# AI-Driven Security Enhancement in Delay Tolerant Networks Using Optimized OBR Protocol and Post-Quantum Cryptography

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**Abstract.**Delay Tolerant Networks (DTNs) present unique challenges in maintaining secure and efficient communication due to intermittent connectivity, high latency, and limited resource availability. This paper proposes an AI-driven framework that enhances the security and performance of DTNs through an optimized Opportunistic Buffer Routing (OBR) protocol integrated with Post-Quantum Cryptography (PQC) techniques. The proposed model leverages machine learning algorithms to dynamically predict optimal routing paths based on node behavior, contact history, and network conditions, thereby improving delivery ratios and reducing delays. In parallel, the incorporation of quantum-resistant cryptographic schemes ensures long-term data security against emerging threats from quantum computing. Simulation results demonstrate that the enhanced OBR protocol significantly outperforms traditional DTN routing methods in terms of delivery efficiency and resilience to attacks, making it a robust solution for future secure communications in challenged network environments.

**Keywords:** Delay Tolerant Networks (DTNs), Opportunistic Buffer Routing (OBR), Artificial Intelligence, Machine Learning, Post-Quantum Cryptography (PQC), Secure Routing, Quantum-Resistant Security, Network Optimization, Intermittent Connectivity, Resilient Communication.

## INTRODUCTION

Delay Tolerant Networks (DTNs) have emerged as a vital communication paradigm for environments where continuous end-to-end connectivity cannot be guaranteed, such as in space communication, disaster recovery, underwater networks, and remote rural areas. These networks operate on a store-carry-forward model, allowing nodes to temporarily store data until a forwarding opportunity arises. While this approach enables communication in challenged and infrastructure-less scenarios, it also introduces significant vulnerabilities in terms of security, latency, and routing efficiency.

Traditional routing protocols in DTNs, such as Epidemic Routing and Spray and Wait, often suffer from excessive overhead, inefficient buffer utilization, and susceptibility to malicious behavior. Furthermore, the dynamic and sparse nature of node connectivity makes it difficult to ensure timely and secure data delivery. To address these challenges, Opportunistic Buffer Routing (OBR) protocols have been explored for their adaptive nature and better buffer management strategies. However, existing OBR implementations still face limitations in coping with intelligent threats and rapidly changing network topologies.

In parallel, the advent of quantum computing poses a new class of security risks to conventional cryptographic methods. Classical encryption algorithms such as RSA and ECC are expected to be vulnerable to quantum attacks, necessitating the transition toward Post-Quantum Cryptography (PQC). PQC schemes are designed to withstand quantum adversaries, ensuring the confidentiality and integrity of transmitted data in future communication systems.

This research presents a hybrid approach that integrates Artificial Intelligence (AI) with an optimized OBR protocol to improve routing decisions and resource utilization in DTNs. Simultaneously, it incorporates PQC techniques to secure data transmissions against both classical and quantum threats. The AI component leverages machine learning algorithms to analyze node behavior, predict future contact opportunities, and adapt routing strategies in real-time. This intelligent and secure framework aims to deliver a robust, future-proof solution for communication in delay-prone and security-sensitive environments.

## LITERATURE SURVEY

Delay Tolerant Networks (DTNs) have attracted considerable attention due to their applicability in communication-challenged environments. The fundamental principles of DTNs were introduced by Fall (2003), who proposed the *store-carry-forward* model as a robust mechanism for environments with intermittent connectivity. Since then, various routing protocols such as Epidemic Routing, Spray and Wait, and Prophet have been developed to address data delivery challenges. However, these protocols are often constrained by high latency, excessive message replication, and inefficient buffer utilization.

To address routing inefficiencies, Opportunistic Buffer Routing (OBR) protocols have been proposed. OBR enhances delivery performance by intelligently selecting messages to forward or drop based on buffer availability and delivery probabilities. Studies by Burgess et al. (2006) and Jain et al. (2004) have highlighted the importance of buffer-aware decisions in improving DTN performance. However, conventional OBR lacks adaptability in dynamic environments and fails to anticipate malicious node behaviors.

Recent advancements in Artificial Intelligence (AI), particularly machine learning, have opened new avenues for optimizing DTN performance. Researchers such as Al-Kashoash and Kemp (2020) demonstrated how reinforcement learning can dynamically optimize routing paths in vehicular DTNs. Similarly, predictive models have been employed to estimate future contact opportunities, thereby enhancing routing accuracy. However, most AI-driven approaches focus primarily on performance, with limited emphasis on robust security integration.

