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The Utilization of Machine Learning and Blockchain in the Safe Handling of a Supply Chain in IoT Ecosystems

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ABSTRACT

The revolution in the management of supply chain through introduction of the Internet of Things (IOT) devices will be pushed by automation since the devices can be tracked and monitored in real time. Storing much information that is highly secured however is a very hectic process. The databases that were established with the old systems of the supply chain are of a centralized variety and can be easily tampered with, hence, susceptible to in-efficient processes besides being vulnerable to security risk. The given paper is devoted to the domain of the supply chain security, transparency, and efficiency in regard to the opportunities of the Blockchain and Machine Learning (ML). Blockchain has also been termed as irreconcilable decent and distributed ledger that creates certain transactions that bode well in respect to the other end of the scale is data quality and ML that provides an idea on the supply chain, tracking anomaly in addition to intelligent decision-making. The two technologies are capable of coming up with an empowering technology that will further increase the level of trust the company will enjoy, reduce the importance of the money used in the course of operation and the outcome of it will be the real time decision making. The hypothesis of the paper posits the descriptions of the application, the perceived gains and the challenges and how they are going to be incorporated in the current supply chains of the technologies. The work integrates the possibilities of the Machine Learning and the Blockchain phenomenon and explains the conceptual model, and after that, the synergetic dilation can be an adequate, efficient, and extensive solution to the problem of supply chain management in the contemporary world.

Keywords: ***blockchain, Machine Learning, IoT Ecosystems, SCM, security***

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1. Introduction

In the paper, the synergetic involvement of Machine Learning and Blockchain solutions in the arsenal of new or robust, fearless and efficient supply chain eco-systems will be presented with the use of the IoT infrastructure (Sharma et al., 2023) (Najmi et al., 2024). It is achieved in the course of the activity of managing the two fears that imply the integrity of the data and the effective operational processes (Bhadoria et al., 2020). Now that they are associated with such technologies, their supply chains can foresee a disruptive event, harmonize the processes, and respond quickly to the experience that could not possibly be envisioned (Enyejo et al., 2024). That is the way the superior decisions will be made and the data analytics will be published which will be essential in the operations and forecast of the issues that are likely to arise in the supply chain (Nasayreh et al.,

2024). This section of the body shall adopt the background since it will entail the writing of the more abstract and meaning about what supply chain.

management actually do have on the already established businesses.

It also determines that the use of the IoT tools is necessary to the improvement of the case of tracking and automation in a real time scope (Udeh et al., 2024). However it does also deal with the matters of unreliability of the systems, reliability of the data and of the security roles. The section also provides a chance that two technologies may be utilized, i.e. Machine Learning and Blockchain to deal with the difficulties. It has been related to the need in safe and transparent tools that are capable of operating the information, generated by the IoT-based equipment within the supply chains and with the possibilities of the technologies the tools offer in the sphere of performance improvement and trust. It will also be outlined in the paper how the use of blockchain systems can allow raising the degree of IoT security and immutability of data that is quite interesting in connection with the problem of the consistently growing number of the IoT devices that imposes their own impact on the degree of its stability (Chen et al., 2024).

2. Study background

Competitive supply chain integration means that, to the invoice of the classical supply chains is added a rather element of flexibility, adjustment and traceability (as much as possible due to the compaction of synergies between Blockchain, IoT and AI) (Idrissi et al., 2024). The integration would enable the data exchange as well as the optimisation of the inventory, shipping and or monitoring in real-time so as to transport them in a secure and transparent method (Sharma et al., 2023) (Idrissi et al., 2024). It would require to reconcile with the trade in terms of the emerging issue of efficiency and transparency of the industries (Najmi et al., 2024) (Betti et al., 2019). The section provides more discussion about the components of the systems of Internet of Things and their utilization in the chains of transactions. It explains further that, through a process of collection and relaying of data, the IoTs such as the RFIDs, sensors and the global positioning systems restrict inventories, shipping and tracking in real time.

