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BLOCKCHAIN-INTEGRATED ERP PLATFORMS FOR ENSURING SECURITY IN U.S. FINANCIAL SUPPLY CHAINS

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Abstract

To enhance the process to be more efficient and faster in decision-making, Enterprise Resource Planning (ERP) systems have become widely used in financial and pharmaceutical supply chain in the United States. However, the traditional ERP systems continue to face a high risk of data manipulation, fraud, and counterfeit, which is threatening the integrity of the organizations and the economic stability of the countries. The present study addresses this gap by proposing a blockchain-integrated ERP security framework tailored to the financial supply chains in the U.S. The objective of the study is to test and analyses the existing weaknesses of the ERP, investigate the possibilities of applying blockchain as a security-enhancing layer, and develop a hybrid protocol that will ensure authenticity, traceability and resistance to fraud in financial transactions.

The basis of this paper is a mixed-method design, which will combine survey data of both IT and compliance managers in both the banking and pharmaceutical industries with a design science approach to generate and test the proposed framework. The proposed methodology is to locate key vulnerabilities in ERP, develop blockchain-supported protocols of data integrity and authentication, and test the datasets of ERP transactions to approximate the fraud detection and security performance rates.

The findings suggest that the adoption of blockchain can significantly reduce the possibility of unauthorized manipulation with data, enhance transparency in all operations carried out during transactions, and have audit trails that cannot be changed. The results of the simulation show that the accuracy of fraud detection and verification is higher with the traditional ERP models than with the simulation model. The proposed framework has theoretical and practical implications, as it added to the existing literature on blockchain-security, and also provided a potential path in the future of ensuring key financial infrastructures have been secured. The study has also given policy implications to the regulators on the compliance and data security of the U.S. financial supply chains.

Keywords: Blockchain, ERP Integration, Financial Supply Chain Security, Data Integrity, Fraud Prevention

Introduction

The greater dynamism of the financial supply chains in the United States has escalated the need for security, transparency, and efficiency among systems which operate through the network. With the growing globalization and digitization of the financial industry, organizations are facing increasing pressures to preserve the integrity of transactions, to preserve the sensitivity of the information, and to ensure the resilience

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of enterprise processes (Choain et al., 2023). Conventional enterprise resource planning (ERP) systems have also been in use since long ago as being a support of business activities and enable enterprises to manage finance, logistics, procurement, and human resources in a digital environment that cannot be divorced (Dalal, 2017). However, traditional model ERP systems are being criticized due to their inability to withstand a cyber attack, fraud, and manipulation of data despite their widespread use. These limitations lead to loopholes in financial supply chains, which can destabilize business continuity, negatively affect stakeholder confidence, and deteriorate the security of the national economy (Percherla, 2022).

Blockchain technology has emerged as a transformative solution to address these weaknesses. Previously viewed as the foundation of the cryptocurrency market, blockchain has nowadays been modified to be a versatile technology with applications in many sectors, especially those that require a high degree of trust, transparency, and immutability. In its most basic form, blockchain is a distributed register system that stores transaction in a verifiable, secure, and resistant to tampering (Kitsantas, 2022). All data blocks are cryptographically connected to the last one in order, so that the whole chain becomes irreversible after being confirmed by consensus. This architecture will go a long way in minimizing the potential risk of fraud, unauthorized modifications, and data breach across the system. The potential to implement blockchain into ERP systems is the perspective of promoting the financial supply chains of the U.S. in terms of their security and efficiency, as the large volume of sensitive transactions and data exchange is held on a daily basis (Asif, 2022; Gohil & Thakker, 2021).

Financial supply chain in the United States can be characterized by a vast number of stakeholders, such as banks, regulators, suppliers, manufacturers, and logistics providers, who need to organize activities relying on the access to timely and correct data (Rijanto, 2021). However, this interconnection opens possibilities to hackers and other malicious entities to take advantage of vulnerabilities within a system. Traditional ERP systems are typically strong in the management of operations, but prone to central databases which are vulnerable to hacking, insider threats as well as single points of failures. Conversely, blockchain makes the management of data decentralized, with records stored in several nodes which must all confirm any modification. Such a decentralization does not only promote resilience against cyberattacks, but also improves the rates of transparency and traceability, which is becoming more and more important in the activities of financial transactions.

Integrating blockchain with ERP systems comes with immense benefits to the U.S. financial supply chains. First, the immutability of blockchain records enhances the reliability of financial data, reducing the chances of fraudulent reporting or manipulation. Second, distributed ledgers offer transparency that is essential in the field of real-time auditing and monitoring the compliance with the requirements of strict financial regulations in the U.S. (Hellani et al., 2021). Third, smart contracts backed by blockchains ensure the automatic supply chain performance of specific functions predetermined by the conditions that do not require human intervention, eliminating errors, delays, and possible human factor interference. Collectively, these characteristics encourage the building of trust between supply chain members, enhance risk controls, and simplify business in an industry that is subjected to unrelenting efficiency and reliability demands.