Security in DTNs has traditionally relied on classical cryptographic algorithms. However, the emergence of quantum computing presents a critical threat to these algorithms. Shor’s algorithm, for instance, can efficiently break RSA and ECC, prompting the need for Post-Quantum Cryptography (PQC). Lattice-based, hash-based, and code-based cryptographic schemes have been identified as promising PQC candidates. Studies by Bernstein et al. (2017) and NIST's Post-Quantum Cryptography Standardization Project emphasize the urgency of adopting quantum-resistant algorithms in future communication systems.

While prior research has either focused on AI-based routing or on quantum-resilient security, there is limited literature combining both approaches in the context of DTNs. This gap motivates the development of a unified framework that leverages AI for intelligent routing and PQC for future-proof security in delay-tolerant environments. The proposed system aims to enhance delivery efficiency, reduce vulnerability to attacks, and secure communications against evolving quantum threats.

## MODEL ARCHITECTURE

The proposed architecture for enhancingsecurity in Delay Tolerant Networks (DTNs) integratesartificial intelligence-drivenroutingwith post-quantum cryptographicmechanisms, structuredaround the store-carry-forward communication paradigm. At the foundation, a Network Node Behavior Collection Layer continuously monitors various network and node-specificparameterssuch as mobility patterns, encounter histories, buffer occupancy, energystatus, and pastdeliverysuccess rates. These real-time behavioralmetrics are transformedintostructuredfeaturevectorsthat serve as input to the AI modules.

At the heart of the model lies the AI-Based Optimized Opportunistic Buffer Routing (OBR) Module, which utilizes machine learning algorithms—such as supervised classifiers or reinforcement learning agents—to predict the most suitable next-hop node. This module intelligently prioritizes messages based on delivery probabilities, buffer availability, and message time-to-live (TTL) values. By dynamically adapting to the changing topology and node behavior, this component ensures high delivery efficiency and low latency in routing.

To fortify data confidentiality and resilience against quantum-era threats, a Post-Quantum Cryptographic Layer is embedded into the architecture. This layer applies quantum-safe cryptographic algorithms such as CRYSTALS-Kyber for encryption and Dilithium for digital signatures. These algorithms secure each packet before storage or transmission and enable secure authentication at every node hop. This ensures that even in resource-constrained DTNs, the communication remains robust against both classical and quantum cryptographic attacks.

In tandem with routing and encryption, the system includes a Trust and Behavior Analysis Engine. This component evaluates node credibility by analyzing their delivery behavior, drop patterns, and responsiveness. It assigns trust scores using AI models such as fuzzy logic or support vector machines. Nodes that exhibit selfish or malicious behavior are penalized or blacklisted, thereby minimizing the impact of insider threats like blackhole and flooding attacks.

All these components operate within the overarching DTN Communication Framework, which orchestrates message buffering, delay-aware scheduling, and intelligent handovers between intermittently connected nodes. To ensure continual performance improvement, a Monitoring and Feedback Loop tracks metrics such as delivery ratio, end-to-end delay, and attack frequency. These insights are fed back into the AI module to retrain the models periodically, enabling adaptive learning based on evolving network conditions.

This cohesive, modular architecture enhances the overall performance and security of DTNs, making them more resilient, intelligent, and future-proof for mission-critical applications in challenging environments.

The AI-based optimized Opportunistic Buffer Routing (OBR) module is a key component of the proposed architecture, designed to enhance the routing efficiency in Delay Tolerant Networks. This module leverages machine learning algorithms to intelligently evaluate and predict the best possible forwarding decisions. Rather than relying on static routing tables or probability-based methods alone, the AI model continuously learns from real-time network features such as node contact frequency, buffer availability, historical delivery outcomes, and time-to-live (TTL) of messages. Based on this information, the system dynamically selects the next-hop node with the highest likelihood of successful message delivery while avoiding congestion and resource wastage. Reinforcement learning, in particular, can be employed to fine-tune routing strategies based on reward feedback from successful transmissions. This dynamic and predictive routing mechanism significantly reduces overhead, improves packet delivery ratios, and adapts efficiently to fluctuating network conditions and mobility patterns.

Integrated into the routing system is the post-quantum cryptographic layer, which ensures that all communications are protected from both classical and quantum attacks. Given the rise of quantum computing, traditional encryption algorithms like RSA and ECC are no longer considered secure for future-proof applications. To address this, the proposed system incorporates quantum-safe algorithms such as CRYSTALS-Kyber for key encapsulation and Dilithium for digital signatures. These algorithms, selected based on NIST's post-quantum cryptography standardization project, provide robust security with efficient computational overhead suitable for resource-limited DTN nodes. Encryption is applied before messages are stored or transmitted, while signature verification ensures data authenticity at each hop. This layer operates transparently alongside the routing mechanism, ensuring secure end-to-end delivery without compromising performance.

