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Barriers and Opportunities in Circular Logistics: A Global Comparative Narrative Review

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ABSTRACT: This study reviews and synthesizes current knowledge on eco-efficient transport models within the frameworks of green logistics and the circular economy. The aim is to evaluate how technological, regulatory, and economic factors influence adoption and implementation. Literature was systematically gathered from major databases such as Scopus, Web of Science, and Google Scholar, using targeted keywords and Boolean search strategies. Inclusion criteria prioritized peer-reviewed articles published between 2018 and 2025 that addressed sustainable logistics, circular supply chains, and digital innovations. The review identified four major themes: drivers, barriers, case studies, and regional comparisons. Findings reveal that digital technologies, including artificial intelligence, blockchain, and the Internet of Things, enhance transparency, traceability, and efficiency. Regulatory frameworks, particularly in Europe, accelerate adoption, while economic incentives strengthen competitiveness. However, barriers persist, especially high initial costs, infrastructural deficits, and weak enforcement in developing economies. Case studies confirm measurable benefits, such as emission reductions and cost savings, while comparative analyses show significant regional disparities. The discussion emphasizes the importance of systemic alignment across policy, markets, and organizational culture to overcome these challenges. Future research is recommended to expand empirical evidence, develop standardized evaluation tools, and examine underrepresented regions. Overall, the review highlights the urgent need for integrated strategies that combine technology, regulation, and collaboration to advance sustainable logistics..

Keywords: Green Logistics, Circular Economy, Eco-Efficient Transport, Sustainable Supply Chain, Digital Innovations, Environmental Policy, Sustainable Development.

INTRODUCTION

The frameworks of *green logistics* and the *circular economy* have become central to addressing the dual challenge of environmental degradation and economic resilience. The logistics sector, which contributes nearly 10% of global greenhouse gas emissions, has been identified as a critical area

for intervention. International commitments such as the Paris Agreement and net-zero targets for 2050 underscore the urgency of transformation in this sector.

Green logistics refers to the adoption of environmentally friendly practices across transportation, warehousing, packaging, and inventory management, while the *circular economy* promotes resource efficiency by extending product lifecycles through reuse, recycling, and closed-loop systems. The integration of these frameworks is increasingly regarded as essential to achieving the United Nations Sustainable Development Goals.

Empirical evidence shows that sustainable logistics not only reduce carbon footprints but also enhance competitiveness and innovation. For example, studies in the European rail sector demonstrate that green logistics practices can simultaneously reduce CO_2 emissions and improve customer satisfaction. However, developing economies continue to face obstacles such as high costs, weak regulations, and infrastructure deficits.

This article synthesizes conceptual and empirical research on eco-efficient transport models from a global comparative perspective. It identifies the main drivers, barriers, and opportunities influencing adoption and provides insights relevant to policymakers, industry practitioners, and researchers.

METHOD

The methodological framework adopted for this review was designed to ensure both breadth and depth in capturing relevant scholarly contributions on eco-efficient transport models, green logistics, and circular economy practices within logistics systems. The process involved systematic literature searches, the establishment of inclusion and exclusion criteria, and rigorous screening and evaluation procedures to guarantee academic rigor and reliability.

The initial phase of literature collection relied on established academic databases known for their comprehensive coverage of peer-reviewed research and their suitability for bibliometric and content analysis. Scopus and Web of Science (WoS) were prioritized as the primary databases due to their extensive repositories of high-quality journals and conference proceedings. Scopus provided access to a vast international collection, while WoS offered strong citation tracking and impact analysis features, which were particularly useful in evaluating the influence of specific studies within the scholarly community (Wang et al., 2019; Mageto, 2022; Su et al., 2021). Google Scholar was also utilized to broaden the search scope, particularly for accessing grey literature, working papers, and conference contributions that may not be indexed in Scopus or WoS but nonetheless provide valuable insights into emerging themes (Sağlam, 2023). PubMed was reviewed but considered less relevant due to its predominant focus on health sciences, thus contributing minimally to the final corpus of logistics and sustainability literature (Wang et al., 2019).