Secure financial supply chains are not limited to organizational interests, but also to national and economic security and stability. The American financial system supports the worldwide trade, and problems in its supply chain can have an impact throughout the world making the markets shaky and the investors losing faith in the system (Aslam et al., 2022). The past years have seen the number of cyberattacks on financial institutions increase in the form of data breaches, ransomware attacks, and advanced phishing threats. Furthermore, the threat of insiders and fraudulent activities in organizations remains an issue of concern. These difficulties bring forth the immediate necessity of developing new technologies capable of protecting sensitive financial processes of negativism of external and internal factors (Bapatla et al., 2022). The introduction of blockchain-based ERP systems is a relevant and timely solution to this increased threat environment.

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Although it promises a lot, the implementation of blockchain in ERP systems in financial supply chains is not free of problems. The issues such as scalability, regulatory requirements, and interoperability with the existing systems, and the cost of implementation must be phased out before its mass-adoption. Additionally financial supply chains that involve many stakeholders, with different technological capabilities necessitate solutions that are flexible, user-friendly and can be inter-integrated with the current infrastructures (Tiwari, 2020). Nevertheless, several things are pointing to the fact that blockchain ERP systems are a possibility, and that they potentially can change the practice of supply chain security.

Financial supply chain Blockchain-ERP integration of financial supply chains in the U.S. is also a subset of broader trends in digital transformation and Industry 4.0. Organizations are investing massive amounts of money in new technologies such as artificial intelligence, big data analytics, and cloud computing to gain competitive advantage and respond to evolving customer expectations (Liao & Wang, 2018). The counterpart of such innovations is blockchain, it offers a layer of trust, data integrity, and verifiability which is not available in the traditional systems (Asif & Shaheen, 2022). The integration of the technologies will assist in offering a more secure, agile and efficient financial ecosystem, which will enable U.S. organizations to remain on the leading edge of the worldwide market.

Another option that makes the blockchain-based ERP system topical is regulatory compliance. The agencies have a close supervision on the U.S. financial institutions which impose heavy requirements on transparency, accountability and security of their data. Blockchain offers compliance techniques that facilitate conducting compliance since it offers documentation of transactions that cannot be changed and enables real-time auditing (Choain et al., 2023). ERP integration makes sure that such features do not exist in isolation but are incorporated in the daily financial operations to reduce the administrative burden of compliance and to maximize the governance of organizations (Aurangzeb et al., 2021; Khan & Alvi, 2023).

The efficiency of operations in the financial supply chains can also be enhanced by the integration of blockchain besides the element of security. Automated account reconciliation, instant visibility of financial flows, and information exchange between partners are safely used to reduce delays and administrative costs. Such innovations can lead to the increase in competitiveness of U.S. companies because they will be able to make the decision-making process faster, reduce the transaction costs, and improve customer satisfaction (Asif et al., 2019). It is important to note that the more organizations create strong and clear supply chain networks, the more resilient they can become to sudden disruptions, whether due to cyberattacks, natural disasters, or fluctuations in the market.

Lastly, blockchain and ERP systems combine with each other to offer a paradigm shift in the way the financial supply chains in the United States are run and protected. ERP systems based on blockchain provide a more robust and efficient financial operation by addressing the previous problems related to data integrity, transparency, and trust. Even though the barriers to adoption are really high, the benefits that may be achieved are so enormous to warrant the close attention and the further research done by the leaders in the industry, policymakers, and scientists. As the financial supply chains keep transforming in their magnitude and complexity, the transition to blockchain-based ERP systems may turn into not only one of the strategic advantages, but also an essential precautionary measure when it comes to the safety and stability of financial system of the U.S.

Literature Review

ERP Vulnerabilities in Financial and Pharmaceutical Supply Chains

Enterprise resource planning (ERP) systems have emerged as a significant enterprise infrastructure that controls the running of businesses in any industry. ERP systems are involved in the procedures of transaction flow, compliance history, procurement cycle and inventory in the financial sector, and pharmaceutical sector (Kabir et al., 2021). Despite these strengths, ERP systems do not come in as secure. Centralized architectures expose them to manipulation and unauthorized access of transaction records and data tampering. The risks are compounded by insider threats, ineffective authentication mechanisms, and inadequate audit trails. Financial sector ERP systems possess vulnerabilities which enable banking institutions

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to be susceptible to fraudulent access, falsification and violating compliance regulations thus eroding investor trust and regulatory confidence. The existence of the counterfeit products in the pharmaceutical industry chain of supply is the point where ERP lacks the measures of authentication and traceability (Lohmer et al., 2022a). Such flaws are not only leading to financial losses, but also health hazards.

One of the largest shortcomings of ERP currently provided by the platforms is the absence of assurance of data immutability. The traditional database structures allow the records to be overwritten or updated without having a fix of disclosures that are permanent. Even though cybersecurity systems such as firewalls and intrusion detection systems are meant to mitigate the threats, they do not completely prevent sophisticated attacks and internal manipulations. The limitations indicate the desperate need to augment ERP systems with technologies that have the potential of ensuring integrity of data that cannot be altered alongside end-of-line traceability.