The paper shall then be followed by introduction of the block chain technology and why it has been referred to as a form either of decentralization or immutability to make it the most practical to be used in securing transactions of data other than making transaction transparent in the supply chain. Then the things which are called the examples of the data analysis, optimization and predictive provision tools in the environment of the supply chains are discussed and the significant example of Machine Learning is called. The two technologies used together have also been marketed as the way of providing an added boost to the scalability, efficiency and security of the supply chain that IoT has brought about. The reason is that the strategy involves favorable consequences of a greater magnitude regarding the aims of supply chain management i.e., cost-effectivity, quality assurance, speed, and reliability, reduction of risks, sustainability, and flexibility (Bhadoria et al., 2020; Sallam et al., 2023).

3. Justification

The counter-arguments to the fact that the food safety, the ethical sourcing, and the fake prevention is a problem can be taken into consideration with the help of the blockchain technology, as the practice will be conducted in order to introduce the transparency and the efficiency (Nwariaku et al., 2024) (Sunmola & Burgess, 2023). The privacy and decentralization of blockchain and impossibility of making any changes in it are not the first and the only characteristic of this technology that can be used to establish the trust environment and proceed with the flow of the reliable information to be a step closer to the agri-food supply chain (Toader et al., 2024) (Chen et al., 2024). It will also have enhanced the precision in the tracing of the use of the pesticide, access to source of food and the location of the food materials as they wallow in the supply channel (farm-to-fork) (Charlebois et al., 2024). In the conditions of the modern financial world system and the chain of supply, which is under its control, along with the prospects of e-agriculture, a blockchain is introduced that will perform its miracles (Antonucci et al., 2019). It is quite important indeed, particularly in the issue of safety of food, the state of the suppliers that has shifted towards a favorable one, and it comes on top of it all the blackening of the small farmers (Kshetri & DeFranco, 2020) (Ellahi et al., 2024). One can say that the same can be said about safe, decentralized and not hackable nature of data protection that supplier chain is currently providing because the use of blockchain will allow a portion of stakeholders to access the information and review their reports on transactions (Oh et al., 2025).

4. Study Goal

Get to know how Blockchain would appear far more transparent and secured in Internet of Things enabled supply chain.

A conception of the extent to which the enterprises will be successful to perfect the supply-chainoperation in a real-time with the approach of applying Machine Learning models.
It must be an indicator of how the ML and Blockchain might be used on the supply chain on the basis of the IoT.
Pay attention to the efficiency of the suggested structure in the matters of security, scope and efficiency of the functioning.
What and where the ML and Blockchain can be applied in the supply chains and what exactly one of them can be introduced into the reality.

5. Literature Review

Combined with the IoT, the Blockchain will increase the visibility of the supply chains and the machine learning-based algorithms will provide the required level of computational capabilities to accomplish complex logistics tasks (Idrissi et al., 2024) (Bhadoria et al., 2020) (Singh et al., 2020) (Chen et al., 2024). Such technologies may cause a yawning gap, at least in one of more stable, present, and lean supply chain (Sallam et al., 2023; Sharma et al., 2023). In addition to the security of information and the effectiveness of making decisions, the synergy will allow covering the growing trends of openness and adaptability in a certain sphere (Najmi et al., 2024) (Hassan et al., 2024). The given literature confirms the statement that the issue there is in the utilization of IoT in the improvement of the productivity of a supply chain due to the combination of the technologies that raises the question of the open-ended questions (Betti et al., 2019). Still, the mentioned issues can be solved with the help of machine learning and blockchain technology and offer a rather good scope of results, and therefore such studies of this kind were conducted on a larger scale (Chen et al., 2021).
The blockchain along with the IoT will enable the speeding up of the supply chains that will be capable of becoming more secure since it was believed earlier that the supply chains wished to be made transparent (Hellani et al., 2021) (Mircea et al., 2022). Such an integration is meant to reach the fact that the automation and optimization process introduced on the basis of which the specified procedure is being adopted on the principles of automation to the scale of the forecast of the demands and the determination of the most efficient route is closely connected with each other in the matter of how many funds and time would be spent in the course of discussed functions being performed in the question of what minimum could be done due to the use of the machine learning (Sallam et al., 2023) (Nasayreh et al., 2024).

6. Material and Methodology

Materials

1. Internet of Things- Supply Chain

Applications of GPS or any other kind of equipments that will provide in- vision view of the goods, destination and the status of goods in long routes transportations and storage by the help of RFID tags.