Complementing these modules is the trust and behavior analysis engine, which safeguards the network against internal threats by continuously monitoring and evaluating node behavior. In decentralized DTNs, nodes may act selfishly or maliciously—dropping packets, misrouting data, or launching denial-of-service attacks. To mitigate these risks, the trust engine analyzes parameters such as packet forwarding success, drop rates, responsiveness, and historical interactions to assign trust scores to each node. Machine learning models such as support vector machines (SVM) or fuzzy logic classifiers are used to interpret these metrics and classify node behavior. Nodes with low trust scores are penalized or excluded from routing decisions, thereby isolating potential threats and preserving the integrity of the network. This behavior-aware trust management mechanism is essential for sustaining a secure and cooperative DTN environment, especially when deployed in mission-critical or adversarial settings.

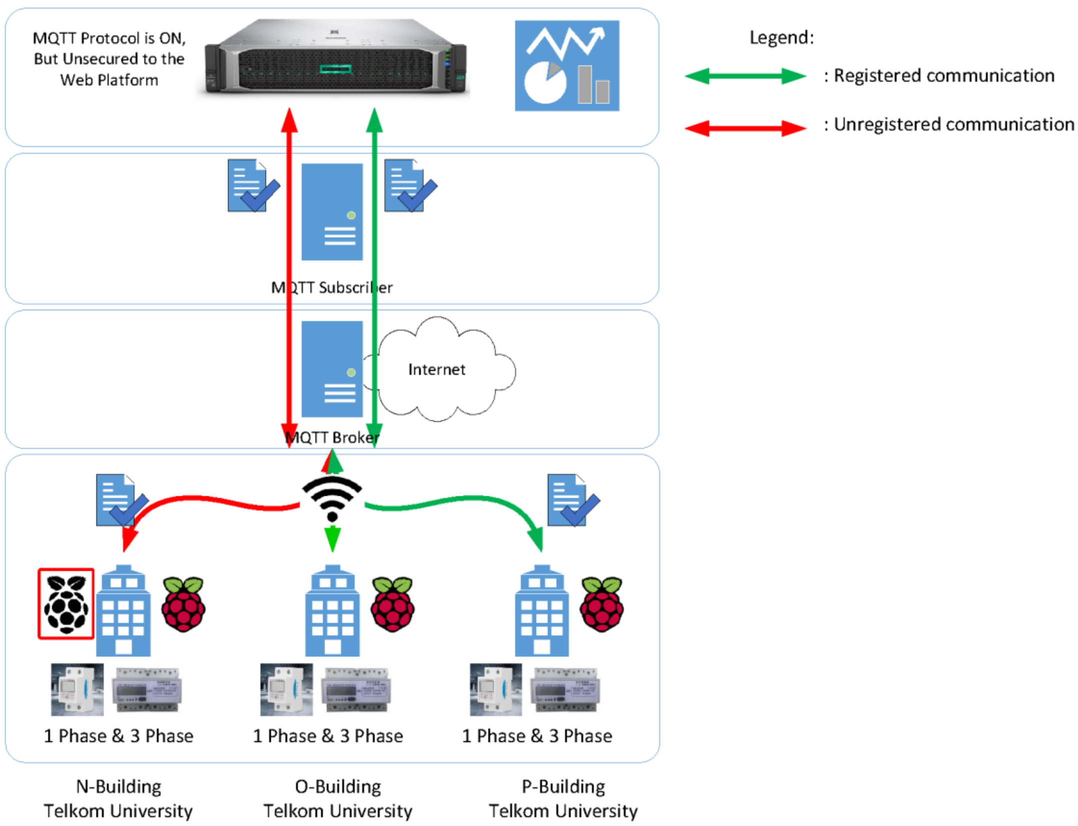


**FIGURE 1.** Post-Quantum Cryptographic Algorithm Implementations for Secure and Efficient Energy Systems Monitoring.

## CONCLUSION

In conclusion, the proposed architecture presents a robust and intelligentframework for enhancing the security and performance of Delay Tolerant Networks (DTNs). By integrating an AI-drivenoptimizedOpportunistic Buffer Routing (OBR) module, the system dynamicallyadaptsroutingdecisionsbased on real-time network conditions, nodebehavior, and deliveryprobabilities. This significantlyimproves message deliveryefficiencywhilereducing congestion and unnecessaryreplication. The incorporation of post-quantum cryptographic techniques ensuresthat the security of data transmission remainsresilientevenagainstemerging quantum computingthreats. Additionally, the trust and behavioranalysis engine provides a proactive defensemechanism by isolatingmisbehaving or maliciousnodes, therebymaintaining the overallintegrity and reliability of the network. Collectively, these components form a comprehensive solution thataddresses the dual challenges of routingefficiency and long-termsecurity in DTNs.

