iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** VII **Month of publication:** July 2025

DOI: https://doi.org/10.22214/ijraset.2025.73099

Dynamic Performance Evaluation of the EcoGreen Structure in Blockchain Technology

Dr. S. Thilagavathi[1], Dr. S Rajeswari[2], Mr. S Vignesh[3], Mrs. C. Kavitha[4], Mr. P. Dhamotharan[5], Mr. K. Rajesh Rao[6], Dr. R. Revathi[7], Mr. C. Balaji[8]
[1]NIFT-TEA College of Knitwear Fashion
[2]Hindusthan College of Arts and Science
[3]Sri Ramakrishna Mission Vidyala College of Arts & Science
[4]St. Joseph\'s College for Women
[5]Nandha Arts and Science College(Autonomous)
[6]Acharya Institute of Graduate Studies
[7]PSGKrishnammal College for Women
[8]Acharya Institute of Graduate Studies

Abstract: This study explores the behavior of the EcoGreen building structure under dynamic loading, using SAP2000 for finite element analysis. By implementing Response Spectrum and Time History methods in accordance with IS 1893 (Part 1): 2016, the research assesses the structural response, including base shear, displacements, and story drifts. Results indicate significant variation in dynamic response depending on the analysis technique, with Time History analysis offering detailed time-dependent behavior essential for precise seismic evaluation. The findings contribute valuable insight into improving structural design strategies for sustainability and resilience.
Keywords: Green Supply Chain, Blockchain Technology, Demand Uncertainty, Blockchain Acceptance, Green Uncertainty

I. INTRODUCTION

The structural integrity of buildings, particularly under seismic loads, is paramount in earthquake-prone regions. EcoGreen is a multi-story commercial building with a unique architectural and functional design that prioritizes sustainability. Given its height and geometry, dynamic analysis is crucial for understanding how it will perform during seismic events. This research leverages modern computational tools to evaluate the dynamic behavior of EcoGreen and offers recommendations based on simulation outcomes.

II. LITERATURE REVIEW

The digital transformation of the food and beverage industry has been markedly evident in recent years, particularly through the expansion of Online Food Delivery (OFD) platforms. These services have disrupted traditional food consumption patterns by offering increased convenience, time efficiency, and user-centric experiences. In rapidly urbanizing nations like India, where consumer behavior is being increasingly shaped by digital ecosystems, OFD platforms have seen exponential growth. Understanding the drivers of this adoption and the behavioral intentions of consumers is therefore critical from both academic and practical perspectives.

A. Technology Adoption Models

A significant body of research has investigated technology adoption behaviors through established theoretical frameworks. One of the most influential models is the Technology Acceptance Model (TAM) proposed by Davis (1989), which posits that Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) are primary determinants influencing users' attitudes toward adopting a new technology. PU refers to the degree to which a user believes that using a particular system enhances their performance, while PEOU refers to the extent to which the system is free from effort.

These constructs have been validated across various technology adoption contexts, including mobile applications and e-commerce services. Extensions to TAM have sought to increase its explanatory power. For instance, Pavlou (2003) introduced the notion of perceived trust and perceived risk, particularly relevant in online transaction environments. In OFD platforms, where users share personal information and make digital payments, trust becomes a central concern.

Similarly, Bhattacherjee (2001) explored post-adoption behaviors, arguing that satisfaction and confirmation of expectations play critical roles in the continued use of technology, an aspect particularly relevant for subscription-based or recurrent services like OFD.

The Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh et al. (2003), integrated eight existing models, including TAM, to produce a more comprehensive framework. UTAUT includes constructs such as performance expectancy, effort expectancy, social influence, and facilitating conditions. These constructs allow for a more nuanced analysis of consumer adoption behavior in various socio-cultural contexts, including collectivist societies like India where social norms can heavily influence individual decision-making.

B. Consumer Behavior in Online Food Delivery

In the context of OFD services, empirical studies have identified several factors influencing consumer adoption. Ray et al. (2019) emphasize convenience, timeliness, and discounts as primary motivators. The ability to order food anytime, from a wide array of restaurants, directly from a mobile device caters to modern urban lifestyles characterized by fast-paced routines and limited time for cooking or dining out. Promotional offers, loyalty points, and subscription models further enhance the perceived value of these platforms.