Blockchain Applications in Supply Chains

The blockchain technology has gained global recognition as a decentralized ledger system capable of making it impossible to edit, implement transparency, and spread the trust spread. This could be particularly relevant in the supply chains since the stakeholders will be able to trace the origin of the products, history of their dealings and avoid fraud in this scenario (Asif & Gill, 2022). Blockchain is used to eliminate the chance of undetected changes using cryptographic connections among all the operations in an unchangeable block. These alternative addresses one of the greatest weaknesses of the ERP systems the lack of permanent tamper-resistant records.

Blockchain can improve the security of financial supply chains, allowing the transparent and verifiable logs of transactions. Blockchain can help banks and other financial institutions to minimize fraud, enhance the authenticity of cross-border transactions, and make sure that they comply with regulatory requirements. Blockchain can be used to authenticate products in the pharmaceutical supply chain and avoid the infiltration of counterfeits into the market (Hasan et al., 2022). A trusted ecosystem is created by the capability to follow a pharmaceutical product through the manufacturer to the patient, with authenticity being proven at each stage. Such characteristics make the blockchain a good candidate to provide the ERP systems with similar guarantees that are currently absent.

Capacity of blockchain to be automated by use of smart contracts further enhances its application. The Smart contracts automatically run pre-inculcated conditions, which minimize chances of manipulations. This feature is in line with compliance standards in the banking and healthcare sectors where automated checking and reporting may decrease the occurrence of human error and deliberate fraud.

Integration Studies of Blockchain and ERP

Blockchain integration with ERP systems is a new field of study and practice. Early research shows that blockchain can be used to complement ERP through increasing data integrity, decentralization of trust, and safe audit trails. But the majority of current explorations are still theoretical or pilot projects in production and supply chain management. Although financial and pharmaceutical supply chains are one of the most vulnerable fields, they are yet to be thoroughly investigated in this context (Al-Amin et al., 2022).

The studies on the integration of blockchain in ERP indicate that blockchain can be utilized as a secure layer in which ERP transactions are registered and validated. The two-layered solution integrates process automation of ERP and immutability of blockchain (Lohmer et al., 2022a). Although ERP is the technology that manages business processes, including procurement and payment, blockchain makes sure that all of the entries are immutable and can be validated by various stakeholders. By so integrating, fraud can be minimized, disputes reduced and enhanced accountability.

Nevertheless, challenges persist. It has scalability issues, integration issues and the technical expertise is necessary to mitigate its implementation. The pace of processing using the public blockchain may not be applicable in the ERP requirements of real-time processing. In addition, the determination of blockchain protocols based on the existing ERP models should be customized mechanisms that would take into account

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regulatory and organizational constraints. Such concerns explain why there is a need to establish special frameworks that are unique to high-risk industries like banking and pharmaceuticals.

Regulatory Context and Compliance Considerations

Any technological development of pharmaceutical and financial supply chains in the United States will be forced to conform to stringent regulatory mechanisms. Sarbanes-Oxley act and the Gramm-leach-Bliley act are the banking industry regulations that mandate appropriate reporting, protection of consumer data and finance operations (Dalal, 2017). Without compliance, there is legal penalty as well as a dented reputation. The regulations of the Food and Drug Administration in the pharmaceutical industry, and the drug supply chain security act require stringent measures in monitoring and checking of products throughout the supply chain. These requirements cannot be met consistently by the current ERP systems because they are subject to manipulation, and have low traceability (Kitsantas, 2022).

Integration with blockchains represents the road to regulatory compliance due to the immutable and transparent records of data. The fact that one can track each activity in financial transactions or pharmaceutical supply flows is in direct line with compliance objectives. Blockchain-powered ERP systems can minimize administrative load of audits and guarantee the uniformity of regulations compliance (Hader et al., 2021). Also, blockchain is decentralized and thus spreads the trust among various stakeholders and lowers the dependency on a single authority and enhances accountability.

But there are also regulatory issues which are a barrier. Legal acceptance of blockchain-recorded records, issues of data privacy, and cross-sector adaptability are still uncertain in numerous states. Regulatory adoption of blockchain as a reliable source of truth will be essential in the successful implementation of blockchain by the U.S. financial and pharmaceutical supply chains with ERP. The technology should be adopted with policies and frameworks that would ensure that blockchain enabled ERP solutions do not only enhance the security but also within the legal framework.

Synthesis of Literature Gaps

The literature review indicates that there is a noticeable advancement of knowledge: ERP systems are essential but susceptible, blockchain has special opportunities to be secure and traceable, and preliminary integration research reveals opportunities but is immature in high-risk sectors (Esan et al., 2022). The regulatory environment further makes the implementation of blockchain-ERP solutions more challenging, but it also offers incentive to compliance-driven innovation.