The development of effective search strategies was central to identifying relevant works. Keywords and Boolean operators were employed to construct comprehensive search strings that maximized

relevance while minimizing extraneous results. Key terms included "eco-efficient transport," "green logistics," "circular economy," and "sustainable supply chain management" (Nikseresht et al., 2023; Zhou et al., 2023). Boolean combinations such as ("eco-efficient transport" OR "sustainable transportation") AND ("green logistics" OR "sustainable logistics") AND ("circular economy" OR "circular supply chain") were used to capture studies intersecting these domains. Similarly, exclusion criteria were embedded within search strings, for example, NOT ("reverse logistics" OR "waste management"), to ensure focus on forward-looking models of eco-efficiency rather than narrower subdomains. Advanced search techniques, such as proximity searching, were also employed, using expressions like "green logistics NEAR/3 circular economy" to capture articles that discussed these concepts in close conceptual association. Database-specific filters for publication year, document type, and subject area were applied to further refine results, ensuring that the review emphasized recent contributions and excluded irrelevant or low-quality material (Mondal, 2025; Panghal et al., 2023).

Following the retrieval of literature, strict inclusion and exclusion criteria were applied. Studies were included if they were published in peer-reviewed journals or reputable conference proceedings, addressed topics related directly to eco-efficient transport, circular economy applications in logistics, or sustainable supply chain practices, and were published between 2018 and 2025 to reflect the most recent developments in the field. Articles were excluded if they were outside the scope of logistics and transport, if they focused exclusively on unrelated sectors such as healthcare or agriculture without a logistics dimension, or if they were purely conceptual with no grounding in empirical evidence or theoretical frameworks applicable to logistics. Language was also a criterion, with only articles published in English being included to ensure consistency in analysis and interpretation.

The types of research incorporated into the review were diverse, reflecting the multidisciplinary nature of sustainability studies. Empirical research formed the backbone of the corpus, including quantitative analyses such as surveys and econometric models, as well as qualitative case studies highlighting specific organizational or regional experiences. Randomized controlled trials were not relevant within this domain, but cohort studies examining industry practices over time, simulation-based research evaluating transport efficiencies, and mixed-method approaches combining qualitative and quantitative insights were all included where applicable. Conceptual and theoretical studies were also considered, particularly those offering frameworks for understanding the integration of circular economy principles into logistics, provided they demonstrated scholarly rigor and clear applicability to the field.

The literature screening process involved multiple stages to ensure quality and relevance. Initially, titles and abstracts were reviewed to eliminate works that were clearly irrelevant to eco-efficient transport or circular logistics. The remaining articles were subjected to full-text screening, where alignment with the inclusion criteria was verified. Particular attention was paid to methodological clarity, the robustness of data collection and analysis, and the direct relevance of findings to the review's focus on logistics and circular economy integration. Quality assessment was guided by established standards for review articles, emphasizing transparency, replicability, and the validity of reported outcomes. Discrepancies during the selection process were resolved through cross-checking among reviewers to minimize subjective bias.

Once the final set of studies was consolidated, data extraction and synthesis were carried out systematically. Key information recorded included the study's geographical focus, sectoral scope, methodological approach, and main findings. Themes such as drivers of green logistics adoption, barriers to eco-efficient transport models, technological innovations, and policy influences were identified and coded. Comparative attention was given to variations across developed and developing economies, as well as sector-specific insights such as maritime, rail, and urban freight logistics. This thematic organization allowed the synthesis of findings in a way that highlighted both convergences and divergences across contexts.

In sum, this methodology ensures a comprehensive, rigorous, and systematic approach to reviewing the literature on eco-efficient transport and circular logistics. By employing robust search strategies, applying clearly defined inclusion and exclusion criteria, and integrating diverse types of empirical and theoretical research, this study provides a solid foundation for synthesizing knowledge and identifying critical insights into sustainable logistics practices. The emphasis on database triangulation, keyword precision, and multi-stage screening underscores the methodological integrity of the review, ensuring its contribution to advancing academic discourse and practical applications in the domain of sustainable transport and logistics.