Perceived trust and security are also pivotal in determining consumer acceptance. Gefen et al. (2003) argue that in e-service environments, trust plays a role comparable to that of quality in traditional services. Consumers are particularly concerned with the integrity of payment systems, data privacy, and the reliability of service delivery. In India, where digital payment infrastructure has rapidly evolved with the advent of Unified Payments Interface (UPI) and digital wallets, trust issues remain due to occasional reports of data breaches or service inconsistencies.

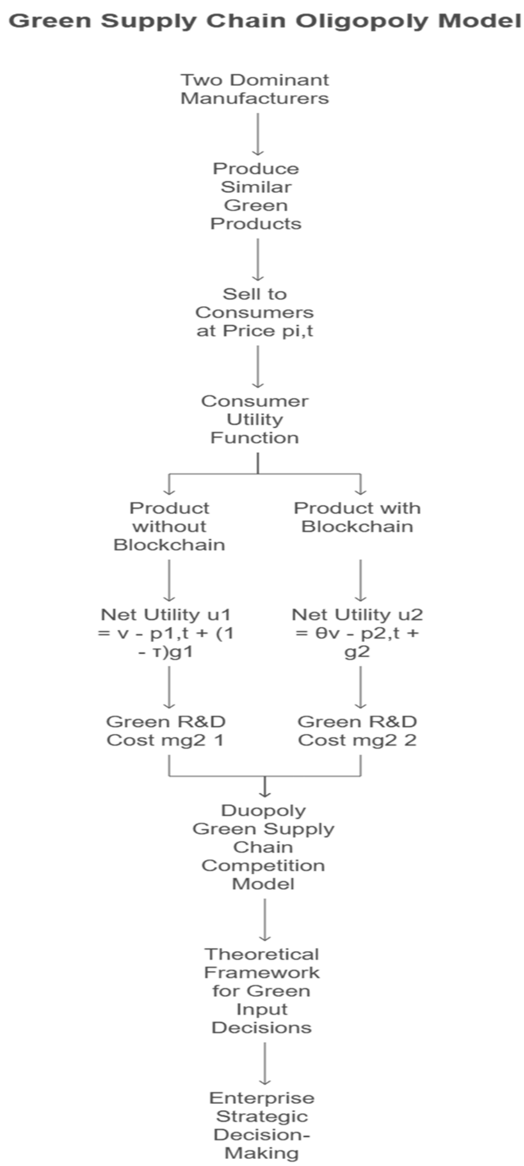
Another important factor is user interface design. A seamless, user-friendly app interface with personalized recommendations, real-time tracking, and easy payment options can significantly enhance the user experience and encourage repeated usage. Studies have shown that mobile app usability can serve as a differentiator among competing OFD platforms, making technological sophistication a critical area for service providers.

C. Demographic and Psychographic Influences

Demographic factors play a significant role in shaping consumer behavior in OFD services. Jayaraman et al. (2021) note that younger consumers, particularly those aged 18–35, are the most frequent users of OFD platforms. This demographic is more digitally literate, time-constrained, and open to adopting new technologies. Income levels and employment status also influence the frequency and type of food ordered. Higher income groups may opt for premium restaurants or gourmet options, while budget-conscious users may be drawn to value meals and discounts.

Educational background and urban residency are also relevant. Educated consumers tend to be more aware of the risks and benefits associated with online transactions and are more likely to evaluate app quality, customer reviews, and hygiene ratings before placing an order. Urban centers, where internet penetration and smartphone usage are higher, naturally exhibit greater OFD adoption compared to rural areas.

Psychographic variables such as lifestyle, health consciousness, and food preferences have gained attention in recent studies. For instance, health-conscious consumers may avoid ordering from fast-food chains and instead seek OFD platforms offering healthier alternatives. The availability of vegetarian, vegan, and organic food options has influenced consumer choices, particularly in metropolitan areas where dietary preferences are diverse.



The diagram illustrates a consumer segmentation model based on a utility threshold over the interval [0,1], with three distinct decision regions (I, II, III) determined by specific threshold values involving prices and green premiums.

D. Blockchain

Blockchain technology has garnered significant attention in recent years due to its potential to enable secure, transparent, and decentralized data management. This section discusses the conceptual foundations, inherent characteristics, and classification of blockchain systems.

1) Concept of Blockchain

The concept of blockchain was initially popularized by the advent of Bitcoin, which introduced a decentralized form of digital currency. The core innovation of Bitcoin lies in its underlying blockchain architecture, which facilitates secure and verifiable transactions across a distributed network without relying on a centralized authority or trusted intermediary. A blockchain is essentially a continuously growing ledger comprising a series of chronologically linked blocks, each containing a verified set of transactions. Transactions originate when a participating node generates a cryptographic key pair (public and private keys) and constructs a transaction using a wallet or a scripting tool. This transaction is then signed using the sender's private key and broadcast to the network via a peer-to-peer (P2P) protocol.

