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Sustainable and Responsible Supply Chain Architectures: Integrating Technology, Ethics, and Multi-Criteria Decision Frameworks for Resilient Healthcare and Industrial Supply Networks

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ABSTRACT

Background: Contemporary supply chains operate within intensifying pressures: environmental sustainability, social responsibility, regulatory compliance, and the need for technological integration. The literature reveals convergent themes—traceability, ethical sourcing, multi-criteria decision support, and emergent digital infrastructures (RFID, IoT, blockchain)—yet exhibits fragmentation in methods and practical integration across sectors such as healthcare, pharmaceuticals, fashion, renewable energy, and food systems (Tan & Sidhu, 2022; Teh et al., 2019; Mejías et al., 2019; Mastrocinque et al., 2020).

Objective: This study synthesizes theoretical constructs and methodological approaches from the provided literature to propose an integrative framework for sustainable, ethically accountable, and technologically enabled supply chains. The framework unifies traceability systems, corporate social responsibility (CSR) reporting, rights-based implementations, and multi-criteria decision support methods (e.g., AHP, fuzzy AHP, TOPSIS) for supplier selection and risk management.

Methods: A rigorous conceptual meta-analysis was conducted across the supplied references to extract design principles, performance metrics, decision criteria, and technology architectures. The methodological approach maps CSR themes to technical enablers (RFID/IoT, blockchain) and to decision tools (AHP variants, TOPSIS, grey-based methods), producing a layered framework with governance, technological, and analytical strata (Tate et al., 2010; Tan & Sidhu, 2022; Chowdhury, 2025; Gupta et al., 2015).

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Results: The integrated model highlights five principal dimensions: (1) Governance & Compliance (regulatory GMP, CSR reporting), (2) Traceability & Transparency (RFID, IoT, blockchain). (3) Environmental & Occupational Health (HVAC energy strategies, lifecycle externalities), (4) Ethical & Human Rights Considerations (seafood and labor rights), and (5) Decision Analytics (AHP, fuzzy AHP, TOPSIS). Mapping evidence indicates complementarities—e.g., blockchain enhances immutable traceability supporting CSR disclosures; AHP-based methods effectively prioritize sustainability criteria when enriched by sensor data streams (Vaittinen, 2016; Tan & Sidhu, 2022; Chowdhury, 2025; Gupta et al., 2015).

Conclusion: The proposed architecture provides a theoretically grounded, practically actionable synthesis for organizations seeking sustainable, socially responsible, and technologically resilient supply chains. Implementation requires careful alignment with sectoral regulatory regimes, investment in capacity building, and an iterative approach to decision model calibration. Future empirical validation in multiple sectors is essential to quantify performance gains and identify socio-technical barriers.

Keywords: sustainable supply chains; RFID and IoT; blockchain; multi-criteria decision analysis; corporate social responsibility; traceability; human rights

Introduction

Global supply chains are undergoing paradigm shift in which sustainability, ethical responsibility. and digital technologies converge to redefine how resources are processed. transported. sourced. and consumed. This transformation is not merely incremental; it is structural, driven by increasing regulatory stringency, heightened consumer expectations, and technological maturation (Tate, Ellram, & Kirchoff, 2010; Tan & Sidhu, 2022). In highly regulated sectors such as pharmaceuticals and healthcare, compliance with Good Manufacturing Practice (GMP) requirements introduces additional layers of governance and traceability demands that interact with sustainability goals (Vaittinen, 2016; Vatovec, Senier, & Bell, 2013). Across food systems and seafood supply chains, human rights and socially responsible sourcing have emerged as central concerns that shape procurement policies and supplier relationships (Teh et al., 2019; Yusuf et al., 2014).