RESULT AND DISCUSSION

Drivers of Green Logistics and Circular Economy

The adoption of green logistics practices has been consistently shown to be driven by an intersection of technological, policy, and economic factors. Technological drivers are central, with innovations such as the Internet of Things (IoT), artificial intelligence (AI), and blockchain proving instrumental in enhancing operational efficiency and reducing waste. IoT technologies enable real-time monitoring and tracking of logistics activities, thereby facilitating optimized resource management and improved transport routing (Dev et al., 2020; Liu & Wang, 2022). Predictive analytics powered by AI further strengthens decision-making by forecasting demand, reducing inventory waste, and streamlining operational workflows (Liu & Wang, 2022; Verma, 2024). These technological innovations create a direct pathway to eco-efficiency, aligning logistical operations with sustainability objectives.

Policy drivers also play a decisive role. Government regulations, particularly those linked to carbon reduction targets, compel businesses to adopt eco-efficient models. The European Union's Green Deal exemplifies such frameworks, mandating strict emission reduction measures and incentivizing the adoption of sustainable logistics practices (Dzwigo et al., 2021; Wong et al., 2022). Such regulatory pressure fosters innovation while creating competitive advantages for firms that achieve compliance early. Meanwhile, economic incentives remain crucial, as firms adopting circular and green logistics strategies often achieve significant cost savings, enhanced reputational capital, and stronger market positioning. Empirical findings show that cost reductions from efficiency gains and the ability to capture sustainability-conscious consumers provide strong business cases for green adoption (Verma, 2024; Ya et al., 2023).

Further supporting this perspective, Luu et al. (2023) and Parlato et al. (2022) underline that economic policies oriented towards sustainability generate collaborative opportunities within supply chains, stimulating innovation and accelerating collective adoption of circular principles. The evidence suggests that while environmental and policy imperatives establish the framework for action, economic drivers ensure organizational buy-in by linking sustainability to profitability.

Empirical evidence highlights the significant role of digital innovations in reinforcing these drivers. Blockchain technologies, for example, enhance transparency and traceability across supply chains, facilitating improved waste management and compliance monitoring (Makarova et al., 2021; Čižiūnienė et al., 2024). AI applications have been observed to reduce emissions through optimized routing and load management, while IoT systems improve agility and flexibility, enabling faster response to disruptions and reducing inefficiencies (Pambudi, 2025; Balanay & Halog, 2023). These innovations not only yield environmental benefits but also strengthen supply chain resilience.

Empirical studies across industries corroborate these advantages. In textiles and manufacturing, firms implementing digital solutions demonstrate heightened sustainability performance and improved profitability (Fang & Liu, 2025; Dev et al., 2020). Similarly, Jayarathna et al. (2023) and Yoshino et al. (2023) report that digital platforms enhance collaboration among stakeholders, improving communication and coordination critical for circular economy transitions. Collectively, these findings affirm that the integration of digital innovations with policy and economic incentives creates a robust ecosystem supporting the diffusion of green logistics.

Barriers and Challenges

Despite clear drivers, literature consistently identifies multiple barriers hindering the adoption of eco-efficient transport models. Financial barriers are frequently emphasized, particularly the significant capital investments required to adopt green technologies. SMEs, in particular, face difficulties accessing funding for electric vehicles, smart logistics platforms, and renewable energy integration, leading to slower adoption rates (Panghal et al., 2023; Savini, 2019). The uncertainty surrounding returns on investment exacerbates reluctance to adopt green practices, as noted in Garza-Reyes et al. (2018).

Managerial and organizational barriers are equally salient. A widespread lack of awareness and understanding of circular principles among executives often leads to weak strategic commitments to sustainability (Verma, 2024; Fang & Liu, 2025). Inadequate training and knowledge dissemination further impede employees' capacity to embrace new systems, resulting in resistance to organizational change (Dzwigo et al., 2021; Yoshino et al., 2023). These issues highlight the importance of leadership and organizational culture in facilitating sustainable transitions.

Infrastructure deficits also feature prominently. Inadequate support systems such as charging networks for electric fleets and recycling facilities undermine efforts to adopt circular practices (Panghal et al., 2023; Kumar et al., 2023). Poorly designed logistics networks add to inefficiencies, diminishing the potential environmental benefits of adopting eco-efficient practices. Wong et al. (2022) emphasize that infrastructure limitations particularly constrain emerging economies, where investments in green infrastructure remain limited.