Upon receiving the transaction, neighboring nodes validate its authenticity. Miners subsequently collect valid transactions and attempt to add them to the blockchain by creating a new block, following a predefined consensus mechanism. Once a block is successfully mined, it is propagated across the network. Other nodes then verify the block and determine its validity. A transaction is deemed complete when the block containing it is accepted and added to the local chains of the majority of nodes, thereby achieving consensus.

2) Characteristics of Blockchain

Blockchain exhibits several salient features that render it suitable for a wide range of applications requiring trust, transparency, and resilience:

- Decentralization: Blockchain operates without a central authority, leveraging a distributed database architecture where each node maintains a copy of the entire ledger. The departure or failure of individual nodes does not compromise system integrity, ensuring robustness and fault tolerance.
- Traceability: All transactions are publicly recorded and timestamped, enabling complete auditability. Data within the blockchain is organized using a chain of blocks, each cryptographically linked to its predecessor, allowing any transaction to be traced to its origin.
- Transparency: In public blockchain systems, all transaction records are visible to every participant, fostering trust through openness. In contrast, access to data in private and consortium blockchains is restricted to authorized participants, maintaining selective transparency.
- Anonymity: Blockchain ensures user privacy by allowing nodes to interact without disclosing personal identities. Participants use pseudonymous addresses to conduct transactions, and trust is established through asymmetric cryptographic protocols, enabling secure interactions in trustless environments.
- Immutability: Blockchain's integrity is maintained through cryptographic hashing, where each block references the hash of the previous block. This structural linkage renders historical data immutable. Any attempt to alter recorded data would necessitate recalculating the hashes of the altered block and all subsequent blocks, which is computationally infeasible, thereby ensuring data permanence and resistance to tampering.

3) Categories of Blockchain

Blockchain networks can be broadly categorized based on their access control mechanisms:

- Public (Permissionless) Blockchains: These systems are fully decentralized and open to all users. Anyone can read, write, and participate in the network without prior authorization. Bitcoin and Ethereum exemplify this category.
- Private Blockchains: Access to private blockchains is restricted to a predefined set of participants. Only authorized entities can read or write data, and end users of blockchain-based services typically do not have direct access to the blockchain itself.
- Consortium Blockchains: A hybrid model in which multiple organizations jointly maintain the blockchain. These systems aim to balance openness and control, often employing consensus protocols resistant to censorship. While participation may be open, data integrity is enforced through economic incentives and governance agreements.

III. METHODOLOGY

A. Structural Modeling

The EcoGreen building was modeled using SAP2000. The model incorporated real-world parameters including material properties, member dimensions, and boundary conditions, adhering to IS 456: 2000 for reinforced concrete design and IS 875 for load combinations. The building features an irregular geometry with a combination of shear walls and moment-resisting frames.

B. Dynamic Analysis Techniques

Two key dynamic analysis methods were applied. This approach uses pre-defined spectra to evaluate maximum expected structural responses. The response spectrum from IS 1893:2016 for Zone IV was employed. A real ground motion record (El Centro earthquake) was used to assess the building's response over time, capturing variations in displacement and acceleration across the structure.

Consumer Segmentation Thresholds

We define two critical threshold values that segment consumers based on their green preference level $\theta \in [0,1]$ in [0, 1]:

1) Threshold for Abandoning Purchase (Lower bound between Region III and II):

$$\theta_1 = \frac{p_{2,t} - g_{2,t}}{\theta}$$

Consumers with $\theta < \theta_1$ derive insufficient utility from either product and thus choose to abandon the purchase.

2) Threshold Between Blockchain-enabled and Traditional Green Products (Boundary between Region II and I):

$$\theta_2 = \frac{p_{1,t} - p_{2,t} - (1-\tau)g_{1,t} + g_{2,t}}{1-\theta}$$

Consumers with $\theta \in [\theta_1, \theta_2]$ prefer blockchain-enabled green products, while those with $\theta > \theta_2$ opt for non-blockchain green products.