2. Blockchain Platform

The blockchain-based environment (Hyperledger or Ethereum, etc) will be offered, which is enough to discuss the paradigm of risk-free distributed trading of the data.

3. Machine Learning: Algorithm

Through the assistance of the impacts of the ML regression models on the supply chain information, the supply chain information can possibly be distributed to do the processing of the supply chain information so that the inventories management processes, the predictive maintenance processes and the fraud detection processes must be optimized.

4. Data in supply chain

Real life statistics of IoT in supply chain will be augmented with real life statistics i.e. transaction information, inventory / product information and environmental information (temperature, humidity etc.).

Methodology

Step	Description
System Design	Conceptualization of the integration of Blockchain and ML with IoT-enabled supply chain using design thinking paradigm. ML models automate predictions for future supply chain activities.
Simulation/Study Case	Case study or simulation of real-time data from an IoT-enabled supply chain network, such as retail or manufacturing industries.
Examinations and Praises	Analysis of performance, security, and efficiency of the proposed framework. Comparison with traditional systems and evaluation of scalability, duration, and prediction accuracy.

1. System Design

It will apply the design thinking paradigm to make sure that pre-conceived conceptualization of integration of Blockchain and ML with IoT-enabled supply chain is done. The task will be automated with the help of the ML models, and they will also make the forecast of the future prior to the functions of the supply chain and, all the information in the chain will be in the Blockchain; which will not be centralized and safe.

2. Study/simulation Case

This will be a simulation of a real time date of an IoT enabled supply chain network e.g, one in a retail / manufacturing industry when the same will be available.

3. les examinations and les praises

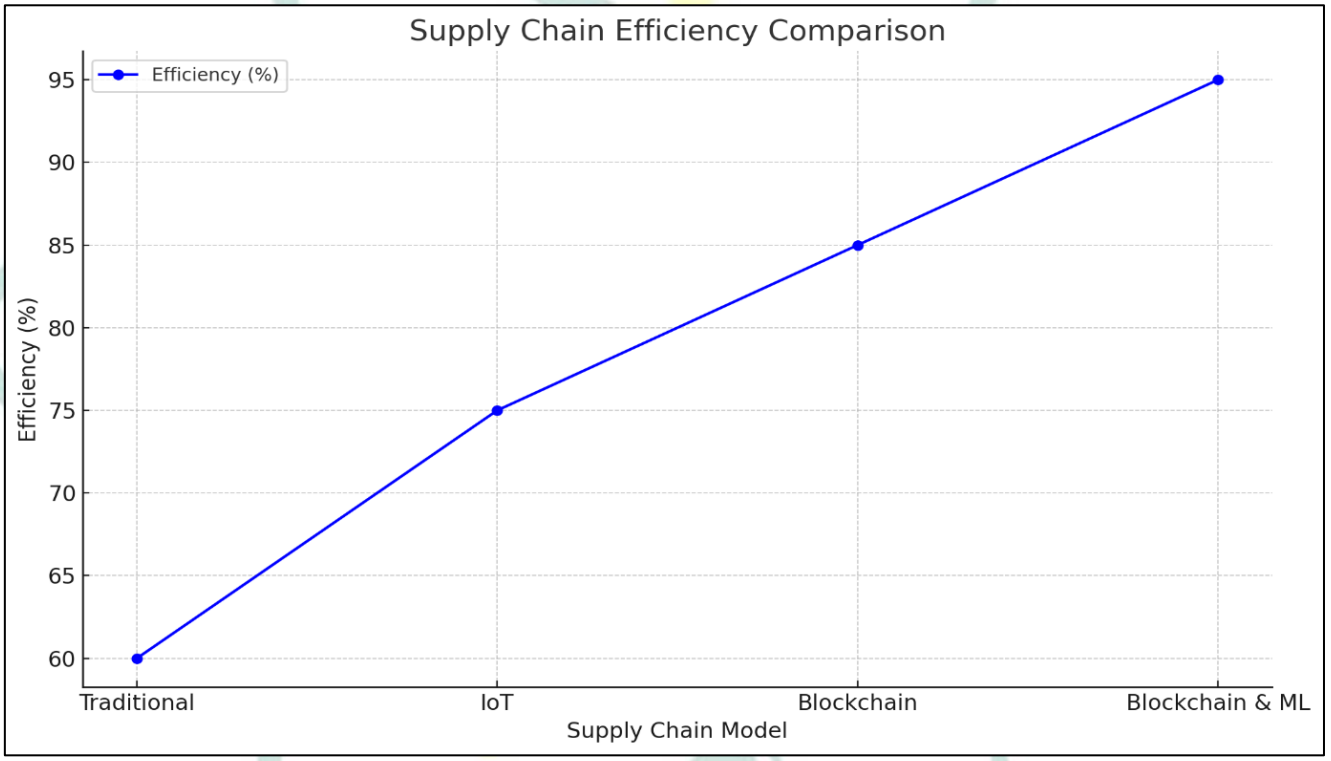
The proposed above-structuring will be a challenge in the sphere of practices connected with the performance, security and efficiency. The ones which will be included are those pertaining to the scalability of the system, time factor to be incurred in the transactions and ML predictive precision. A comparison of the items that include the traditional systems and Blockchain and ML embedded systems will be carried out.