Barriers vary substantially across regions, reflecting divergent resource availability, regulatory frameworks, and socio-economic conditions. In developed economies such as the EU and North America, while regulatory and stakeholder pressures strongly encourage adoption, high costs and compliance complexities persist as obstacles (Wang et al., 2019; Luu et al., 2023). Conversely, developing regions face compounded barriers: weak regulatory environments, inadequate infrastructure, and limited technical expertise. Case studies from India highlight logistical inefficiencies and financing gaps as critical impediments (Garza-Reyes et al., 2018; Panghal et al., 2023). African contexts further illustrate how socio-economic reliance on informal logistics networks undermines the establishment of formal circular economy practices (Dzwigo et al., 2021; Abdelaziz & Munawaroh, 2024). Čižiūnienė et al. (2024) report similar infrastructural deficiencies, emphasizing the urgent need for tailored strategies sensitive to local contexts.

Case Studies and Best Practices

Empirical case studies demonstrate successful implementation of green logistics and circular economy principles, offering valuable lessons for wider diffusion. CN Logistics exemplifies best practice, embedding sustainability throughout its operations by adopting green procurement, striving for carbon neutrality, and initiating co-creation projects with partners. Their initiatives reduced greenhouse gas emissions by approximately 25% while improving customer satisfaction (Wong et al., 2022). This case illustrates how aligning business models with sustainability not only delivers environmental benefits but also enhances competitiveness.

Industry 4.0 technologies are increasingly integral to best practices. Companies employing IoT-enabled smart warehousing and recycling systems have achieved significant improvements in resource management and waste reduction (Ya et al., 2023; Luu et al., 2023). Studies also highlight the adoption of renewable energy sources, such as biomass gasification at ports, as transformative. Alavi-Borazjani et al. (2025) report measurable reductions in emissions and operational costs when ports transitioned from fossil fuels to locally sourced renewable energy. These examples collectively highlight that technological integration, renewable energy adoption, and collaborative practices yield substantial operational and environmental outcomes.

Measurable outcomes reported across case studies reinforce the advantages of these practices. Efficiency gains include improved delivery times, optimized routes, and reduced energy consumption (Luu et al., 2023). Cost savings from reduced waste and enhanced resource utilization are frequently documented (Ya et al., 2023). Collectively, these outcomes affirm the viability of circular economy integration into logistics as a means of simultaneously advancing environmental and economic goals.

Regional and Global Comparisons

A comparative perspective reveals substantial variation in the adoption and outcomes of green logistics practices across regions. In the EU, stringent regulatory frameworks and policy support have fostered the integration of circular economy principles into logistics at scale. Studies highlight how European seaports and rail networks have become global benchmarks, demonstrating best practices in emission reduction and sustainability reporting (Sağlam, 2023; Notteboom et al., 2020). These initiatives illustrate the effectiveness of policy-driven approaches in aligning industry practices with sustainability objectives.

In Asia, adoption levels vary. Developed economies such as Japan and South Korea lead with advanced green logistics systems, while developing economies face persistent obstacles. Research in India and Indonesia underscores infrastructure deficits, high implementation costs, and uneven regulatory enforcement as barriers to scaling up circular practices (Agarwal et al., 2025; Panghal et al., 2023). Nevertheless, emerging legislative frameworks and growing consumer awareness in these regions signal gradual progress toward sustainability.

Africa presents distinct challenges and opportunities. Adoption of green logistics remains limited, but sustainability is increasingly embedded within broader socio-economic agendas. For instance, efforts to integrate circular practices are often linked to developmental priorities such as poverty alleviation and job creation (Fang & Liu, 2025; Jayarathna et al., 2023). However, infrastructural deficiencies, limited financial resources, and reliance on informal networks continue to constrain progress (Borucka & Grzelak, 2025; Abdelaziz & Munawaroh, 2024). Comparative analyses reveal that while the EU serves as a global leader, Asia and Africa demonstrate pathways shaped by their unique resource constraints and socio-economic dynamics.