The literature provided reveals multiple, sometimes parallel efforts address to sustainability: technological innovations (RFID, blockchain) IoT. for traceability transparency (Tan & Sidhu, 2022; Chowdhury, 2025), methodological approaches for multicriteria decision making (AHP, fuzzy AHP, TOPSIS) that help prioritize sustainability indicators (Gupta et al., 2015; Shankar et al.,

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2016; Li, Fang, & Song, 2019), corporate reporting and thematic analyses that reveal CSR as a communication and governance instrument (Tate et al., 2010; Turcsanyi & Sisaye, 2013), and domain-specific studies that highlight sectoral nuances (Vaittinen, 2016; Mejías et al., 2019; Mastrocinque et al., 2020). There is a recurring recognition that neither technology nor governance alone suffices; sustainable supply chains require integrative frameworks that combine ethical. environmental. technical, and analytical components.

Despite widespread scholarship, important gaps persist. First, research remains dispersed across disciplinary silos—with engineeringcentric studies on sensors and energy conservation (Vakiloroava et al., 2014), management literature on CSR reporting (Tate et al., 2010), and operations research on supplier selection (Bai & Sarkis, 2018). This fragmentation complicates the translation of academic advances into operational strategies for firms. Second, while many decision support models exist (e.g., AHP and fuzzy variants), there is limited consensus on how to operationally link real-time traceability data to multi-criteria models for dynamic decision making (Tan & Sidhu, 2022; Xu et al., 2021). Third. the socio-ethical dimension particularly the centrality of human rights in procurement choices—has been emphasized in domain studies (Teh et al., 2019) but insufficiently embedded into quantitative evaluation frameworks. supplier Finally,

regulatory and sectoral heterogeneity (pharmaceutical GMP, food safety, fashion) complicates the transferability of best practices and requires adaptive governance layers (Vaittinen, 2016; Mejías et al., 2019).

This article acts as an integrative synthesis and methodological proposal. By drawing strictly from the provided references, it aims to: (a) consolidate theoretical constructs linking technology, ethics, and analytic methods; (b) propose a lavered framework operationalizes traceability, CSR, human rights, and multi-criteria decision making; and (c) outline an implementation roadmap and research agenda. The work intentionally from presenting new refrains primary empirical data; instead, it generates a comprehensive, literature-anchored blueprint that can guide empirical validation and organizational adoption.

METHODOLOGY

The methodological approach undertaken in this study is a structured conceptual metasynthesis of the supplied literature, applying systematic extraction and integrative mapping techniques suitable for a literature-based theoretical development. The objective was to derive design principles, decision criteria, technological enablers. and governance mechanisms from empirical and conceptual studies, and then to synthesize these elements into a coherent framework.

Selection and Scope of Sources

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The study strictly utilized the provided references, which span technologies (RFID, IoT, HVAC energy strategies). methodologies (AHP, fuzzy AHP, TOPSIS, greybased methods), CSR and human rights literature. and sectoral case studies (pharmaceutical GMP, renewable energy, fashion, seafood). Each reference was read with attention to: conceptual frameworks proposed, decision criteria identified, methodological approaches used for evaluation prioritization. and observations about technology adoption or governance challenges (Tan & Sidhu, 2022; Tate et al., 2010; Teh et al., 2019; Gupta et al., 2015). The scope included both theoretical and applied contributions.

Data Extraction and Thematic Coding

From each source, salient elements were coded into thematic categories: (1) Technology & Traceability, (2) Governance & CSR, (3) Ethical Rights Considerations. Human Environmental & Occupational Health, (5) Decision Analytics & Methods, and (6) Sectoral Constraints & Regulatory Compliance. Coding relied on iterative reading and cross-validation references across to ensure internal consistency. For example, Tan and Sidhu's (2022) review of RFID and IoT provided code anchors for technological enablers; Tate et al. (2010) informed governance and reporting dimensions; Teh et al. (2019) provided specific human rights criteria applicable to seafood and analogous supply chains.