Looking forward, several enhancements can be incorporated to further strengthen the proposed system. One potential direction is the implementation of federated learning techniques, which would enable distributed training of the AI model across nodes without sharing sensitive data. This would not only improve privacy but also reduce centralized computation overhead. Another avenue is the integration of lightweight blockchain mechanisms for decentralized trust validation, which could enhance transparency and reduce reliance on individual trust scoring. Additionally, optimizing the post-quantum cryptographic layer for resource-constrained DTN environments—by exploring hybrid cryptographic approaches or compressed key formats—can make the system even more efficient. Future work could also explore real-world testbed deployment in vehicular or rural communication scenarios to evaluate the practical scalability and resilience of the proposed architecture under dynamic, real-time constraints.

## REFERENCES

1. Srinivasan, R. (2025). Friction Stir Additive Manufacturing of AA7075/Al2O3 and Al/MgB2 Composites for Improved Wear and Radiation Resistance in Aerospace Applications. *J. Environ. Nanotechnol*, *14*(1), 295-305.
2. Deepa, R., Karthick, R., Velusamy, J., & Senthilkumar, R. (2025). Performance analysis of multiple-input multiple-output orthogonal frequency division multiplexing system using arithmetic optimization algorithm. Computer Standards & Interfaces, 92, 103934.
3. Vijayalakshmi, K., Amuthakkannan, R., Ramachandran, K., &Rajkavin, S. A. (2024). Federated Learning-Based Futuristic Fault Diagnosis and Standardization in Rotating Machinery. *SSRG International Journal of Electronics and Communication Engineering*, *11*(9), 223-236.
4. Rajakannu, A. (2024). Implementation of Quality Function Deployment to Improve Online Learning and Teaching in Higher Education Institutes of Engineering in Oman. *International Journal of Learning, Teaching and Educational Research*, *23*(12), 463-486.
5. Rajakannu, A., Ramachandran, K. P., & Vijayalakshmi, K. (2024). Application of Artificial Intelligence in Condition Monitoring for Oil and Gas Industries.
6. Al Haddabi, T., Rajakannu, A., & Al Hasni, H. (2024). Design and Development of a Low-Cost Parabolic Type Solar Dryer and Its Performance Evaluation in Drying of King Fish–Case Study in Oman.
7. Rajakannu, A., Ramachandran, K. P., & Vijayalakshmi, K. (2024). Condition Monitoring of Drill Bit for Manufacturing Sector Using Wavelet Analysis and Artificial Neural Network (ANN).