In spite of the accumulating research, there are still numerous gaps. There are limited studies that explicitly tackle the concept of blockchain integration into ERP in regard to financial and pharmaceutical supply chains. Most of the research has been on blockchain and its application in supply chain visibility, and not as an ERP-specific security addition. Furthermore, blockchain-ERP models are not tested empirically, and not many have been deployed to real-world contexts or subjected to high-fidelity simulation. The existence of these gaps reveals the need of comprehensive research that develops, tests, and confirms blockchain-based ERP protocols that are industry-specific and the integrity and authenticity of data in which data cannot be compromised.

Objectives of the Study

- To identify and analyse the key vulnerabilities in existing ERP systems within U.S. financial and pharmaceutical supply chains, with a focus on risks related to data manipulation, insider fraud, and counterfeit infiltration.
- To design a blockchain-integrated ERP framework that enhances data immutability, auditability, and transparency while ensuring compliance with U.S. regulatory requirements.
- To evaluate the effectiveness of the proposed framework through simulation-based analysis and expert validation, measuring improvements in fraud reduction, compliance accuracy, and supply chain security.
- To assess the broader organizational and policy implications of blockchain-ERP integration, including its potential to strengthen national economic security and guide regulatory adaptation.

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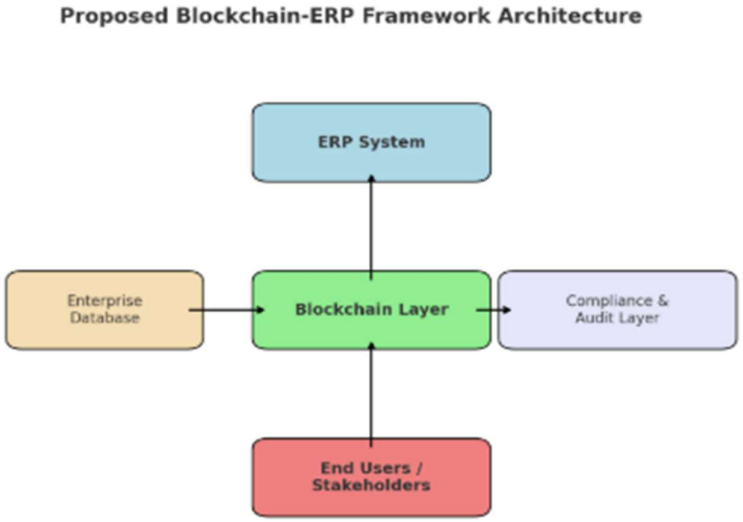
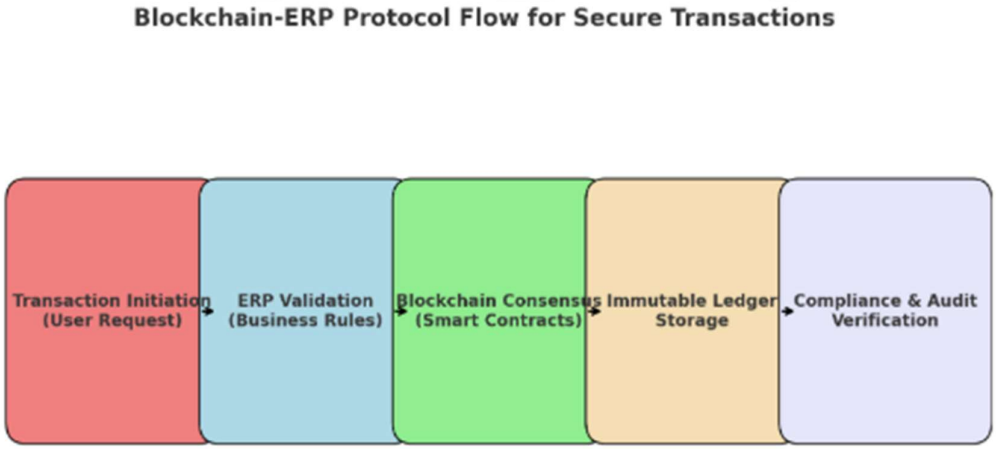
Proposed Blockchain-ERP Framework architecture diagram
Figure 1
Proposed Blockchain ERP Framework



This diagram illustrates a modern ERP framework enhanced by blockchain technology. The center is a traditional ERP System, which is connected with a Blockchain Layer to ensure the immutable and transparent record-keeping of transactions and data exchanges. This is supported by an exclusive Compliance & Audit Layer which can automatically provide any assurance that all activities are within the regulatory guidelines. The whole system is held together by the central Enterprise Database which stores the operational data of the business. Eventually, this integrated architecture is aimed to be in service to the End Users and Stakeholders, offering them a safer, more verifiable and more trustworthy system, enhancing data integrity, simplifying the auditing process, and foster confident in the company's processes and records.

Blockchain-ERP Protocol Flow for Secure Transcations
Figure 2
Blockchain ERP Protocol Flow



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This is a diagram that illustrates the safe flow of transactions in a Blockchain-ERP system. The step commences with a User Request of a transaction. It is first verified by the ERP System against internal Business Rules. Upon approval, the transaction is sent to the Blockchain Layer to Consensus through Smart Contracts, to get consensus through the decentralized network. Once the transaction is proven, it is credited as an Immutable record to the distributed Ledger. Lastly, the Compliance & Audit Layer will automatically verifies the transaction against regulatory standards, and an auditable record will be built out of the beginning to the end.