Synthesis via Integrative Mapping

The core methodological move was to construct an integrative map that connects themes across lavers. This involved: (a) linking traceability technologies to CSR reporting requirements and to decision criteria (e.g., environmental footprint, social performance); (b) mapping analytical methods (AHP, fuzzy AHP, TOPSIS) onto decision problems such as sustainable supplier selection and risk ranking; and (c) situating sectoral constraints (e.g., pharmaceutical GMP compliance) as contextual modifiers that shape governance and technical choices (Vaittinen, 2016). The integrative mapping produced a multi-layer framework with governance, technology, and analytical strata—each with specific components and interfaces.

Model Development: A Layered Framework

Using insights from the mapping exercise, a layered model was specified. Each layer was defined with its components and operational logic: the governance layer (CSR disclosures, regulatory compliance), the traceability layer (RFID/IoT data pipelines, blockchain for immutability), the analytics layer (multicriteria decision methods with fuzzy and grey extensions for uncertainty), and the socioethical overlay (human rights and occupational health criteria). The model specification included descriptions of inputs, data flows, decision points, and feedback loops, informed by the literature (Tan & Sidhu, 2022; Chowdhury, 2025; Gupta et al., 2015; Teh et al., 2019).

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Validation Logic and Falsifiability

Given the conceptual nature of the work, validation falsifiable is proposed via hypotheses that can be tested empirically in subsequent studies. Examples include: (1) integrating blockchain with RFID/IoT improves verifiable traceability and reduces disputed provenance incidents (Chowdhury, 2025); (2) AHP-based prioritization calibrated with sensor data yields higher alignment with sustainability targets than static evaluations (Gupta et al., 2015; Mastrocinque et al., 2020); and (3) embedding human rights metrics in supplier selection reduces social risk incidents over time (Teh et al., 2019).

Limitations of the Methodology

The methodological choices intentionally rely only on the supplied literature; while this constraint ensures fidelity to the user's input, it limits the incorporation of other emergent works published outside the list. Moreover, the absence of primary empirical data in this study constrains claims about magnitudes of effect; instead, the study focuses on structural relationships and plausible mechanisms grounded in prior research (Tate et al., 2010; Tan & Sidhu, 2022).

RESULTS

The synthesis yields a comprehensive, multilayered framework for sustainable and responsible supply chain management. The results below are presented as a descriptive analysis of the synthesized model components,

the relationships between them. and implications for practice and research. Each major finding is anchored in the provided literature.

1. Five Core Dimensions of Sustainable Supply Chain Architecture

The literature converges on five principal dimensions—Governance & Compliance. Traceability & Transparency, Environmental & Occupational Health, Ethical & Human Rights Considerations, and Decision Analytics—that together constitute the architecture of sustainable supply chains (Tate et al., 2010; Tan & Sidhu, 2022; Teh et al., 2019; Vakiloroava et al., 2014).

Governance & Compliance

Governance includes CSR reporting, regulatory (e.g., pharmaceutical compliance internal policies, and supplier audits. CSR reports serve both as an external communication tool and an internal governance instrument to align supply chain actions with strategic sustainability goals (Tate et al., 2010). In regulated industries, GMP compliance imposes binding process controls and documentation requirements that can be leveraged to embed sustainability checks into existing compliance systems (Vaittinen, 2016).

Traceability & Transparency

Traceability emerges as a technical and organizational imperative. RFID and IoT

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technologies enable high-resolution, real-time visibility of goods and environmental conditions (Tan & Sidhu, 2022). Blockchain offers immutable provenance records that complement sensor data by preventing tampering and facilitating auditable histories (Chowdhury, 2025). Together, these technologies form a layered traceability stack: sensor acquisition, edge processing, distributed ledger anchoring, and enterprise integration.

Environmental & Occupational Health

Environmental externalities and worker health of supply are important facets chain sustainability. Studies highlight the environmental impacts of medical and pharmaceutical supply chains and the benefits of energy saving interventions (Vatovec et al., 2013; Vakiloroaya et al., 2014). HVAC systems, cold chain energy use, and transportation for efficiencies are recurring levers environmental footprint reduction (Vakiloroaya et al., 2014).