8. Sakthibalan, P., Saravanan, M., Ansal, V., Rajakannu, A., Vijayalakshmi, K., & Vani, K. D. (2023). A Federated Learning Approach for ResourceConstrained IoT Security Monitoring. In *Handbook on Federated Learning* (pp. 131-154). CRC Press.
9. Prova, N. N. I. (2024, August). Healthcare Fraud Detection Using Machine Learning. In *2024 Second International Conference on Intelligent Cyber Physical Systems and Internet of Things (ICoICI)* (pp. 1119-1123). IEEE.
10. Prova, N. N. I. (2024, August). Advanced Machine Learning Techniques for Predictive Analysis of Health Insurance. In *2024 Second International Conference on Intelligent Cyber Physical Systems and Internet of Things (ICoICI)* (pp. 1166-1170). IEEE.
11. Sidharth, S. (2023). AI-Driven Anomaly Detection for Advanced Threat Detection.
12. Prova, N. N. I. (2024, August). Garbage Intelligence: Utilizing Vision Transformer for Smart Waste Sorting. In *2024 Second International Conference on Intelligent Cyber Physical Systems and Internet of Things (ICoICI)* (pp. 1213-1219). IEEE.
13. Prova, N. N. I. (2025). Enhancing Agricultural Research with an Attention-Based Hybrid Model for Precise Classification of Rice Varieties. *Authorea Preprints*.
14. Prova, N. N. I. (2024, October). Improved Solar Panel Efficiency through Dust Detection Using the InceptionV3 Transfer Learning Model. In *2024 8th International Conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud)(I-SMAC)* (pp. 260-268). IEEE.
15. Sidharth, S. (2017). Real-Time Malware Detection Using Machine Learning Algorithms.
16. Arun, R., Bhakar, S., Turlapati, V. R., Shanthi, P., & Saikumari, V. (2024). From Data to Decisions on Artificial Intelligence's Influence on Digital Marketing Research. In *Optimizing Intelligent Systems for Cross-Industry Application* (pp. 1-18). IGI Global.
17. Turlapati, V. R., Thirunavukkarasu, T., Aiswarya, G., Thoti, K. K., Swaroop, K. R., & Mythily, R. (2024, November). The Impact of Influencer Marketing on Consumer Purchasing Decisions in the Digital Age Based on Prophet ARIMA-LSTM Model. In *2024 International Conference on Integrated Intelligence and Communication Systems (ICIICS)* (pp. 1-6). IEEE.
18. Sidharth, S. (2019). Quantum-Enhanced Encryption Methods for Securing Cloud Data.
19. Indoria, D., Dakshinamoorthy, B., Karthik, M., Sharma, M., Kaliappan, S., & Manikandan, G. (2024, December). Transforming HR in Finance by Leveraging IoT and AI for Strategic Talent Management. In *2024 International Conference on Innovative Computing, Intelligent Communication and Smart Electrical Systems (ICSES)* (pp. 1-6). IEEE.
20. Wisetsri, W., Clingan, P., Dwyer, R. J., &Bakhronova, D. (Eds.). (2024). Emerging Trends in Smart Societies: Interdisciplinary Perspectives.
21. Kumar, P., Indoria, D., Chanti, Y., Tayal, M., Singh, J., & Munagala, M. (2024, May). Enhancing Security for Online Transactions through Supervised Machine Learning in Credit Card Fraud Detection. In *2023 International Conference on Smart Devices (ICSD)* (pp. 1-6). IEEE.
22. Indoria, D., Singh, J., Garg, N., Tiwari, M., Karthik, B. N., & Shaik, N. (2024, March). Security Evaluation and Oversight in Stock Trading Using Artificial Intelligence. In *International Conference on Innovation and Emerging Trends in Computing and Information Technologies* (pp. 105-115). Cham: Springer Nature Switzerland.
23. Devi, K., & Indoria, D. (2024). Impact of Russia-Ukraine War on the Financial Sector of India. *Drishtikon: A Management Journal*, *15*(1).
24. Indoria, D., Kiran, P. N., Kumar, A., Goel, M., Shelke, N. A., & Singh, J. (2023, November). Artificial intelligence and machine learning in human resource management and market research for enhanced effectiveness and organizational benefits. In *2023 International Conference on Computing, Communication, and Intelligent Systems (ICCCIS)* (pp. 1135-1140). IEEE.

25. Kalimuthu, S., Perumal, T., Yaakob, R., Marlisah, E., & Babangida, L. (2021, March). Human Activity Recognition based on smart home environment and their applications, challenges. In *2021 International Conference on Advance Computing and Innovative Technologies in Engineering (ICACITE)* (pp. 815-819). IEEE.
26. Vidhyasagar, B. S., Lakshmanan, A. S., Abishek, M. K., & Kalimuthu, S. (2023, October). Video captioning based on sign language using yolov8 model. In *IFIP International Internet of Things Conference* (pp. 306-315). Cham: Springer Nature Switzerland.
27. Ramanujam, E., Kalimuthu, S., Harshavardhan, B. V., & Perumal, T. (2023, October). Improvement in Multi-resident Activity Recognition System in a Smart Home Using Activity Clustering. In *IFIP International Internet of Things Conference* (pp. 316-334). Cham: Springer Nature Switzerland.
28. Vidhyasagar, B. S., Harshagnan, K., Diviya, M., & Kalimuthu, S. (2023, October). Prediction of Tomato Leaf Disease Plying Transfer Learning Models. In *IFIP International Internet of Things Conference* (pp. 293-305). Cham: Springer Nature Switzerland.
29. Sidharth, S. (2022). Zero Trust Architecture: A Key Component of Modern Cybersecurity Frameworks.
30. Vidhyasagar, B. S., Arvindhan, M., Arulprakash, A., Kannan, B. B., & Kalimuthu, S. (2023, November). The crucial function that clouds access security brokers play in ensuring the safety of cloud computing. In *2023 International Conference on Communication, Security and Artificial Intelligence (ICCSAI)* (pp. 98-102). IEEE.
31. Sidharth, S. (2018). Optimized Cooling Solutions for Hybrid Electric Vehicle Powertrains.
32. Sivakumar, K., Perumal, T., Yaakob, R., &Marlisah, E. (2024, March). Unobstructive human activity recognition: Probabilistic feature extraction with optimized convolutional neural network for classification. In *AIP Conference Proceedings* (Vol. 2816, No. 1). AIP Publishing.
33. Raja, D. R. K., Abas, Z. A., Kumar, G. H., Murthy, C. R., & Eswari, V. (2024). Hybrid optimization algorithm for resource-efficient and data-driven performance in agricultural IoT. *TELKOMNIKA (Telecommunication Computing Electronics and Control)*, *23*(1), 201-210.
34. Kumar, G. H., Raja, D. K., Varun, H. D., &Nandikol, S. (2024, November). Optimizing Spatial Efficiency Through Velocity-Responsive Controller in Vehicle Platooning. In *2024 8th International Conference on Computational System and Information Technology for Sustainable Solutions (CSITSS)* (pp. 1-5). IEEE.
35. Kumar, G. H., KN, V. S., Patil, P., Moinuddin, M., Faraz, M., & Kumar, Y. D. (2024, September). Human-Computer Interaction for Drone Control through Hand Gesture Recognition with MediaPipe Integration. In *2024 International Conference on Vehicular Technology and Transportation Systems (ICVTTS)* (Vol. 1, pp. 1-6). IEEE.
36. Kumar, G. H., Raja, D. K., Suresh, S., Kottamala, R., & Harsith, M. (2024, August). Vision-Guided Pick and Place Systems Using Raspberry Pi and YOLO. In *2024 2nd International Conference on Networking, Embedded and Wireless Systems (ICNEWS)* (pp. 1-7). IEEE.
37. Sidharth, S. (2020). The Rising Threat of Deepfakes: Security and Privacy Implications.
38. Raja, D. K., Abas, Z., Eswari, V., Kumar, G. H., & Kalpanad, V. (2024). Integrating RFID Technology with Student Information Systems. *High Performance Computing, Smart Devices and Networks*, 125.
39. Kumar Raja, D. R., Abas, Z., Eswari, V., Hemanth Kumar, G., & Kalpana, V. (2023, December). Integrating RFID Technology with Student Information Systems for Enhanced Management of Attendance and Financial Records. In *International Conference on Computer Vision, High-Performance Computing, Smart Devices, and Networks* (pp. 125-135). Singapore: Springer Nature Singapore.