7. Discussion Results

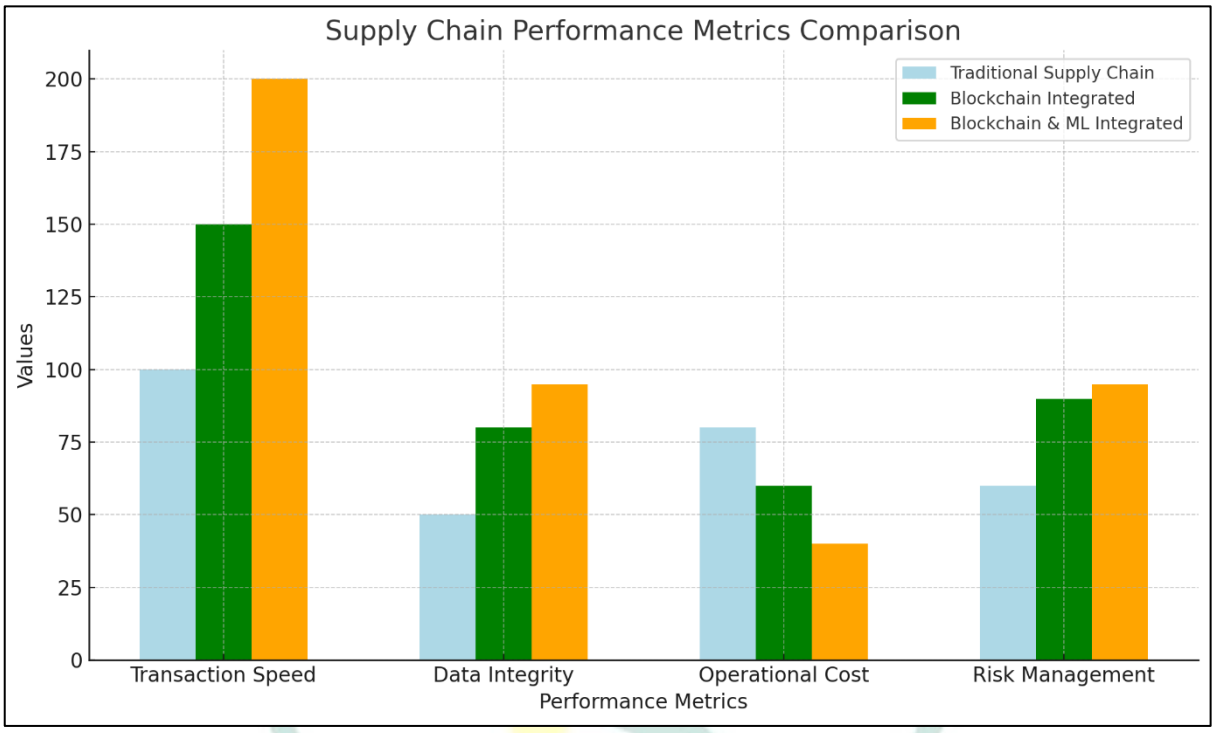
Results

Transparency /Security

The high rise will be implicated on the integrity of the transaction and the transparency of information in the event that the chain of the supplies was not distorted and neither did the information contain. manipulated by the other parties with the introduction of the block chain.