Ethical & Human Rights Considerations

rights considerations Human in procurement—especially in sectors such as and fashion—demand rigorous supplier scrutiny and social performance metrics (Teh et al., 2019; Mejías et al., 2019). Rights-based approaches highlight worker conditions, fair pay, freedom of association, and non-discrimination as essential criteria, and they call for mechanisms to monitor and remediate violations.

Decision Analytics

Multi-criteria decision tools, particularly variants of AHP, fuzzy AHP, TOPSIS, and greybased methods, are repeatedly used to evaluate supplier sustainability performance and to prioritize interventions (Gupta et al., 2015; Shankar et al., 2016; Li, Fang, & Song, 2019; Bai & Sarkis, 2018). These methods accommodate heterogeneous criteria and stakeholder preferences while enabling structured trade-off analysis.

2. Technology-Governance Complementarities

A central insight is that technological systems governance instruments complementary rather than substitutive. RFID and IoT facilitate data capture necessary for rigorous CSR reporting and supplier audits (Tan & Sidhu, 2022; Tate et al., 2010). Blockchain provides an immutable layer that can increase stakeholder trust in CSR claims by making provenance data tamper-evident (Chowdhury, 2025). In regulated environments, digital traceability can reduce audit burdens by producing continuous, verifiable records (Vaittinen, 2016). Thus, the integrated approach reduces information asymmetries and strengthens enforceability of sustainability commitments.

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3. Decision Methodologies and the Role of Uncertainty

The reviewed that literature shows uncertainty—stemming from subjective judgments, fuzzy criteria, and incomplete data—permeates supplier evaluation. Fuzzy AHP and linguistic preference models have been successfully applied to capture decision maker uncertainty and to improve robustness of supplier rankings (Shen et al., 2013; Mangla et al., 2015; Sharma et al., 2018). Grey-based TOPSIS and rough cloud approaches extend this capacity by accommodating incomplete or ambiguous metric values (Li, Fang, & Song, 2019; Bai & Sarkis, 2018). The results suggest a layered analytic approach: deterministic AHP stable. high-certainty contexts fuzzy/grev adaptations when criteria or data quality are uncertain.

4. Sectoral Nuances and Regulatory Constraints

Sectoral cases underscore that regulatory contexts significantly shape feasible designs. Pharmaceutical supply chains must prioritize GMP compliance and controlled storage conditions; traceability systems must therefore capture temperature and humidity metrics with high fidelity, and governance must map onto inspection regimes (Vaittinen, 2016). Fashion and renewable energy sectors emphasize capacity building and traceability across multi-tier supplier networks, where indirect suppliers are hard to monitor and where interventions must scale beyond first-

relationships (Mejías et al., 2019; Mastrocinque et al., 2020). These nuances imply that one-size-fits-all architectures are unrealistic; instead, modular frameworks that can be tailored to regulatory and operational constraints are necessary.

5. Human Rights as an Operative Criterion

Human rights must be embedded operational criteria, not treated as an abstract value. Teh et al. (2019) demonstrate how rights-based indicators can be operationalized in seafood supply chains, including metrics for labor inspections, grievance mechanisms, and contractual clauses. Integrating human rights multi-criteria selection into mechanisms changes supplier prioritization and can lead to different procurement decisions than purely cost-focused evaluations (Teh et al., 2019; Yusuf et al., 2014). The implication is that analytic models must include social performance metrics quantitatively and qualitatively, and that organizations must monitoring and remediation invest in capacities.

6. Decision Support Implementation: Illustrative AHP-Fuzzy Pipeline

The literature supplies concrete methodological recipes for implementation. For example, standard AHP steps—criteria identification, pairwise comparisons, weight derivation, consistency checks, and ranking can be augmented with fuzzy logic to accommodate linguistic judgments (Gupta et al., 2015; Shen et al., 2013). A plausible pipeline

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is: (a) derive criteria set (environmental, social, governance, operational), (b) collect sensor and audit data to inform criteria measures (Tan & Sidhu, 2022; Vaittinen, 2016), (c) elicit stakeholder weights using pairwise comparisons with fuzzy scales (Shankar et al., 2016), (d) compute aggregated scores and conduct sensitivity analysis, and (e) implement decisions with contractual safeguards and monitoring plans. This pipeline is supported across multiple studies that emphasize AHP's flexibility and the utility of fuzzy extensions in uncertain contexts (Gupta et al., 2015; Mangla et al., 2015; Sharma et al., 2018).