40. Sidharth, S. (2024). Strengthening Cloud Security with AI-Based Intrusion Detection Systems.
41. Seshanna, M., Kumar, H., Seshanna, S., & Alur, N. (2021). THE INFLUENCE OF FINANCIAL LITERACY ON COLLECTIBLES AS AN ALTERNATIVE INVESTMENT AVENUE: EFFECTS OF FINANCIAL SKILL, FINANCIAL BEHAVIOUR AND PERCEIVED KNOWLEDGE ON INVESTORS'FINANCIAL WELLBEING. *Turkish Online Journal of Qualitative Inquiry*, *12*(4).
42. Rao, P. S. (2008). *International Business Environment*. HIMALAYA PUBLISHING HOUSE 2nd Rev. ed..
43. Sreekanthaswamy, N., Anitha, S., Singh, A., Jayadeva, S. M., Gupta, S., Manjunath, T. C., & Selvakumar, P. (2025). Digital Tools and Methods. *Enhancing School Counseling With Technology and Case Studies*, *25*.
44. Sidharth, S. (2016). The Role of Artificial Intelligence in Enhancing Automated Threat Hunting 1Mr. Sidharth Sharma.
45. Sreekanthaswamy, N., & Hubballi, R. B. (2024). Innovative Approaches ToFmcg Customer Journey Mapping: The Role Of Block Chain And Artificial Intelligence In Analyzing Consumer Behavior And Decision-Making. *Library of Progress-Library Science, Information Technology & Computer*, *44*(3).
46. Kalluri, S. V. S., & Narra, S. (2024). Predictive Analytics in ADAS Development: Leveraging CRM Data for Customer-Centric Innovations in Car Manufacturing. *vol*, *9*, 6.
47. Kalluri, V. S. Optimizing Supply Chain Management in Boiler Manufacturing through AI-enhanced CRM and ERP Integration. *International Journal of Innovative Science and Research Technology (IJISRT)*.
48. Kalluri, V. S. Impact of AI-Driven CRM on Customer Relationship Management and Business Growth in the Manufacturing Sector. *International Journal of Innovative Science and Research Technology (IJISRT)*.
49. Sidharth, S. (2017). Cybersecurity Approaches for IoT Devices in Smart City Infrastructures.
50. Sidharth, S. (2019). DATA LOSS PREVENTION (DLP) STRATEGIES IN CLOUD-HOSTED APPLICATIONS.
51. Kalaiselvi, B., & Thangamani, M. (2020). An efficient Pearson correlation based improved random forest classification for protein structure prediction techniques. *Measurement*, *162*, 107885.
52. Prabhu Kavin, B., Karki, S., Hemalatha, S., Singh, D., Vijayalakshmi, R., Thangamani, M., ... &Adigo, A. G. (2022). Machine learning-based secure data acquisition for fake accounts detection in future mobile communication networks. *Wireless Communications and Mobile Computing*, *2022*(1), 6356152.
53. Geeitha, S., & Thangamani, M. (2018). Incorporating EBO-HSIC with SVM for gene selection associated with cervical cancer classification. *Journal of medical systems*, *42*(11), 225.
54. Kumar, J. S., Archana, B., Muralidharan, K., & Kumar, V. S. (2025). Graph Theory: Modelling and Analyzing Complex System. *Metallurgical and Materials Engineering*, *31*(3), 70-77.
55. Anandasubramanian, C. P., & Selvaraj, J. (2024). NAVIGATING BANKING LIQUIDITY-FACTORS, CHALLENGES, AND STRATEGIES IN CORPORATE LOAN PORTFOLIOS. *Tec Empresarial*, *6*(1).
56. Madem, S., Katuri, P. K., Kalra, A., & Singh, P. (2023, May). System Design for Financial and Economic Monitoring Using Big Data Clustering. In *2023 International Conference on Advances in Computing, Communication and Applied Informatics (ACCAI)* (pp. 1-7). IEEE.
57. Srikanth, V., & Dhanapal, D. R. (2012). E-commerce online security and trust marks. *International Journal of Computer Engineering and Technology*, *3*(2), 238-255.
58. Srikanth, V., Walia, R., Augustine, P. J., Simla, J., & Jegajothi, B. (2022, March). Chaotic Whale Optimization based Node Localization Protocol for Wireless Sensor Networks Enabled Indoor