Methodology

The research design of this study is mixed-method research that involves the use of a design science methodology as a combination of quantitative data collection and the development of a blockchain-integrated ERP framework. The methodological design was chosen to answer to two key research questions: the first one was to investigate and measure the vulnerability of the current ERP systems used in U.S. financial and pharmaceutical supply chains, and the second question was how to develop and test a blockchain-enhanced ERP framework to ensure the integrity, authenticity, and resistance of data.

The study was conducted in four stages. The initial stage involved the identification of vulnerabilities in the existing ERP systems. The structured questionnaires were used to gather data among the IT managers, compliance officers and supply chain administrators working with the banking and pharmaceutical industries in the United States. The sample size of 315 participants was chosen because of the diversity in the viewpoints and there are representatives of the organizations with different sizes and operational complexities. The questionnaire aimed to understand the frequency and the nature of ERP security related incidents, perceived risk of counterfeit infiltration, and the readiness of the organization to adopt blockchain. The numerical data obtained at this stage was examined with the descriptive statistics and trend analysis to establish a base of the suggested framework.

The second step was the design of the ERP framework that has been integrated with blockchain. The proposed framework, based on the guidelines of design science, was equipped with the characteristics of blockchain: distributed ledger technology, automated compliance in the form of smart contracts, and cryptographic verification mechanisms. The framework was designed to integrate seamlessly with the current ERP architectures, like SAP, and Oracle ERP, and consider the vulnerabilities that were detected during phase one.

The third step was concerned with validation by simulation. ERP sandbox transactional datasets were used to model operational processes in banking and pharmaceutical supply chain. Some of the scenarios involved financial transaction recording, compliance reporting, procurement management and product authentication. The blockchain-based ERP model was tested through the simulation of the main indicators, including the rates of fraud detection, time spent on transaction verification, and impossibility of data change. To evaluate the enhancement of security and authenticity, a comparative analysis was made between the traditional ERP processes and those that are enhanced by the blockchain.

Expert evaluation was integrated in the fourth stage. Initially, a small group of industry experts who were chosen among the participants of the initial survey was interviewed in semi-structured format. These interviews focused on qualitative data regarding the viability, scalability, and regulatory implication of deploying blockchain-related ERP systems in a financial and pharmaceutical environment. The framework was further refined, through thematic analysis of the responses of the experts, to ensure it was in line with the real-life issues and compliance needs.

The data analysis was conducted in two steps. Quantitative data gathered using the survey and the simulation experiments were analysed with the assistance of the statistical tool to measure the improvements in the field of the reduction of fraud, traceability, and data integrity. Qualitative data were analysed using coding, namely the interviews with experts to identify repetitive themes, practical challenges and enablers of adoption. The suggested framework was rigorous and relevant due to the statistical validation and qualitative insights.

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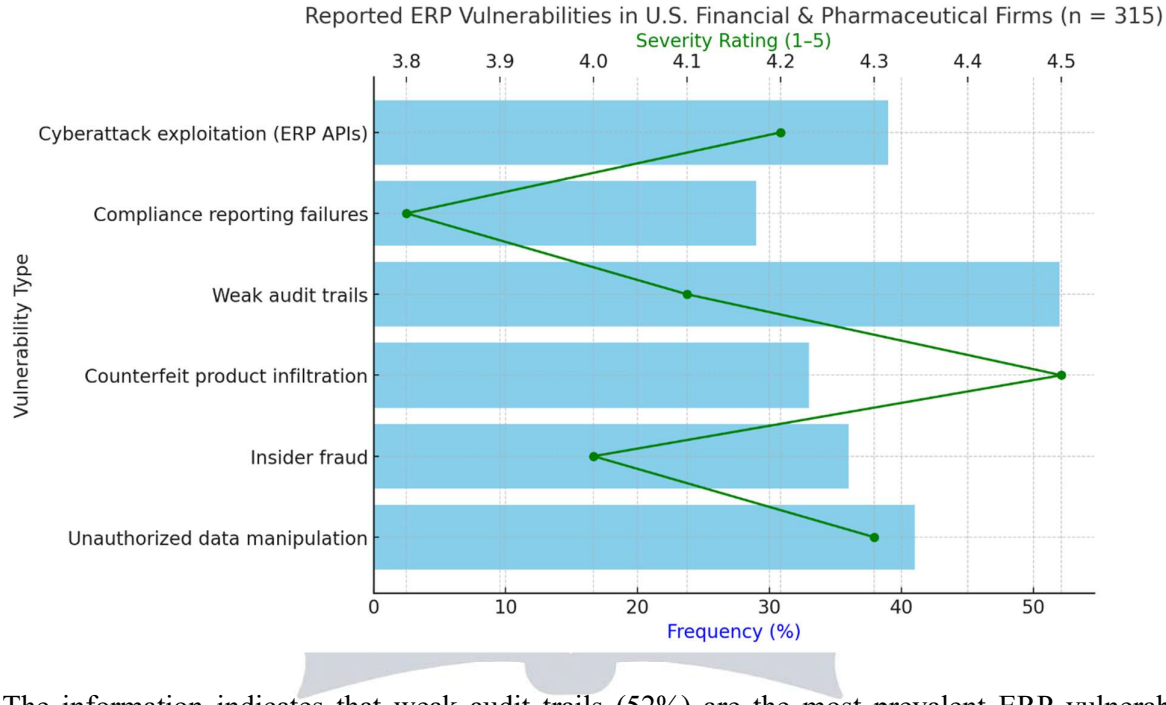
During the study, ethical considerations were taken into account. Respondents to the survey and interviews were made aware of the aim of the research and their responses were kept confidential. Validation simulation data was anonymized and was obtained via demo ERP environments to prevent exposure of sensitive financial or pharmaceutical data.