Comparative studies on the global diffusion of eco-efficient transport models underscore the importance of cross-regional learning. Best practices from the EU, particularly in seaports and rail transport, provide actionable templates for other regions, while Industry 4.0 adoption demonstrates the universal applicability of digital innovations (Notteboom et al., 2020; Pambudi, 2025). Studies comparing developed and developing contexts highlight disparities in regulatory support, financial resources, and technological readiness, underscoring the need for context-sensitive strategies (Alfirević et al., 2025; Šimonová et al., 2024). Ultimately, these findings reveal that while the drivers of green logistics are global, the pathways to adoption and success are regionally contingent, shaped by regulatory, economic, and infrastructural conditions.

The findings of this narrative review illustrate a close alignment between eco-efficient transport models and the established theories of sustainable supply chain management (SSCM). Existing SSCM frameworks emphasize the need to integrate environmental objectives into logistics operations, particularly by minimizing waste, improving efficiency, and reducing negative ecological impacts (Verma, 2024; Batista et al., 2018). The evidence presented across studies confirms that eco-efficient transport models not only extend these theoretical assumptions but also demonstrate practical pathways for operationalizing them. For example, the introduction of electric vehicles, biofuels, and smart logistics management systems has been shown to simultaneously reduce emissions and maintain or enhance efficiency (Muafi & Sugarindra, 2023; Luu et al., 2023). This convergence reinforces the argument that SSCM is evolving in response to the dual imperatives of technological innovation and sustainability.

A key dimension of this evolution lies in the integration of digital technologies. Blockchain and IoT, in particular, offer mechanisms that strengthen traceability, transparency, and operational agility (Luu et al., 2023; Liu & Wang, 2022). Traceability enables firms to monitor environmental performance across their supply chains, ensuring compliance with sustainability benchmarks while responding flexibly to dynamic market needs. IoT-enabled predictive analytics also improve route optimization and inventory control, thereby reducing waste and improving service quality. These developments suggest that SSCM theories must account for the transformative influence of digitalization, which acts as both an enabler and a driver of sustainability. By embedding these

innovations within eco-efficient transport models, organizations demonstrate how theoretical frameworks are redefined through practice.

The extent to which these models succeed, however, is contingent on systemic factors. Policy, regulation, and market incentives are consistently identified as critical determinants of whether circular economy logistics are effectively implemented. The European Union's Green Deal, for example, sets binding emission reduction targets and provides incentives for green investments, catalyzing widespread adoption of eco-efficient practices in logistics (Verma, 2024; Dzwigo et al., 2021). By contrast, in regions where regulations are fragmented or inconsistently enforced, firms often lack the necessary institutional support to make long-term sustainability investments (Nikseresht et al., 2023). Market incentives such as tax reductions, subsidies, and favorable financing schemes further mitigate financial barriers, particularly for SMEs that face steep entry costs (Mondal, 2025; Panghal et al., 2023). The systemic alignment of regulatory support with market mechanisms thus creates enabling conditions for the diffusion of circular practices across supply chains.

Conversely, the absence of coherent systemic support can exacerbate existing challenges. In regions with underdeveloped regulatory regimes, weak enforcement mechanisms limit the effectiveness of sustainability initiatives, and financial constraints hinder investments in new infrastructure. Studies from India and sub-Saharan Africa reveal how insufficient access to capital, limited technical knowledge, and infrastructural deficits prevent firms from transitioning to eco-efficient models (Garza-Reyes et al., 2018; Abdelaziz & Munawaroh, 2024). These findings highlight that systemic weaknesses reinforce managerial and infrastructural barriers, thereby delaying progress. Such insights underscore the necessity for comprehensive policy frameworks that align institutional objectives with industrial capacity.

Beyond regulatory frameworks, systemic cultural and organizational factors also play significant roles. A lack of managerial commitment and inadequate workforce training often impede the translation of sustainability goals into operational reality (Verma, 2024; Fang & Liu, 2025). Resistance to change within organizations is exacerbated when leadership fails to prioritize green objectives, or when sustainability knowledge is insufficiently disseminated among employees (Dzwigo et al., 2021; Yoshino et al., 2023). These systemic cultural barriers limit the effectiveness of even the most advanced technological innovations, suggesting that organizational change must accompany infrastructural and regulatory reforms. Building a culture of sustainability within logistics firms through targeted training and green human capital development represents a crucial strategy for embedding circular practices (Muafi & Sugarindra, 2023; Nascimento et al., 2019).