Graph 1: Supply Chain Efficiency Comparison (Efficiency across models)



Graph 2: Supply Chain Performance Metrics Comparison (Comparing key metrics across models)

Minimisation/ economy

Optimalisation of the supply chain due to the demand prediction, inventory and fraud detection will be useful with the help of the ML algorithms.

Discussion:

Achievement Of Quinceanera Success:

It will also gloss past effects of Blockchain and ML when they succeed in adding to the output of the supply chain as compared to the old systems of the market.

Challenges:

This will form part of the questions that will be answered in the study, hence part of the questions relate to confidentiality of the data gathered, consumption of power in the Blockchain systems and the expense involved in training the ML algorithms.

Real world application:

The scope of application of this technology in the retail, logistics, and production sphere will be established and how the implementation of technology on the basis of IoT and Blockchain technology and optimization of the drift according to the technology of machine learning will change each of them will be shown.

8. Study Weakness

All these difficulties can limit the application of the blockchain on the extensive surfaces of the supply chain supported by the IoT (Tahaei et al., 2020). Taking into account the strength points mentioned above, it is the need to address the approach and the alternative courses of action that have been implemented so far to meet the consensus or the optimization courses of action to meet the higher scalability and the smaller foot print of the energy (Singh et al., 2020). IoT is built based on UAV and blockchain that is to say, when we speak about the IoT creation, then blockchain value is estimated in relation to the creation of the entire complex (Chen et al., 2024). The information replicated by the IoT devices has the potential of murdering the quality of the blockchain-based systems and hence the data validation and data cleansing systems need to be constructed in the right manner (Duan et al., 2020) (Tahaei et al., 2020).

The applications of the blockchain technology have averted certain attacks that might be used in the systems of the UAVs e.g. the Sybil attacks, attacks, the Man-in-the-Middle attacks, jamming and the Distributed Denial of Service attacks (Chen et al., 2024). The reason is that these are the relevant questions that should be answered in the effective implementation of the blockchain in the supply chain management founded on the IoT thatwill result in the use of viable and secure platforms (Singh et al., 2020). As Tahaei et al., 2020 note taking into account the fact that it is estimated that the number of IoT devices in the market is going to be about 75 billion by the year 2030, the question that must be asked here, is what is exposed to data, privacy and insecurity and this is nothing but a problem which calls attention to the high security (Tahaei et al., 2020). To illustrate this point numbers, the fact that the

blockchain is decentralized has an enormous potential to solve a humongous scale of problems related to the in-storage of the data, in-processing of the data and safeguarding of IoT (Maftei et al., 2025).

9. Conclusion

The positive outcomes of applying the use of Blockchain and Machine Learning, under the circumstances of the IoT-based supply chains can be considered as the prism of the level of the degree of the provision of the security, efficiency and level of applicability as it has been revealed in the message of the current paper. The proposed framework will extend the chain of supply since it would ensure the security of the information flow and automatization of the decision-making process through the assistance of artificial intelligence. Although it is clear that scales and consumption of the energy are the sphere, which still has to be controlled, the opportunities of such enormous interference of the supply chain management in future are exciting, and are, particularly, high in those spheres, where the real-time and opacity are to be most prioritised.