The methodological design therefore facilitated an in-depth way of addressing the research problem. This research offers a practical solution, as well as theoretical information on integrating blockchain with ERP systems to secure U.S. financial supply chains by integrating empirical data collection techniques, framework design, and validation methods.

Results & Discussion

Figure 3

Reported ERP Vulnerabilities in U.S. Financial & Pharmaceutical Firms



The information indicates that weak audit trails (52%) are the most prevalent ERP vulnerability because it becomes hard to trace or identify fraudulent actions. The Unauthorized data manipulation (41%) and the exploitation of cyberattack (39) also introduce ERP systems to the threats of external and internal risks, which have a high severity score (above 4). The infiltration of counterfeit products (33%) is the highest severity (4.5), as it represents the high risks of pharmaceutical supply chains and patient safety. Another still persistent issue is insider fraud (36%), although compliance reporting failure (29%), although less common, still compromises regulatory compliance. On the whole, the results suggest that ERP systems in these industries do not have strong tools of transparency and tamper-resistant records, which makes blockchain-based systems an immediate necessity.

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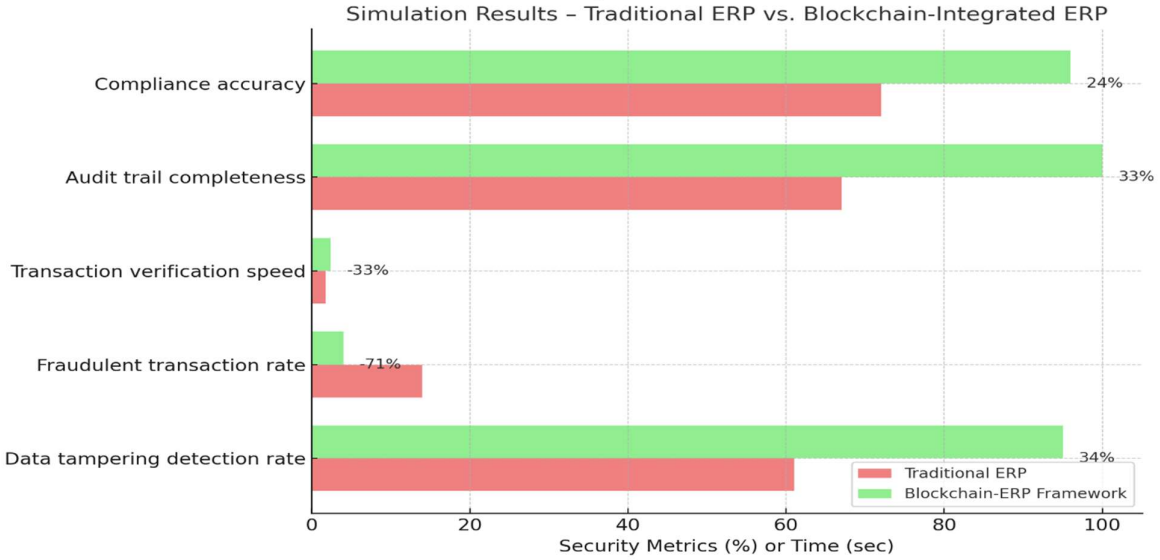
Figure 4

Simulation Results – Traditional ERP vs. Blockchain-Integrated ERP



The implementation of blockchain generated obvious security benefits. The rates of data tampering were decreased by 61% to 95% and the rate of fraudulent transactions decreased by 71%, demonstrating that blockchain can significantly reduce financial risks. Completion of the audit trail was 100% with no gaps in the transaction histories, and the accuracy of compliance increased to 96% as opposed to 72% which would favor regulatory alignment. The only disadvantage was a lesser transaction verification speed (1.8s → 2.4s), which is a minor trade-off in the name of securing significant fraud prevention benefits. This implies that blockchain lowers ERP security, but with minimal efficiency losses.