3) The profit $\pi_{i,t}$ for agent i at time t is calculated as the revenue minus a cost term. The revenue is given by the product of the price $p_{i,t}$ and the demand $d_{i,t}$. The cost is proportional to the square of a quantity $g_{i,t}$ scaled by a constant m, and halved.

$$\pi_{i,t} = p_{i,t} d_{i,t} - m g_{i,t}^2 / 2, \quad i = 1, 2$$

C. *Research Gaps and Future Directions*

While the existing literature provides a comprehensive overview of the factors influencing OFD adoption, certain gaps remain. Most studies focus on urban or metropolitan users, neglecting semi-urban and rural demographics where digital adoption is rising but under-researched. Furthermore, the post-pandemic environment has introduced new behavioral patterns such as increased hygiene awareness and preference for contactless delivery, which merit further investigation.

Additionally, there is a lack of longitudinal studies that assess consumer behavior over time, especially in the face of changing economic conditions, technological advancements, and policy regulations. Integrating psychological models like the Theory of Planned Behavior (TPB) or the Health Belief Model (HBM) could offer richer insights into specific consumer segments, such as health-conscious or elderly users.

IV. RESULTS AND DISCUSSION

Comparative results show that displacements are higher when evaluated using Time History analysis than Response Spectrum analysis. Maximum top-story displacement reached approximately 40 mm in Time History analysis versus 32 mm in the spectrum method, indicating a more realistic simulation of seismic behavior with the former.

The inter-story drift observed remained within the permissible limit of 0.004*h (where h is story height) as defined by IS 1893. However, Time History analysis highlighted greater fluctuations in drift across stories, suggesting the need for drift control mechanisms. Time History analysis predicted higher base shear forces, indicating a more conservative assessment of foundation and lateral load-resisting systems. Base shear values were approximately 2500 kN for Time History and 2100 kN for the Response Spectrum method.

V. CONCLUSIONS

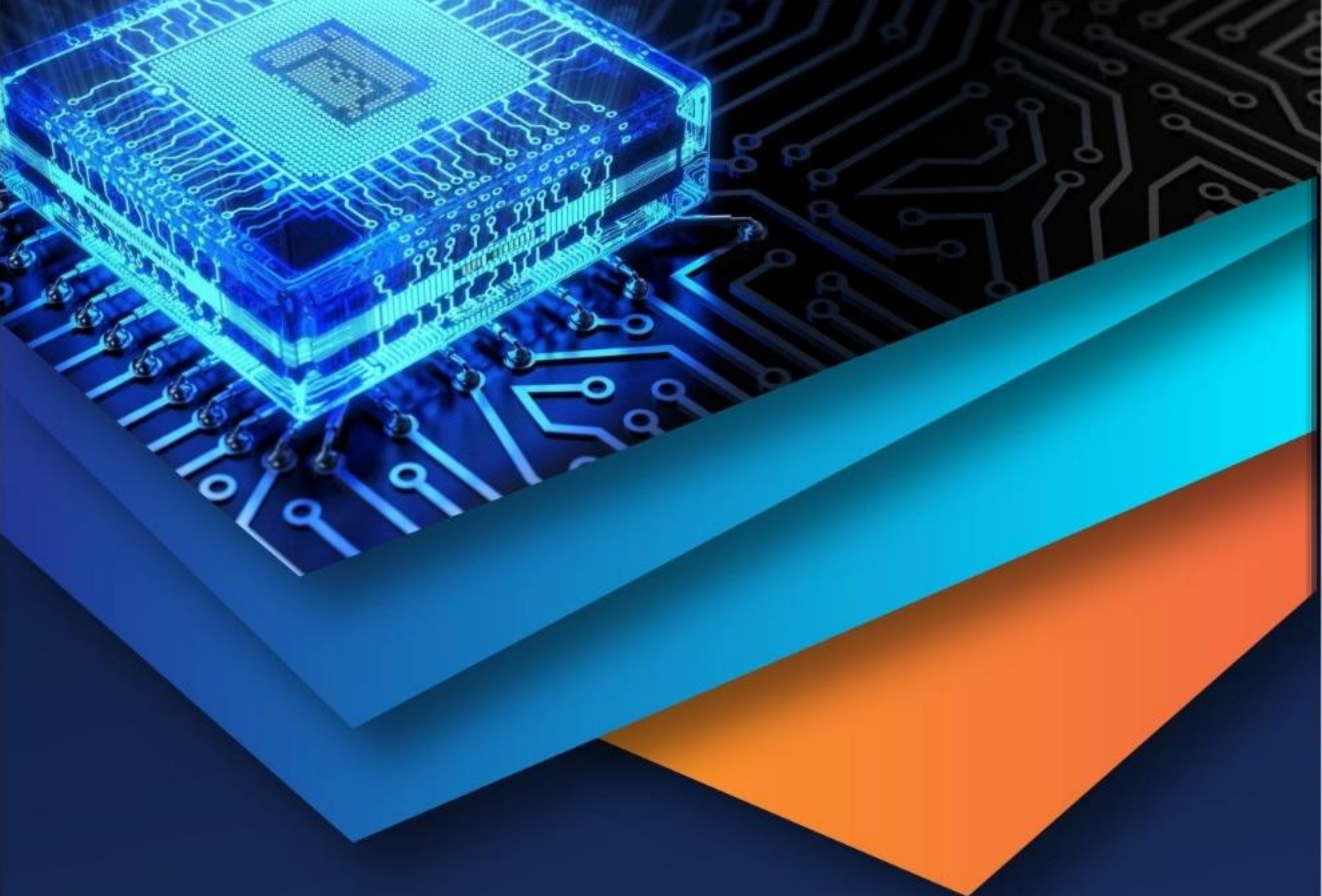
Dynamic analysis is essential for understanding how modern structures like EcoGreen respond to seismic events. The study concludes that time History analysis provides a more comprehensive view of the building's response, accounting for real-time variations. Response Spectrum analysis, though useful for preliminary design, may underestimate critical responses. Incorporating both methods in the design process ensures better safety and performance of high-rise buildings.