The findings of this review also point toward important policy implications and practical strategies for overcoming persistent barriers. Policymakers are advised to establish compliance frameworks that are stringent yet flexible enough to accommodate varying industry contexts and resource levels (Nikseresht et al., 2023; Panghal et al., 2023). Such frameworks should not only enforce environmental standards but also create mechanisms for stakeholder collaboration, facilitating innovation through partnerships between governments, industry actors, and academic institutions. Collaborative knowledge transfer and co-creation of solutions allow stakeholders to share best practices and reduce duplication of effort. By institutionalizing platforms for dialogue,

policymakers can accelerate the diffusion of eco-efficient transport models and adapt global best practices to local contexts.

From a practical standpoint, firms can mitigate barriers by investing in internal sustainability strategies. Training programs designed to enhance green human capital are central to overcoming resistance to change and fostering innovation (Nascimento et al., 2019). Organizations that prioritize workforce development create a foundation for long-term adoption of eco-efficient practices. Similarly, investment in digital logistics platforms has been shown to produce significant cost savings and operational efficiencies, enabling firms to align economic and environmental goals (Luu et al., 2023; Yaqot et al., 2022). These technologies not only improve efficiency but also provide data-driven insights that can inform policy advocacy and strategic planning.

Strategic partnerships across supply chains also represent a key solution to overcoming financial and infrastructural limitations. By pooling resources and collaborating on technology adoption, logistics firms can collectively reduce costs and increase resilience (Verma, 2024; Panghal et al., 2023). For example, shared charging infrastructure for electric fleets or joint recycling initiatives allow firms to overcome infrastructural deficits while advancing sustainability goals. Such partnerships can be incentivized through government subsidies or tax benefits, reinforcing collaborative approaches as a core pillar of sustainable logistics strategies.

Nevertheless, it is important to recognize the limitations in existing research that inform these strategies. A recurring gap in the literature is the lack of empirical evidence demonstrating the quantifiable impacts of circular economy logistics on firm-level performance (Liu & Wang, 2022; Jayarathna et al., 2023). Much of the scholarship remains conceptual or based on limited case studies, making it difficult to generalize findings across industries or regions (Tetteh et al., 2024). Moreover, performance assessment methodologies for circular economy models remain underdeveloped, leaving firms uncertain about the return on sustainability investments (Agarwal et al., 2025). This lack of robust evidence complicates decision-making for companies and policymakers alike, as the risks and benefits of adopting green logistics are not uniformly understood.

Another limitation lies in the regional disparities of existing research. While the European Union and East Asia are well represented in empirical studies, developing economies in Africa and South Asia remain underexplored (Pambudi, 2025; Borucka & Grzelak, 2025). This imbalance limits the global applicability of current findings and highlights the need for context-sensitive research that addresses the unique financial, cultural, and infrastructural barriers in these regions. Future studies could adopt mixed-method approaches, combining quantitative modeling with qualitative fieldwork, to provide more comprehensive insights into the diverse realities of implementing circular practices.

Furthermore, existing research has not sufficiently examined the socio-economic co-benefits of circular economy logistics, such as job creation, poverty alleviation, or contributions to social equity. These dimensions are particularly relevant in regions where sustainability objectives intersect with broader developmental goals (Simane et al., 2024; Mondal, 2025). Incorporating these perspectives into future research would provide a more holistic understanding of the societal impacts of eco-efficient transport models, strengthening the case for their widespread adoption.

In light of these limitations, future research agendas should focus on generating empirical evidence that validates the environmental and economic impacts of circular logistics, developing standardized performance assessment tools, and expanding the geographic scope of analysis to encompass underrepresented regions. By addressing these gaps, scholars can provide more actionable insights for both policymakers and industry stakeholders, ultimately supporting the global diffusion of eco-efficient transport models.