Communication. In *2022 International Conference on Electronics and Renewable Systems (ICEARS)* (pp. 702-707). IEEE.

59. Srikanth, V., Natarajan, V., Jegajothi, B., Arumugam, S. D., & Nageswari, D. (2022, March). Fruit fly optimization with deep learning based reactive power optimization model for distributed systems. In *2022 International Conference on Electronics and Renewable Systems (ICEARS)* (pp. 319-324). IEEE.
60. Singh, S., Srikanth, V., Kumar, S., Saravanan, L., Degadwala, S., & Gupta, S. (2022, February). IOT Based Deep Learning framework to Diagnose Breast Cancer over Pathological Clinical Data. In *2022 2nd International Conference on Innovative Practices in Technology and Management (ICIPTM)* (Vol. 2, pp. 731-735). IEEE.
61. Srikanth, V., & Dhanapal, R. (2011). A business review of e-retailing in India. *International journal of business research and management*, *1*(3), 105-121.
62. Srikanth, V. (2011). An Insight to Build an E-Commerce Website with OSCommerce. *International Journal of Computer Science Issues (IJCSI)*, *8*(3), 332.
63. Srikanth, V., Aswini, P., Asha, V., Pithamber, K., Sobti, R., & Salman, Z. (2024, November). Development of an Electric Automation Control Model Using Artificial Intelligence. In *2024 Second International Conference Computational and Characterization Techniques in Engineering & Sciences (IC3TES)* (pp. 1-5). IEEE.
64. Punithavathi, R., Selvi, R. T., Latha, R., Kadiravan, G., Srikanth, V., & Shukla, N. K. (2022). Robust Node Localization with Intrusion Detection for Wireless Sensor Networks. *Intelligent Automation & Soft Computing*, *33*(1).
65. Srikanth, V., Aswini, P., Chandrashekar, R., Sirisha, N., Kumar, M., & Adnan, K. (2024, November). Machine Learning-Based Analogue Circuit Design for Stage Categorization and Evolutionary Optimization. In *2024 Second International Conference Computational and Characterization Techniques in Engineering & Sciences (IC3TES)* (pp. 1-6). IEEE.
66. Lopez, S., Sarada, V., Praveen, R. V. S., Pandey, A., Khuntia, M., &Haralayya, D. B. (2024). Artificial intelligence challenges and role for sustainable education in india: Problems and prospects. *Sandeep Lopez, Vani Sarada, RVS Praveen, Anita Pandey, Monalisa Khuntia, BhadrappaHaralayya (2024) Artificial Intelligence Challenges and Role for Sustainable Education in India: Problems and Prospects. Library Progress International*, *44*(3), 18261-18271.
67. Yamuna, V., Praveen, R. V. S., Sathya, R., Dhivva, M., Lidiya, R., & Sowmiya, P. (2024, October). Integrating AI for Improved Brain Tumor Detection and Classification. In *2024 4th International Conference on Sustainable Expert Systems (ICSES)* (pp. 1603-1609). IEEE.
68. Kumar, N., Kurkute, S. L., Kalpana, V., Karuppannan, A., Praveen, R. V. S., & Mishra, S. (2024, August). Modelling and Evaluation of Li-ion Battery Performance Based on the Electric Vehicle Tiled Tests using Kalman Filter-GBDT Approach. In *2024 International Conference on Intelligent Algorithms for Computational Intelligence Systems (IACIS)* (pp. 1-6). IEEE.
69. Sharma, S., Vij, S., Praveen, R. V. S., Srinivasan, S., Yadav, D. K., & VS, R. K. (2024, October). Stress Prediction in Higher Education Students Using Psychometric Assessments and AOA-CNN-XGBoost Models. In *2024 4th International Conference on Sustainable Expert Systems (ICSES)* (pp. 1631-1636). IEEE.
70. Anuprathibha, T., Praveen, R. V. S., Sukumar, P., Suganthi, G., & Ravichandran, T. (2024, October). Enhancing Fake Review Detection: A Hierarchical Graph Attention Network Approach Using Text and Ratings. In *2024 Global Conference on Communications and Information Technologies (GCCIT)* (pp. 1-5). IEEE.
71. Shinkar, A. R., Joshi, D., Praveen, R. V. S., Rajesh, Y., & Singh, D. (2024, December). Intelligent solar energy harvesting and management in IoT nodes using deep self-organizing maps. In *2024 International Conference on Emerging Research in Computational Science (ICERCS)* (pp. 1-6). IEEE.
72. Praveen, R. V. S., Hemavathi, U., Sathya, R., Siddiq, A. A., Sanjay, M. G., &Gowdish, S. (2024, October). AI Powered Plant Identification and Plant Disease Classification System. In *2024 4th International Conference on Sustainable Expert Systems (ICSES)* (pp. 1610-1616). IEEE.