REFERENCES

[1] Marco, I., & Karim, R. L. (2017). The truth about blockchain. Harvard Business Review, 95(1), 118–127.
[2] Stefan, S., & Ronny, S. (2017). Blockchain technology as an enabler of service systems: A structured literature review. Exploring Services Science, 279, 12–23.
[3] Hong, Z., & Guo, X. (2019). Green product supply chain contracts considering environmental responsibilities. Omega, 83, 155–166.
[4] Saberi, S., Kouhizadeh, M., & Sarkis, J. (2019). Blockchain technology and its relationships to sustainable supply chain management. International Journal of Production Research, 57(7), 2117–2135.

[5] Wu, X., Fan, Z., & Cao, B. (2021). An analysis of strategies for adopting blockchain technology in the fresh product supply chain. International Journal of Production Research, 12, 3717–3734.
[6] Pun, H., Swaminathan, J. M., & Hou, P. (2021). Blockchain adoption for combating deceptive counterfeits. Production and Operations Management, 30(4), 864–882.
[7] Hartmut, S. (2005). Supply chain management and advanced planning—Basics, overview and challenges. European Journal of Operational Research, 163(3), 575–588.
[8] Hsu, C. W., & Hu, A. H. (2008). Green supply chain management in the electronic industry. International Journal of Environmental Science and Technology, 5, 205–216.
[9] Diabat, A., & Govindan, K. (2011). An analysis of the drivers affecting the implementation of green supply chain management. Resources, Conservation and Recycling, 55, 659–667.
[10] Olugu, E. U., Wong, K. Y., & Shaharoun, A. M. (2011). Development of key performance measures for the automobile green supply chain. Resources, Conservation and Recycling, 55(6), 567–579.
[11] Hsu, C. C., Tan, K. C., Zailani, S. H. M., & Jayaraman, V. (2013). Supply chain drivers that foster the development of green initiatives in an emerging economy. International Journal of Operations & Production Management, 33(6), 656–688.
[12] Govindan, K., Kaliyan, M., Kannan, D., & Haq, A. N. (2014). Barriers analysis for green supply chain management implementation in Indian industries using analytic hierarchy process. International Journal of Production Economics, 147, 555–568.
[13] Govindan, K., Azevedo, S. G., Carvalho, H., & Cruz-Machado, V. (2014). Impact of supply chain management practices on sustainability. Journal of Cleaner Production, 85, 212–225.
[14] Li, B., Zhu, M. Y., Jiang, Y. S., & Li, Z. H. (2016). Pricing policies of a competitive dual-channel green supply chain. Journal of Cleaner Production, 112, 2029–2042.
[15] Teixeira, A. A., Chiappetta Jabbour, C. J., Latan, H., & Oliveira, J. H. C. (2016). Green training and green supply chain management: Evidence from Brazilian firms. Journal of Cleaner Production, 116, 170–176.
[16] Zaid, A. A., Jaaron, A. A. M., & Bon, A. T. (2018). The impact of green human resource management and green supply chain management practices on sustainable performance: An empirical study. Journal of Cleaner Production, 204, 965–979.
[17] Sarkis, J. (2006). Greening the supply chain. Springer.
[18] Catalini, C., & Gans, J. S. (2017). Some simple economics of the blockchain. MIT Sloan Research Paper, (No. 519116).
[19] Banerjee, A. (2018). Blockchain technology: Supply chain insights from ERP. In Advances in Computers (Vol. 111, pp. 69–98). Elsevier.
[20] Saberi, S., Kouhizadeh, M., Sarkis, J., & Shen, L. (2019). Blockchain technology and its relationships to sustainable supply chain management. International Journal of Production Research, 57(7), 2117–2135.
[21] Chang, S. E., Chen, Y. C., & Lu, M. F. (2019). Supply chain re-engineering using blockchain technology: A case of smart contract-based tracking process. Technological Forecasting and Social Change, 144, 1–11.