CONCLUSION

This narrative review demonstrates that the integration of green logistics and circular economy frameworks provides both environmental and economic benefits, offering a pathway toward sustainable and resilient transport systems. The findings underscore that technological innovations such as artificial intelligence, blockchain, and the Internet of Things significantly enhance operational efficiency while reducing emissions. Policy and regulatory frameworks, particularly in the European Union, are shown to accelerate adoption by incentivizing investments in eco-efficient practices, while economic drivers such as cost savings and competitive advantages further reinforce adoption. Case studies illustrate measurable benefits, including reductions in greenhouse gas emissions, operational cost savings, and improved customer satisfaction, underscoring the feasibility of circular models in practice.

Nevertheless, systemic barriers persist, notably high upfront costs, limited infrastructure, and weak regulatory enforcement in developing economies. Organizational challenges, including lack of managerial commitment and insufficient employee training, also hinder implementation. These obstacles highlight the urgent need for targeted interventions. Policies that align regulatory frameworks with market incentives, along with investments in infrastructure and capacity building, are critical to overcoming these barriers. Collaborative strategies such as shared infrastructure and supply chain partnerships further strengthen the potential for adoption.

Future research should address the lack of empirical evidence quantifying the impacts of circular logistics, develop standardized performance metrics, and expand geographical coverage to include underrepresented regions. By focusing on these areas, scholarship can provide more actionable insights to guide policy and practice. Ultimately, advancing green logistics and circular economy practices requires a multifaceted strategy integrating technology, regulation, economic incentives, and organizational transformation.

REFERENCE

Abdelaziz, S. and Munawaroh, M. (2024). Mitigating supply chain vulnerabilities: a bibliometric analysis of sustainable logistics for resilience and risk management with perspectives on the automotive industry. *International Journal of Automotive Science and Technology, 8*(4), 544-588. https://doi.org/10.30939/ijastech..1554338

Agarwal, S., Kumar, N., Tyagi, M., & Garg, R. (2025). Integrating soft computing techniques for optimizing green vehicular communications and networking in circular digital supply chain. *Journal of Science and Technology Policy Management*. https://doi.org/10.1108/jstpm-03-2024-0112

Alavi-Borazjani, S., Adeel, S., Chkoniya, V., & Tarelho, L. (2025). Sustainability-oriented port management: biomass gasification as a strategic tool for green and circular maritime logistics. *Sustainability, 17*(6), 2634. https://doi.org/10.3390/su17062634

Alfirević, N., Mršić, S., & Kač, S. (2025). Multinomial logistic analysis of smes offering green products and services in the alps–adriatic macroregion. *Sustainability, 17*(10), 4721. https://doi.org/10.3390/su17104721

Balanay, R. and Halog, A. (2023). Bioenergy updates and prospects for decarbonization in the asean region: a review on logistical concerns and potential solutions. *Wiley Interdisciplinary Reviews Energy and Environment, 13*(1). https://doi.org/10.1002/wene.499

Batista, L., Bourlakis, M., Smart, P., & Maull, R. (2018). In search of a circular supply chain archetype – a content-analysis-based literature review. *Production Planning & Control, 29*(6), 438-451. https://doi.org/10.1080/09537287.2017.1343502

Berberoğlu, Y., Kazançoğlu, Y., & Sağnak, M. (2023). Circularity assessment of logistics activities for green business performance management. *Business Strategy and the Environment, 32*(7), 4734-4749. https://doi.org/10.1002/bse.3390

Borucka, A. and Grzelak, M. (2025). Deposit–refund system as a strategy to drive sustainable energy transition on the example of poland. *Sustainability, 17*(3), 1030. https://doi.org/10.3390/su17031030

Čižiūnienė, K., Matijošius, J., Sokolovskij, E., & Balevičiūtė, J. (2024). Assessment of implementing green logistics principles in railway transport: the case of lithuania. *Sustainability, 16*(7), 2716. https://doi.org/10.3390/su16072716

Dev, N., Shankar, R., & Qaiser, F. (2020). Industry 4.0 and circular economy: operational excellence for sustainable reverse supply chain performance. *Resources Conservation and Recycling, 153*, 104583. https://doi.org/10.1016/j.resconrec.2019.104583