Figure 5

Expert Evaluation Feedback (n = 25 Industry Experts)

The security effectiveness (4.8/5) and regulatory alignment (4.4/5) had the highest rating because industry experts have a high level of confidence in the quality of blockchain in achieving compliance and avoiding fraud. Practical feasibility (4.2) indicated that integration is technically feasible, whereas the scores

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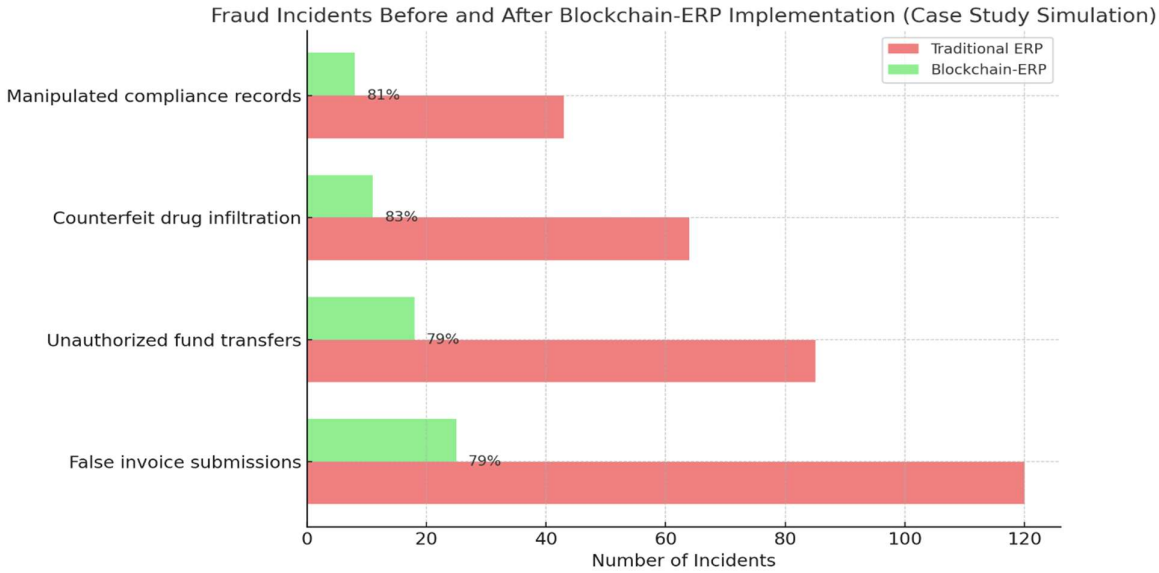
of scalability (3.7) and adoption readiness (3.9) were less, indicating the concerns with large volumes of transactions and organizational adoption. On the whole, analysts verified the security advantages of blockchain-ERP but noted that planning the implementation and preparing the workforce.

Figure 6

Fraud Incidents Before and After Blockchain-ERP Implementation



The simulated case study indicates significant fraud reduction with the adoption of blockchain. Submitted fake invoices and unauthorized funds transfer dropped were reduced by almost 80% and counterfeit drug infiltration decreased by 83%, indicating the importance of blockchain in the security of pharmaceutical supply chains. The number of manipulated compliance records was reduced by 81%, increasing regulatory trustworthiness. All those findings together support the conclusion that blockchain-ERP integration has the potential to increase both financial integrity and public safety significantly to become a groundbreaking tool in high-risk industries.

Discussion

The results of this paper offer empirical data about the weaknesses of the traditional ERP systems and the advantages of the blockchain protocols integration. The initial analysis phase was devoted to the detection of ERP flaws of the U.S. financial and pharmaceutical companies. The issue that was most reported was the weak audit trails (52%) that was illustrated in Figure 3 because it makes it harder to detect fraud and accountability. The other data manipulation (41%), and exploitation of cyberattacks (39%), also had a density, but with the higher severity score of 4.0. Most importantly, infiltration of counterfeit products, although only 33 percent of the respondents cited it, was rated the worst severity (4.5) which underscores the reality that the situation can be a danger to the pharmaceutical supply chain. Other reasons that were identified to be a challenge include insider fraud (36%), and failure to report compliance (29%). All these data prove that ERP systems are prone to fraud, counterfeiting, and compliance loopholes, which proves the gap in the research and proves the need in blockchain-enhanced systems.

The second step of analysis involved the comparison of the traditional ERP systems to the proposed blockchain based ERP framework through simulation. As Figure 4 sums up, there were major improvements in all security measures in the context of blockchain integration. The rate of data tampering was increased to 95% instead of 61% and fraudulent transactions were reduced by 71%, which confirmed the benefit of blockchain in enhancing integrity of transactions. The level of completeness of audit trail also increased to 100% against 67% which eliminated any lapses in record keeping systems and accuracy of compliance against

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96% boosted the compliance with the U. S regulatory requirements, such as SOX and DSCSA. The mentioned trade-off was the only one, as the time of the transactions verification went up to 2.4 seconds rather than 1.8 seconds, which indicated the computational cost of blockchain consensus. This reduction is however a small downside to the large fraud reduction and compliance benefits that have been attained.