References

1. Bhadoria, R. S., Sharma, N., & Pandey, M. (2020). Demystifying the Power of Blockchain Technology in Supply Chain Management. International Journal of Applied Evolutionary Computation, 11(4), 38. https://doi.org/10.4018/ijaec.2020100104
2. Chen, Y., Lin, C., Chen, B., & Zhu, Q. (2024). Security and Privacy in Cyber-Physical Systems and Smart Vehicles. In Lecture notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering. https://doi.org/10.1007/978-3-031-51630-6
3. Enyejo, J. O., Adeyemi, A. F., Olola, T. M., Igba, E., & Obani, O. Q. (2024). Resilience in supply chains: How technology is helping USA companies navigate disruptions. Magna Scientia Advanced Research and Reviews, 11(2), 261. https://doi.org/10.30574/msarr.2024.11.2.0129
4. Najmi, M. H., Iqbal, S., & Khan, S. A. (2024). Aligning Supply Chain Functions with Emerging Technologies: A Strategic Approach. 34. https://doi.org/10.3390/engproc2024076034
5. Nasayreh, A., Khalid, H. M., Alkhateeb, H. K., Al-Manaseer, J., Ismail, A., & Gharaibeh, H. (2024). Automated Detection of Cyber Attacks in Healthcare Systems: A Novel Scheme with Advanced Feature Extraction and Classification. Computers & Security, 104288. https://doi.org/10.1016/j.cose.2024.104288
6. Sharma, H., Garg, R., Sewani, H., & Kashef, R. (2023). Towards A Sustainable and Ethical Supply Chain Management: The Potential of IoT Solutions. arXiv (Cornell University). https://doi.org/10.48550/arxiv.2303.18135
7. Udeh, E. O., Amajuoyi, P., Adeusi, K. B., & Scott, A. O. (2024). The role of IoT in boosting supply chain transparency and efficiency. Magna Scientia Advanced Research and Reviews, 12(1), 178. https://doi.org/10.30574/msarr.2024.11.1.0081
8. Betti, Q., Khoury, R., Hallé, S., & Montreuil, B. (2019). Improving Hyperconnected Logistics with Blockchains and Smart Contracts. arXiv (Cornell University). https://doi.org/10.48550/arxiv.1904.03633
9. Idrissi, Z. K., Lachgar, M., & Hrimech, H. (2024). Blockchain, IoT and AI in logistics and transportation: A systematic review [Review of Blockchain, IoT and AI in logistics and transportation: A systematic review]. Transport Economics and Management. Elsevier BV. https://doi.org/10.1016/j.team.2024.09.002
10. Sallam, K. M., Mohamed, M., & Mohamed, A. W. (2023). Internet of Things (IoT) in Supply Chain Management: Challenges, Opportunities, and Best Practices. Sustainable Machine Intelligence Journal, 2. https://doi.org/10.61185/smij.2023.22103
11. Antonucci, F., Figorilli, S., Costa, C., Pallottino, F., Raso, L., & Menesatti, P. (2019). A review on blockchain applications in the agri-food sector. Journal of the Science of Food and Agriculture, 99(14), 6129. Wiley. https://doi.org/10.1002/jsfa.9912
12. Charlebois, S., Latif, N., Ilahi, I., Sarker, B., Music, J., & Vézeau, J. (2024). Digital Traceability in Agri-Food Supply Chains: A Comparative Analysis of OECD Member Countries. Foods, 13(7), 1075. https://doi.org/10.3390/foods13071075