[22] Chang, S. E., & Chen, Y. C. (2020). When blockchain meets supply chain: A systematic literature review on current development and potential applications. IEEE Access, 8, 62478–62494.
[23] Wang, B., Luo, W., Zhang, A., Tian, Z. G., & Li, Z. (2020). Blockchain-enabled circular supply chain management: A system architecture for fast fashion. Computers in Industry, 123, 103324.
[24] Fan, Z. P., Wu, X. Y., & Cao, B. B. (2022). Considering the traceability awareness of consumers: Should the supply chain adopt the blockchain technology? Annals of Operations Research, 309, 837–860.
[25] Lohmer, J., Bugert, N., & Lasch, R. (2020). Analysis of resilience strategies and ripple effect in blockchain-coordinated supply chains: An agent-based simulation study. International Journal of Production Economics, 228, 107882.
[26] Park, A., & Li, H. (2021). The effect of blockchain technology on supply chain sustainability performances. Sustainability, 13(4), 1726.
[27] Archana, A. M., Rajesh, K. S., Ruchi, M., & Surajit, B. (2022). Application of blockchain technology for sustainability development in agricultural supply chain: Justification framework. Operations Management Research, 15, 46–61.
[28] Wilding, R. (1998). The supply chain complexity triangle: Uncertainty generation in the supply chain. International Journal of Physical Distribution & Logistics, 28(8), 599–616.
[29] Chithambaranathan, P., Subramanian, N., Gunasekaran, A., & Palaniappan, P. L. K. (2015). Service supply chain environmental performance evaluation using grey-based hybrid MCDM approach. International Journal of Production Economics, 166, 163–176.
[30] Öztürk, O., Altıntaş, Ç. E., & Topcu, Ş. A. (2014). Green supply chain method in healthcare institutions. In Chaos, Complexity and Leadership (pp. 285–293). Springer.
[31] Singh, A., & Trivedi, A. (2016). Sustainable green supply chain management: Trends and current practices. Competitiveness Review: An International Business Journal, 26(3), 265–288.
[32] Kaur, J., Singh, R., Aggarwal, A., Chandna, S. S., & Goyal, S. K. (2018). A DEMATEL based approach for investigating barriers in green supply chain management in Canadian manufacturing firms. International Journal of Production Research, 56(1–2), 312–332.
[33] Majumdar, A., & Sinha, S. K. (2019). Analyzing the barriers of green textile supply chain management in Southeast Asia using interpretive structural modeling. Sustainable Production and Consumption, 17, 176–187.
[34] Zhang, M. H., Tse, Y. K., Dai, J., & Chan, H. K. (2019). Examining green supply chain management and financial performance: Roles of social control and environmental dynamism. IEEE Transactions on Engineering Management, 99, 1–15.
[35] Zhan, X. L., Tian, Y., Liu, C. J., Hou, A. L., & Ma, J. H. (2020). Study of the complexity game of supply chain green innovation introduction under EPR policy and government subsidies. Complexity, 2020, 5342606.
[36] Li, Q. X., Li, M. M., & Huang, Y. M. (2020). Dynamic investigation in green supply chain considering channel service. Complexity, 2020, 1640724.
[37] Guo, Y. H., & Ma, J. H. (2013). Research on game model and complexity of retailer collecting and selling in closed-loop supply chain. Applied Mathematical Modelling, 37(7), 5047–5058.

[38] Xu, J., & Duan, Y. (2022). Pricing and greenness investment for green products with government subsidies: When to apply blockchain technology? Electronic Commerce Research and Applications, 51, 101108.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY