 Accuracy of the neuro-fuzzy decision system (see online version for colours)



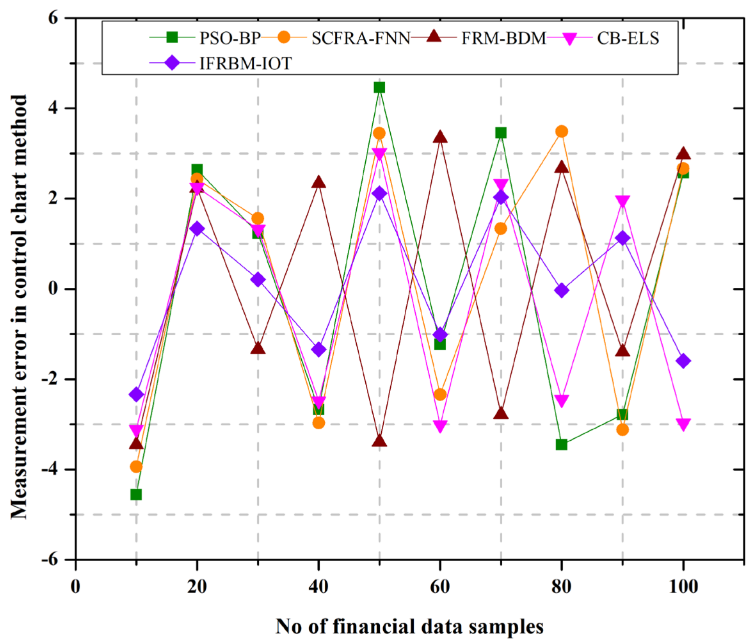
4.3 Measurement error rate in control chart method

Error quantification using a control chart is shown in Figure 9. The control chart used for risk assessment in electronic commerce might be negatively affected in two ways by measurement inaccuracy. If the error rate increases, the control limits will expand, making spotting signals in the charts harder. The measuring above error measures the variance in the product. There's a wide range of result quantities measured. There must be too much uncertainty in these measurements. A Type I mistake occurs when a process is assumed to be out of control when the control chart indicates otherwise. If a measurement of the process's output is beyond the chart's control limitations, the process may be out of control. The preceding approval criteria indicate that more than the variance is unacceptable. Acknowledgments, timeouts, and negative acknowledgments are a few basic error-control methods. Both single-bit and burst mistakes may occur in a network. One bit of data is changed when there is a single-bit mistake, whereas two or more bits are changed when there is a burst error. The error measurement is calculated for the different conventional methods on which error rate of the proposed has the lower error rate.

4.4 Hyperledger blockchain security performance ratio

The performance efficiency of blockchain security, which had a significant effect on the FRM, is shown in Figure 10. Hyperledger blockchain outperforms other e-commerce platforms in performance modelling due to its increased transaction throughput and stringent financial data protection features enabled by the IoT. Hyperledger blockchain is a public implementation of a distributed ledger platform with a modular design for the execution of smart contracts. Hyperledger Fabric, a cutting-edge permissioned blockchain architecture, can boost transaction throughput from 3000 to 20,000 per second. Distributed blockchain technology can scale to accommodate various use cases in industries, including risk management and business. To calculate the latency and throughput of the system for a given arrival rate, this model breaks down the transaction flow into its constituent parts. In addition, a mathematical configuration selection technique is presented for finding the optimal setup to boost productivity. Substantial experiments are carried out on a real-time system to verify the accuracy of the suggested model and methods. The performance ratio of the permissioned blockchain technology had a higher performance ratio.