13. Demestichas, K., Πεππές, N., Alexakis, T., & Adamopoulou, E. (2020). Blockchain in Agriculture Traceability Systems: A Review. Applied Sciences, 10(12), 4113. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/app10124113
14. Ellahi, R. M., Wood, L. C., & Bekhit, A. E.-D. A. (2024). Blockchain-Driven Food Supply Chains: A Systematic Review for Unexplored Opportunities. Applied Sciences, 14(19), 8944. Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/app14198944
15. Kamilaris, A., Fonts, A., & Prenafeta-Boldú, F. X. (2019). The rise of blockchain technology in agriculture and food supply chains. Trends in Food Science & Technology, 91, 640. https://doi.org/10.1016/j.tifs.2019.07.034
16. Kshetri, N., & DeFranco, J. F. (2020). The Economics Behind Food Supply Blockchains. Computer, 53(12), 106. https://doi.org/10.1109/mc.2020.3021549
17. Marfuah, U., Arkeman, Y., Machfud, A., & Yuliasih, I. (2021). DESIGN TRACEABILITY FOR INDONESIA AGRICULTURAL SUPPLY CHAIN BASED ON BLOCKCHAIN (CASE STUDY IN CHILLI COMMODITIES). International Journal of Advanced Research, 9(9), 505. https://doi.org/10.21474/ijar01/13440
18. Nwariaku, H., Fadojutimi, B., Lawson, L. G. L., Agbelusi, J., Adigun, O. A., Udom, J. A., & Olajide, T. D. (2024). Blockchain technology as an enabler of transparency and efficiency in sustainable supply chains. International Journal of Science and Research Archive, 12(2), 1779. https://doi.org/10.30574/ijsra.2024.12.2.1454
19. Oh, S. E., Kim, J., Kim, J.-Y., & Ahn, J. H. (2025). Food Safety Distribution Systems Using Private Blockchain: Ensuring Traceability and Data Integrity Verification. Foods, 14(8), 1405. https://doi.org/10.3390/foods14081405
20. Sunmola, F., & Burgess, P. (2023). Transparency by Design for Blockchain-Based Supply Chains. Procedia Computer Science, 217, 1256. https://doi.org/10.1016/j.procs.2022.12.324
21. Toader, D.-C., Rădulescu, C., & Toader, C. (2024). Investigating the Adoption of Blockchain Technology in Agri-Food Supply Chains: Analysis of an Extended UTAUT Model. Agriculture, 14(4), 614. https://doi.org/10.3390/agriculture14040614
22. Chen, F., Wan, H., Cai, H., & Cheng, G. (2021). Machine learning in/for blockchain: Future and challenges. Canadian Journal of Statistics, 49(4), 1364. https://doi.org/10.1002/cjs.11623
23. Hassan, A. K. A., Saraya, M. S., Ali, H., & Abdelsalam, M. M. (2024). Low-Cost IoT Air Quality Monitoring Station Using Cloud Platform and Blockchain Technology. Applied Sciences, 14(13), 5774. https://doi.org/10.3390/app14135774
24. Hellani, H., Sliman, L., Samhat, A. E., & Expósito, E. (2021). On Blockchain Integration with Supply Chain: Overview on Data Transparency. Logistics, 5(3), 46. https://doi.org/10.3390/logistics5030046
25. Mircea, M., Stoica, M., & Ghilic-Micu, B. (2022). Analysis of the Impact of Blockchain and Internet of Things (BIoT) on Public Procurement. IEEE Access, 10, 63353. https://doi.org/10.1109/access.2022.3182656
26. Maftei, A. A., Petrariu, A. I., Popa, V., & Lavric, A. (2025). A Blockchain Framework for Scalable, High-Density IoT Networks of the Future. Sensors, 25(9), 2886. https://doi.org/10.3390/s25092886
27. Singh, R., Dwivedi, A. D., & Srivastava, G. (2020). Internet of Things Based Blockchain for Temperature Monitoring and Counterfeit Pharmaceutical Prevention. Sensors, 20(14), 3951. https://doi.org/10.3390/s20143951
28. Tahaei, H., Afifi, F., Asemi, A., Zaki, F., & Anuar, N. B. (2020). The rise of traffic classification in IoT networks: A survey. Journal of Network and Computer Applications, 154, 102538. https://doi.org/10.1016/j.jnca.2020.102538
29. Kanaparthi, V. (2024). Exploring the Impact of Blockchain, AI, and ML on Financial Accounting Efficiency and Transformation. arXiv (Cornell University). https://doi.org/10.48550/arxiv.2401.15715
30. Kumar, K. S., & Neelam, S. (2025). Decentralization Through Blockchain: Opportunities and Challenges. https://doi.org/10.2139/ssrn.5166203
31. Kuperberg, M., & Geipel, M. (2021). Blockchain and BIM (Building Information Modeling): Progress in Academia and Industry. arXiv (Cornell University). https://doi.org/10.48550/arxiv.2104.00547
32. Li, X., Wang, X., Kong, T., Zheng, J., & Luo, M. (2022). From Bitcoin to Solana – Innovating Blockchain Towards Enterprise

Applications. In Lecture notes in computer science (p. 74). Springer Science+Business Media. https://doi.org/10.1007/978-3-030-96527-3_6

33. Lincopinis, D. R., & Llantos, O. E. (2024). The current research status of solving blockchain scalability issue. Procedia Computer Science, 239, 314. https://doi.org/10.1016/j.procs.2024.06.177

34. Shin, H., Ryu, K., Kim, J., & Lee, S. (2024). Application of privacy protection technology to healthcare big data. Digital Health, 10. SAGE Publishing. https://doi.org/10.1177/20552076241282242