73. Ramesh, T. R., Lilhore, U. K., Poongodi, M., Simaiya, S., Kaur, A., & Hamdi, M. (2022). Predictive analysis of heart diseases with machine learning approaches. *Malaysian Journal of Computer Science*, 132-148.
74. Ramesh, T. R., Vijayaragavan, M., Poongodi, M., Hamdi, M., Wang, H., & Bourouis, S. (2022). Peer-to-peer trust management in intelligent transportation system: An Aumann's agreement theorem based approach. *ICT Express*, *8*(3), 340-346.
75. Ramesh, T. R., & Kavitha, C. (2013). Web user interest prediction framework based on user behavior for dynamic websites. *Life Sci. J*, *10*(2), 1736-1739.
76. Jayapandiyan, J. R., Kavitha, C., & Sakthivel, K. (2020). Enhanced least significant bit replacement algorithm in spatial domain of steganography using character sequence optimization. *Ieee Access*, *8*, 136537-136545.
77. Sakthivel, K., Jayanthiladevi, A., & Kavitha, C. (2016). Automatic detection of lung cancer nodules by employing intelligent fuzzy c-means and support vector machine. *BIOMEDICAL RESEARCH-INDIA*, *27*, S123-S127.
78. Sakthivel, K., Nallusamy, R., & Kavitha, C. (2014). Color image segmentation using SVM pixel classification image. *World Academy of Science, Engineering and Technology International Journal of Computer, Electrical, Automation, Control and Information Engineering*, *8*(10), 1924-1930.
79. Hussain, M. I., Shamim, M., Ravi Sankar, A. V., Kumar, M., Samanta, K., & Sakhare, D. T. (2022). The effect of the Artificial Intelligence on learning quality & practices in higher education. *Journal of Positive School Psychology*, 1002-1009.
80. Prasad, V., Dangi, A. K., Tripathi, R., & Kumar, N. (2023). Educational Perspective of Intellectual Property Rights. *Russian Law Journal*, *11*(2S), 257-268.
81. Shreevamshi, D. V. K., Jadhavar, S. S., Vemuri, V. P., & Kumar, A. (2022). Role Of Green HRM in Advocating Pro-Environmental Behavior Among Employees. *Journal of Positive School Psychology*, *6*(2), 3117-3129.
82. Somasundaram, R., Chandra, S., Tamilarasu, J., Kinagi, A. M., & Naveen, S. (2025). Human Resource Development (HRD) Strategies for Emerging Entrepreneurship: Leveraging UX Design for Sustainable Digital Growth. In *Navigating Usability and User Experience in a Multi-Platform World* (pp. 221-248). IGI Global.