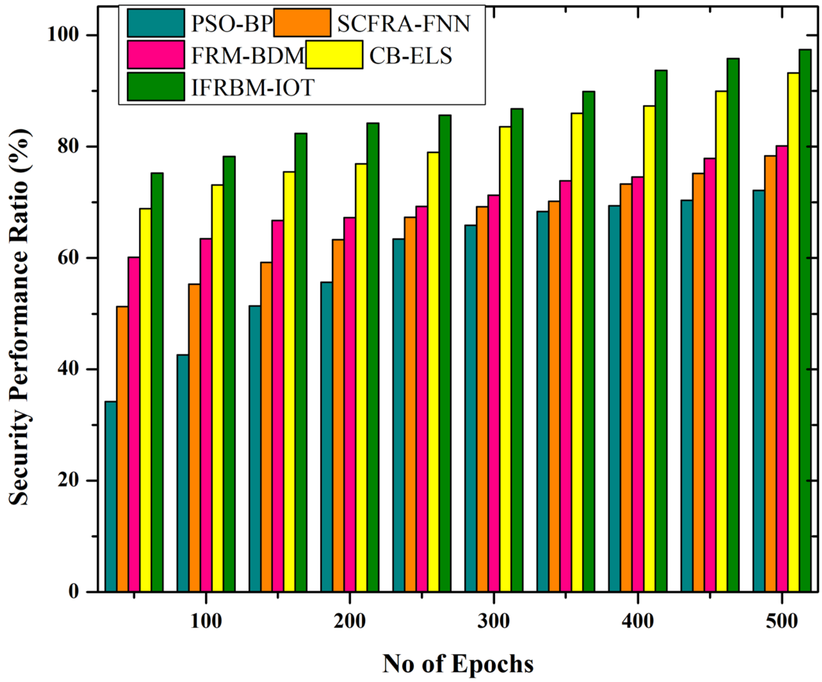
Figure 9 Measurement error rate in control chart method (see online version for colours)



When implementing IFRBM-IoT, a big e-commerce company could anticipate spending millions on hardware (IoT devices, edge servers, and blockchain nodes) and another million on software integration, AI model training, and blockchain maintenance annually. Infrastructure needs may affect this estimate. Operational costs include cybersecurity, audits, cloud and edge computing, and compliance checks. Despite the high initial cost, less fraud, improved risk management, and increased financial security can yield a good return on investment.

The primary scaling hurdles are integration difficulties with current e-commerce infrastructures, high computing needs for neuro-fuzzy processing, and constraints on blockchain transaction throughput. Consensus mechanisms in blockchain reduce transaction speeds while monitoring risks in real-time through the IoT necessitates heavy computational resources on the cloud and at the edge. Further complicating large-scale implementation is ensuring compliance across several foreign regulatory regimes.

Figure 10 Hyperledger blockchain security performance ratio (see online version for colours)



4.5 Discussion

E-commerce and the IoT bring human civilisation to a new level of sophistication. The benefits to productivity and ease of living are extraordinary. This is the current fad that might perhaps go further. IoT is often regarded as one of the most significant big data sources of the massive amounts of sensory data it generates daily from connected devices. However, internet banking has numerous flaws and defects because of the insufficient risk prevention management platform, a lack of professional skills, and the insufficiency of essential laws and regulations. IoT has had a profound effect on the growth of online banking. Although there have been many positive outcomes from using internet information technology, there have also been some negative ones. Intelligence technology development has offered people enormous possibilities and difficulties and has infiltrated numerous industries, notably internet finance. Consequently, the study integrates the foundation of the IoT with the Neuro-fuzzy decision-making approach to investigate the topic of online FRM; this is of excellent period significance and research worth.

IFRBM-IoT oversees international financial transactions by monitoring real-time currency exchange rates through its Neuro-Fuzzy Decision System for adaptive risk assessment. Blockchain smart contracts facilitate currency conversion at optimal rates while ensuring compliance with international financial regulations. Thanks to edge computing, the system can dynamically consider local economic conditions, inflation patterns, and transaction risks for localised financial assessments. Thus, international financial transactions will be secure, cost-effective, and independent of currency fluctuations. As a result, an overview of the IoT standard model is presented.