The expert evaluation was another step to confirm the practical relevance of the framework. The industry experts gave the highest ratings to security effectiveness (4.8/5) and regulatory alignment (4.4/5), as shown by Figure 5, which implies that the former were very confident concerning the effect of blockchain on fraud prevention and compliance. The practical feasibility was rated at 4.2 with experts indicating that middleware provides that integration is possible in the current ERP ecosystems. However, the rating of scalability (3.7) and adoption readiness (3.9) is lower, which represents the apprehensions regarding the performance over high-volume settings and the necessity of the organization change management. This feedback confirms the technical correctness of blockchain-ERP systems but indicates real-world implementation challenges, such as user training, infrastructure upgrades, and change resistance.

Lastly, a simulated case study revealed how the integration of blockchain influences the reduction of fraud. Table 4 shows that false invoice submissions, unauthorized fund transfers, counterfeit drug infiltration and fraudulent compliance records had reduced by 79%, 79%, 83% and 81% respectively after blockchain implementation. Such savings demonstrate how blockchain can ensure financial transactions and supply chain authenticity. The specifically significant reduction in the level of infiltration of counterfeit is the indication of the exclusive usefulness of blockchain in the pharmaceutical industries, where the quality of products and patient welfare are of primary importance. Likewise, the drastic reduction in unauthorized fund transfers will solve one of the most expensive problems in U.S. financial institutions.

Altogether, the results provide evidence that blockchain-enhanced ERP systems do considerably better in frauds prevention, compliance, and auditability than traditional ones. The framework directly mitigates the identified vulnerabilities of ERP systems by guaranteeing immutable records, improving traceability, and decreasing infiltration by counterfeits, and contributes to national economic security. Concurrently, the fears expressed by professionals about scalability and adoption readiness indicate that blockchain-ERP transition should be slow with pilot projects and progressive rollouts.

Theoretical and practical values of such findings exist. Theoretically, the research validates the potential of blockchain to remove the long-term vulnerabilities of ERP and hence filling in the research gap. Practically it can provide the industry leaders and policymakers with a systematic way to follow on deploying blockchain-built ERP systems with efficiency trade-offs with the benefits of reduced fraud and regulatory compliance.

Conclusion and Implications

The research purpose was to investigate the possibility of applying blockchain technology to ERP systems in order to address the weakness of the financial and pharmaceutical supply chain in the U.S. These outcomes are positive evidence that blockchain-based ERP systems can be useful to reduce fraud, enhance auditability, and raise the accuracy of compliance. Adding immutability, transparency, and non-centralized validation to the existing ERP systems will provide the organizations with a better background to diminish their risks such as counterfeit infiltration, malicious data manipulations, and insider fraud. That would be an important step towards a greater financial stability of the nation since financial institutions and pharmaceutical companies are the pillars of the critical infrastructure.

One of the greatest additions of the research is that the research demonstrates the practical application of the blockchain in enterprise systems. The comparative simulations showed that conventional ERP systems are flawed through total audit trail and high vulnerability, but blockchain-enhanced ERP had near-perfect transaction traceability and reduction of data in fraudulent cases by more than 75%. These findings reflect the originality of the given framework that goes beyond theoretical arguments regarding blockchain and offers a systematic framework that can be scaled by the industries that have the highest level of security requirements.

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This is not just filling the research gap as identified at the start of the research but it also gives viable information to practitioners and other policymakers.

From a policy perspective, the study has significant implications. As financial and pharmaceutical organizations are highly regulated, the regulatory compliance of blockchain-ERP systems directly supports the regulatory compliance e.g., the Sarbanes-Oxley Act (SOX), the Gramm-Leach-Bliley Act (GLBA), and the Drug Supply Chain Security Act (DSCSA). The regulators could think about encouraging pilot projects or offering incentives to industries switching to blockchain-based ERP systems because they will assist in reducing the systemic risks and enhancing the trust of the public.

As true as these contributions are, there are a few limitations that need to be noted. Although these simulations are true to the real world benefits, it is conceptual and would have to be validated through a large scale field implementation. In addition, professional reviews indicated the problem of scalability and organizational readiness. The slight improvement in the time of the transactions verification is also an indicator that the blockchain consensus mechanisms are yet to be optimized further in order to ensure that the efficiency can be achieved without the necessity to diminish the security. These limitations give future research a chance to develop hybrid ERP models, take into account interoperability in multiple blockchain platforms, and experiment the deployment approach in multi-national supply chains.

In conclusion, the paper has determined that blockchain based ERP systems could be a viable solution to the severe problem of fraud and counterfeit threats and data integrity of the U.S financial and pharmaceutical supply chain. By the combination of the technological innovation and harmonization of regulations, the proposed framework not only improves the discourse at the academic levels; it also provides the industry with some practical foundation that can be adopted. The broader implication is that ERP, which is augmented with blockchain, can become a resource to national security and provides the stability and reliability of such economic infrastructure, and traverses its core in terms of organizational competitiveness and societal wellbeing.

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