7. Traceability and Capacity Building as Sustainability Enablers

Case literature, particularly in fashion and multi-tier supply chains, emphasizes traceability management systems coupled with capacity building as effective levers to improve sustainability (Mejías et al., 2019). Traceability systems alone are insufficient if suppliers lack the technical or managerial capacity to comply sustainability norms. Therefore, with investment in supplier training, shared platforms, and collaborative logistics networks is necessary to realize sustainability benefits (Mejías et al., 2019; Xu et al., 2021).

8. Emerging Role of Platform Economies and **Collaborative Logistics**

Collaborative logistics and platform business models create opportunities for new

sustainability bv aggregating demand. optimizing routing, and enabling shared asset utilization (Xu et al., 2021). Platforms can also facilitate data sharing and standardizationkey prerequisites for effective traceability and for the performance of decision analytics that rely on consistent metrics across stakeholders (Xu et al., 2021).

9. Integration Challenges Potential and Unintended Effects

While integrated architectures promise improvements, the literature warns of potential unintended consequences. For instance. heightened transparency can expose sensitive commercial information and may lead to strategic withholding or gaming by suppliers unless governance safeguards are in place (Tate et al., 2010). The technical complexity and cost of implementing RFID/IoT/blockchain may also disproportionately burden small suppliers, potentially displacing vulnerable firms unless capacity building and equitable financing mechanisms are provided (Mejías et al., 2019; Tan & Sidhu, 2022).

DISCUSSION

The integrative framework and descriptive results invite several interrelated interpretations, practical implications, and directions for future research. This discussion elaborates on theoretical contributions. organizational implications, methodological

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considerations, and limitations, linking each to the literature.

Theoretical Contributions

This work contributes to theory by proposing an integrated socio-technical model that explicitly links technology, governance, human rights, and decision analytics. Existing work tends to emphasize particular elements: technology reviews focus on RFID/IoT infrastructures (Tan & Sidhu, 2022), CSR literature analyzes thematic reporting and its strategic functions (Tate et al., 2010), and research provides multiple operations decision-making tools (Gupta et al., 2015; Shankar et al., 2016). By synthesizing these strands into a layered architecture, the study highlights system-level interactions that have been under-theorized—such as how immutable ledgers (blockchain) can translate sensor data into verifiable CSR claims that then feed into multi-criteria selection processes (Chowdhury, 2025; Tan & Sidhu, 2022; Tate et al., 2010).

A critical theoretical nuance is the reification of human rights as operational decision criteria. While human rights have been conceptually acknowledged in supply chain discourse, integrating them within quantitative decision frameworks such as AHP or TOPSIS is less common. This synthesis articulates how human rights indicators can be framed, weighted, and monitored alongside environmental economic indicators, thereby moving human

rights from rhetorical commitment t₀ operational practice (Teh et al., 2019).

Organizational Implications and Managerial **Pathways**

The layered framework suggests practical pathways for managers. First, organizations should treat traceability investments as foundational infrastructure rather than optional enhancements. RFID/IoT deployments provide the data currency necessary for both compliance sustainability reporting (Tan & Sidhu, 2022). Second, blockchain should be considered where immutable provenance is critical particularly for high-value or high-risk products—while acknowledging cost and governance trade-offs (Chowdhury, 2025). Third, decision analytics should not be static: AHP and related methods must be coupled with real-time or periodically refreshed data streams and should incorporate fuzzy and grey methods when decision contexts are uncertain (Gupta et al., 2015; Shen et al., 2013; Li, Fang, & Song, 2019). Finally, capacity building and equitable adoption strategies are essential to prevent supplier exclusion and to ensure that sustainability transitions are inclusive (Mejías et al., 2019).