The IFRBM-IoT concept automates financial transactions, enforces loan agreements, and controls liquidity risks via DeFi protocols. It uses Hyperledger Blockchain smart contracts. The Neuro-Fuzzy Decision System monitors DeFi transaction patterns for fraud, flash loan attacks, and anomalous trading patterns. Real-time data analytics enabled by the IoT can help e-commerce enterprises foresee hazards in decentralised markets. This makes financial activities transparent and reduces susceptibility to unexpected lending pools and decentralised exchange instability.

5 Conclusion

The finance division of an e-commerce website handles all financial risks. An essential aspect of the FRM system for IoT entrepreneurs is the financial management system, which provides a consolidated view of the organisation's business health and the most effective channel for monitoring the national financial system's rollout. The IoT is driving rapid progress in the information industry. As e-commerce grows, enterprise FRM solutions will become the standard. Standardising internal quality assurance processes and providing companies with the tools to accomplish optimal security and quality assurance are two key benefits of an organisational FRM system focusing on customer satisfaction. The paper proposed an e-commerce platform-based intelligent financial risk blockchain management (IFRBM-IoT) system. Integrating Hyper ledger blockchain technology and the Neuro-fuzzy decision method into an e-commerce platform's FRM system, the framework facilitates in-depth analysis of financial risk evaluation, and promises increased data credibility, accountability, confidentiality, and integrity. The results of the empirical data analysis show that the model is effective at assessing data and has an excellent symmetric fit for dealing with financial risks inherent to an online company strategy. Financial risk analysis, accuracy rate, performance rate, and error measurement of IFRBM-IoT are some performance metrics generated for the proposed work. The technique helps control financial risks and evaluate the efficacy of data security measures. The corporate financial risk control information management system and the ideas discussed in this paper need to be further developed and polished in the future.

Conflicts of interest

The authors declare no conflict of interest.

References

Abba, Z.Y.I., Balta-Ozkan, N. and Hart, P. (2022) 'A holistic risk management framework for renewable energy investments', *Renewable and Sustainable Energy Reviews*, Vol. 160, p.112305.

Chen, Y., Zheng, W., Li, W. and Huang, Y. (2021) 'Large group activity security risk assessment and early risk warning based on random forest algorithm', *Pattern Recognition Letters*, Vol. 144, pp.1–5.

Chiang, C-H., Chen, L-B., Kuo, S-Y., Chen, T-Y. and Chen, X-C. (2022) 'Risk management in cross-border E-commerce by AIoT technology', *2022 IEEE International Conference on Consumer Electronics-Taiwan*, IEEE, Taipei, Taiwan, pp.317–318.

Dashottar, S. and Srivastava, V. (2021) 'Corporate banking–risk management, regulatory and reporting framework in India: a blockchain application-based approach', *Journal of Banking Regulation*, Vol. 22, pp.39–51.

Hameed, W.U., Waseem, M., Sabir, S.A. and Dahri, A.S. (2020) 'Effect of enterprise risk management system and implementation problem on financial performance: an empirical evidence from Malaysian listed firms', *Abasyn Journal of Social Sciences*, Vol. 12, No 1, pp.12–24.

Jin, G., Meng, Q. and Feng, W. (2022) 'Optimization of logistics system with fuzzy FMEA-AHP methodology', *Processes*, Vol. 10, No. 10, p.1973.

Landi, G.C., Iandolo, F., Renzi, A. and Rey, A. (2022) 'Embedding sustainability in risk management: the impact of environmental, social, and governance ratings on corporate financial risk', *Corporate Social Responsibility and Environmental Management*, Vol. 29, No. 4, pp.1096–1107.

Li, X., Wang, J. and Yang, C. (2022) 'Risk prediction in the financial management of listed companies based on optimized BP neural network under digital economy', *Neural Computing and Applications*, Vol. 35, No. 3, pp.2045–2058.

Lu, H., Liu, X. and Falkenberg, L. (2022) 'Investigating the impact of corporate social responsibility (CSR) on risk management practices', *Business and Society*, Vol. 61, No. 2, pp.496–534.

Luo, Q., Liao, R., Li, J., Ye, X. and Chen, S. (2022) 'Blockchain-enabled credibility applications: extant issues, frameworks, and cases', *IEEE Access*, Vol. 10, pp.45759–45771.

Mahmood, N.S. and Ahmed, E.M. (2022) 'Mediating effect of risk management practices in Iraqi private banks financial performance', *Journal of Financial Services Marketing*, Vol. 28, No. 2, pp.358–377.

Naim, A. (2022) 'Role of artificial intelligence in business risk management', *American Journal of Business Management*, *Economics and Banking*, Vol. 1, pp.55–66.

Odigbo, J.A., Abdulmalik, A.Y. and Shuaibu, H. (2022) 'Effect of enterprise risk management on financial performance of deposit money banks', *Sapientia Global Journal of Arts*, *Humanities and Development Studies*, Vol. 5, No. 2, pp.179–191.

Qiu, W. (2021) 'Enterprise financial risk management platform based on 5G mobile communication and embedded system', *Microprocessors and Microsystems*, Vol. 80, p.103594.

Qu, Q., Liu, C. and Bao, X. (2021) 'E-commerce enterprise supply chain financing risk assessment based on linked data mining and edge computing', *Mobile Information Systems*, pp.1–9.

Rahmati, S., Mahdavi, M.H., Ghoushchi, S.J., Tomaskova, H. and Haseli, G. (2022) 'Assessment and prioritize risk factors of financial measurement of a management control system for production companies using a hybrid Z-SWARA and Z-WASPAS with FMEA method: a meta-analysis', *Mathematics*, Vol. 10, No. 2, p.253.

Shahbazi, Z. and Byun, Y-C. (2022) 'Machine learning-based analysis of cryptocurrency market financial risk management', *IEEE Access*, Vol. 10, pp.37848–37856.

Song, Y., Du, H., Piao, T. and Shi, H. (2024) 'Research on financial risk intelligent monitoring and early warning model based on LSTM, transformer, and deep learning', *Journal of Organizational and End User Computing*, Vol. 36, No. 1, pp.1–24.

Sun, P. and Gu, L. (2021) 'Optimization of cross-border e-commerce logistics supervision system based on internet of things technology', *Complexity*, Vol. 2021, No. 1, pp.1–11.

Wang, L. and Wang, Y. (2022) 'Supply chain financial service management system based on blockchain IoT data sharing and edge computing', *Alexandria Engineering Journal*, Vol. 61, No. 1, pp.147–158.

Wang, Y. (2021) 'Research on supply chain financial risk assessment based on blockchain and fuzzy neural networks', *Wireless Communications and Mobile Computing*, Vol. 2021, No. 1, pp.1–8.

Yue, H., Liao, H., Li, D. and Chen, L. (2021) 'Enterprise financial risk management using information fusion technology and big data mining', *Wireless Communications and Mobile Computing*, Vol. 2021, No. 1, pp.1–13.

Zhang, Y., Jiang, Z., Peng, C., Zhu, X. and Wang, G. (2024) 'Management analysis method of multivariate time series anomaly detection in financial risk assessment', *Journal of Organizational and End User Computing*, Vol. 36, No. 1, pp.1–19.

Zhao, X., Wang, W., Liu, G. and Vakharia, V. (2024) 'Optimizing financial risk models in digital transformation-deep learning for enterprise management decision systems', *Journal of Organizational and End User Computing*, Vol. 36, No. 1, pp.1–19.

Zhou, H., Sun, G., Fu, S., Liu, J., Zhou, X. and Zhou, J. (2019) 'A big data mining approach of PSO-based BP neural network for financial risk management with IoT', *IEEE Access*, Vol. 7, pp.154035–154043.

Zhu, Z. and Liu, N. (2021) 'Early warning of financial risk based on K-means clustering algorithm', *Complexity*, Vol. 2021, No. 1, pp.1–12.

Website

https://www.kaggle.com/datasets/ranadeep/credit-risk-dataset