Methodological Reflections Research and Agenda

Methodologically, the synthesis reveals opportunities to advance both measurement and modeling. Empirical research should empirically test the hypothesized causal

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mechanisms—for example, whether blockchain-anchored sensor records reduce verification costs and procurement disputes (Chowdhury, 2025). Comparative experiments could assess whether supplier selection using an AHP-fuzzy approach calibrated with IoT data yields better social and environmental outcomes than traditional procurement heuristics (Gupta et al., 2015; Shankar et al., 2016). Another avenue is longitudinal studies that measure the diffusion effects of traceability systems across multi-tier networks and the role of platform intermediaries in accelerating adoption (Xu et al., 2021).

Ethical and Social Considerations

metrics **Embedding** human rights operationally raises ethical and practical complexities. Measurement itself can be invasive—enabled by surveillance technologies—and requires rigorous safeguards for privacy and consent. Moreover, the social costs of exclusionary procurement must be mitigated through financing, multiparty cost sharing, and technical assistance to smaller suppliers (Teh et al., 2019; Mejías et al., 2019). The literature suggests that traceability and transparency improve accountability but must be paired with remediation mechanisms and worker voice channels to be effective (Teh et al., 2019; Yusuf et al., 2014).

Limitations and Counter-Arguments

There are several limitations and potential integrated counter-arguments to the

framework. First, technological determinism is a risk: the assumption that digital tools alone will produce sustainability outcomes neglects power relations and incentive structures within supply chains (Tate et al., 2010). Second, the cost and complexity of implementing sophisticated systems may create unequal adoption that advantages larger firms and penalizes smaller ones, potentially harming broader sustainability goals that require inclusive supply networks (Mejías et al., 2019). Third, methodological rigor in multi-criteria approaches depends on robust criteria and stakeholder selection participation; otherwise, weights may reflect managerial biases rather than societal priorities (Gupta et al., 2015). Each counter-argument directs attention to the necessity of governance, capacity building, and participatory processes.

Practical Roadmap for Implementation

Implementing the integrated architecture involves phased steps:

- 1. Assessment Criteria Definition: and Convene stakeholders to define sustainability, ethical, operational, and regulatory criteria. Use CSR reports and human rights assessments as starting points. (Tate et al., 2010; Teh et al., 2019)
- 2. Pilot Traceability Systems: Deploy RFID/IoT in a controlled segment to capture provenance and environmental data. Evaluate data quality and integration challenges. (Tan & Sidhu, 2022)

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- 3. Select Appropriate Ledger Solutions: Where immutable provenance is business-critical, pilot blockchain anchoring of sensor records, carefully evaluating cost-benefit trade-offs. (Chowdhury, 2025)
- 4. Build Decision Analytics Pipeline: Implement AHP/fuzzy AHP models with criteria weights elicited from stakeholders; integrate sensor and audit data as inputs. Conduct sensitivity analysis and scenario testing. (Gupta et al., 2015; Shen et al., 2013)
- 5. Capacity Building & Remediation Mechanisms: Invest in supplier training, finance mechanisms. and grievance/ remediation systems to ensure equitable adoption. (Mejías et al., 2019; Teh et al., 2019)
- 6. Scale and Institutionalize: Embed learnings into procurement contracts, CSR reporting compliance templates. and regulatory protocols (Vaittinen, 2016; Tate et al., 2010).

CONCLUSION

The synthesis presented in this article demonstrates that sustainable and socially responsible supply chains require integrated socio-technical architectures that combine traceability technologies, rights-based and multi-criteria decision governance, analytics. From the literature, five kev dimensions emerge—governance compliance. traceability & transparency, environmental & occupational health, ethical &

human rights considerations, and decision analytics—each and essential mutually reinforcing (Tate et al., 2010; Tan & Sidhu, 2022; Teh et al., 2019; Vakiloroaya et al., 2014). Technological enablers like RFID, IoT, and blockchain are necessary but insufficient; they must be integrated with capacity building, participatory weighting of decision criteria, and adaptive governance to ensure equitable and effective outcomes (Chowdhury, 2025; Mejías et al., 2019).

Methodologically, multi-criteria decision tools such as AHP and its fuzzy and grey variants offer operational mechanisms to prioritize sustainability trade-offs under uncertainty (Gupta et al., 2015; Shen et al., 2013; Li, Fang, & Song, 2019). The framework proposed provides a structured implementation roadmap that underscores phased adoption, stakeholder engagement, and iterative calibration of decision models. However, empirical validation remains a critical next Future research should pursue comparative field studies across sectors pharmaceuticals, food, fashion, renewable energy—to quantify the performance impacts of integrated architectures and to identify contextual barriers and enablers (Vaittinen, 2016; Mastrocinque et al., 2020; Xu et al., 2021).

Sustainability is not solely a technological challenge but a governance and ethical one. The integration of technology with rights-based metrics and inclusive decision frameworks offers a pathway to supply chains that are not only efficient but also just and resilient. The

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literature provides promising building blocks; the challenge now is for practitioners and researchers to operationalize, test, and refine these models in real-world settings.

REFERENCES

- 1. Tan, W.C., & Sidhu, M.S. (2022). Review of RFID and IoT integration in supply chain management. **Operations** Research Perspectives, 9, 100229.
- 2. Tate, W.L., Ellram, L.M., & Kirchoff, J.F. (2010). Corporate social responsibility reports: a thematic analysis related to supply chain management. Journal Of Supply Chain Management, 46(1), 19-44.
- 3. Teh, L.C., Caddell, R., Allison, E.H., Finkbeiner, E.M., Kittinger, J.N., Nakamura, K., & Ota, Y. (2019). The role of human rights in implementing socially responsible seafood. PloS One, 14(1), e0210241.
- 4. Chowdhury, W. A. (2025). Blockchain for Sustainable Supply Chain Management: Reducing Waste Through Transparent Resource Tracking. Journal of Procurement and Supply Chain Management, 4(2), 28–34. https://doi.org/10.58425/jpscm.v4i2.435
- 5. Turcsanyi, J., & Sisaye, S. (2013). Corporate social responsibility and its link to financial performance: Application to Johnson & Johnson, a pharmaceutical company. World Iournal of Science, Technology Sustainable Development, 10(1), 4-18.
- **6.** Vaittinen, S. (2016).Supply chain management in a highly regulated environment-a Case study of supplier GMP-

- compliance management in the pharmaceutical industry.
- 7. Vakiloroaya, V., Samali, B., Fakhar, A., & Pishghadam, K. (2014). A review of different strategies for HVAC energy saving. Energy Conversion and Management, 77, 738-754.
- 8. Varadarajan, R. (2017). Innovating for sustainability: A framework for sustainable innovations and a model of sustainable innovations orientation. Journal of the Academy of Marketing Science, 45, 14-36.
- 9. Vatovec, C., Senier, L., & Bell, M. (2013). An ecological perspective on medical care: environmental, occupational, and public health impacts of medical supply and pharmaceutical chains. EcoHealth, 10, 257-267.
- **10.** Völker, S., & Kistemann, T. (2011). The impact of blue space on human health and wellbeing-Salutogenetic health effects of inland surface waters: A review. International Journal of Hygiene and Environmental Health, 214(6), 449-460.
- 11. Yusuf, Y., Hawkins, A., Musa, A., El-Berishy, N., Schulze, M., & Abubakar, T. (2014). Ethical supply chains: analysis, practices and performance measures. International Journal of Logistics Systems and Management, 17(4), 472-497.
- **12.** Gupta, S.; Dangayach, G.S.; Singh, A.K.; Rao, P.N. (2015). Analytic Hierarchy Process (AHP) Model for Evaluating Sustainable Manufacturing Practices in Indian Electrical Panel Industries. Procedia Social Behavioral Sciences, 189, 208–216.

VOLUME 05 ISSUE 11 Pages: 145-158

OCLC - 1368736135









- 13. Shankar, K.; Kumar, P.; Kannan, D. (2016). the Drivers of Advanced Analyzing Sustainable Manufacturing System Using AHP Approach. Sustainability, 8, 824.
- 14. Mangla, S.K.; Kumar, P.; Barua, M.K. (2015). Risk analysis in green supply chain using fuzzy AHP approach: A case study. Resources, Conservation and Recycling, 104, 375–390.
- 15. Sharma, Y.K.; Yadav, A.K.; Mangla, S.K.; Patil, P.P. (2018). Ranking the Success Factors to Improve Safety and Security in Sustainable Food Supply Chain Management Using Fuzzy AHP. Materials Today: Proceedings, 5, 12187-12196.
- 16. Kumar, D.; Garg, C.P. (2017). Evaluating sustainable supply chain indicators using fuzzy AHP. Benchmarking: An International Journal, 24, 1742-1766.
- 17. Mejías, A.M.; Bellas, R.; Pardo, J.E.; Paz, E. (2019). Traceability management systems and capacity building as new approaches for improving sustainability in the fashion multitier supply chain. International Journal of Production Economics, 217, 143–158.
- 18. Mastrocinque, E.; Ramírez, F.J.; Honrubia-Escribano, A.; Pham, D.T. (2020). An AHPbased multi-criteria model for sustainable supply chain development in the renewable Expert energy sector. **Systems** with Applications, 150, 113321.
- 19.Li, J.; Fang, H.; Song, W. (2019). Sustainable supplier selection based on SSCM practices: A rough cloud TOPSIS approach. Journal of Cleaner Production, 222, 606-621.
- 20.Bai, C.; Sarkis, J. (2018). Integrating Sustainability into Supplier Selection: A Grev-

- Based **TOPSIS** Analysis. Technology, Economics and Development of Economy, 24, 2202-2224.
- 21. Shen, L.; Olfat, L.; Govindan, K.; Khodaverdi, R.; Diabat, A. (2013). A fuzzy multi-criteria approach for evaluating green supplier's performance in green supply chain with linguistic preferences. Resources, Conservation and Recycling, 74, 170–179.
- **22.** Xu, X.; He, Y.; Ji, Q. (2021). Collaborative Logistics Network: A New Business Mode in the Platform Economy. International Journal of Logistics Research and Applications.
- 23.Xu, C.; Wang, S. (2021). Industrial Three-Division Network System in China: Efficiencies and Their Impact Factors. Environmental Science and Pollution Research, 28(34), 47375-47394.
- **24.**Xue, J.; Li, G.; Li, N. (2021). Does Green and Sustainable Engagement Benefit Online Platforms in Supply Chains? The Role of Green and Public Concern. International Journal of Logistics Research and Applications.
- **25.** Yi, X. J.; Sheng, K.; Yu, T.; Wang, Y. Y.; Wang, S. H. (2020). R&D Investment and Financing Efficiency Environmental in Chinese Protection Enterprises: Perspectives of Covid-19 and Supply Chain Financial Regulation. International Journal of Logistics Research and Applications.
- 26. Yu, M.; Cao, E. (2020). Information Sharing Format and Carbon Emission Abatement in a Supply Chain with Competition. International Journal of Production Research, 58(22), 6775-6790.

VOLUME 05 ISSUE 11 Pages: 145-158

OCLC - 1368736135











- 27. Zailani, S.; Jeyaraman, K.; Vengadasan, G.; Premkumar, R. (2012). Sustainable Supply Chain Management (SSCM) in Malaysia: A Survey. International Journal of Production Economics, 140(1), 330-340.
- 28. Zhang, X.; Liu, S. (2021). Action Mechanism and Model of Cross-Border E-Commerce Green Supply Chain Based on Customer Behavior. Mathematical **Problems** Engineering, 2021, 6670308.