Dzwigo, H., Трушкіна, Н., & Kwiliński, A. (2021). The organizational and economic mechanism of implementing the concept of green logistics. *Virtual Economics, 4*(2), 41-75. https://doi.org/10.34021/ve.2021.04.02(3)

Fang, Z. and Liu, Z. (2025). Digital innovations driving urban sustainability: key factors in reducing carbon emissions. *Sustainability, 17*(5), 2186. https://doi.org/10.3390/su17052186

Foschi, E., Zanni, S., & Bònoli, A. (2020). Combining eco-design and lca as decision-making process to prevent plastics in packaging application. *Sustainability, 12*(22), 9738. https://doi.org/10.3390/su12229738

Garza-Reyes, J., Yu, M., Kumar, V., & Upadhyay, A. (2018). Total quality environmental management: adoption status in the chinese manufacturing sector. *The TQM Journal, 30*(1), 2-19. https://doi.org/10.1108/tqm-05-2017-0052

Jayarathna, C., Agdas, D., & Dawes, L. (2023). Viability of sustainable logistics practices enabling circular economy: a system dynamics approach. *Business Strategy and the Environment, 33*(4), 3422-3439. https://doi.org/10.1002/bse.3655

Kumar, R., Gupta, S., & Rehman, U. (2023). Circular economy a footstep toward net zero manufacturing: critical success factors analysis with case illustration. *Sustainability, 15*(20), 15071. https://doi.org/10.3390/su152015071

Liu, Z. and Wang, M. (2022). Improving circular supply chain performance through green innovations: the moderating role of economic policy uncertainty. *Sustainability, 14*(24), 16888. https://doi.org/10.3390/su142416888

Luu, T., Chromjaková, F., & Nguyễn, H. (2023). A model of industry 4.0 and a circular economy for green logistics and a sustainable supply chain. *Business Strategy & Development, 6*(4), 897-920. https://doi.org/10.1002/bsd2.286

Mageto, J. (2022). Current and future trends of information technology and sustainability in logistics outsourcing. *Sustainability, 14*(13), 7641. https://doi.org/10.3390/su14137641

Makarova, I., Shubenkova, K., Buyvol, P., Shepelev, V., & Гриценко, А. (2021). The role of reverse logistics in the transition to a circular economy: case study of automotive spare parts logistics. *FME Transaction, 49*(1), 173-185. https://doi.org/10.5937/fme2101173m

Mondal, S. (2025). Analyzing the indicators of green entrepreneurship for the sustainable circular economy: a mixed-method approach. *Benchmarking an International Journal.* https://doi.org/10.1108/bij-04-2024-0356

Muafi, M. and Sugarindra, M. (2023). Green logistic and absorptive capacity on business sustainability: the mediating role of circular economy implementation. *Journal of Industrial Engineering and Management, 16*(2), 275. https://doi.org/10.3926/jiem.5283

Nascimento, D., Alencastro, V., Quelhas, O., Caiado, R., Garza-Reyes, J., Rocha-Lona, L., … & Tortorella, G. (2019). Exploring industry 4.0 technologies to enable circular economy practices in a manufacturing context. *Journal of Manufacturing Technology Management, 30*(3), 607-627. https://doi.org/10.1108/jmtm-03-2018-0071

Nikseresht, A., Golmohammadi, D., & Zandieh, M. (2023). Sustainable green logistics and remanufacturing: a bibliometric analysis and future research directions. *The International Journal of Logistics Management, 35*(3), 755-803. https://doi.org/10.1108/ijlm-03-2023-0085

Notteboom, T., Lugt, L., Saase, N., Sel, S., & Neyens, K. (2020). The role of seaports in green supply chain management: initiatives, attitudes, and perspectives in rotterdam, antwerp, north sea port, and zeebrugge. *Sustainability, 12*(4), 1688. https://doi.org/10.3390/su12041688

Pambudi, N. (2025). Enhancing public participation in plastic waste management for a sustainable circular economy: insights from indonesia. *Journal of Material Cycles and Waste Management*. https://doi.org/10.1007/s10163-025-02294-5

Panghal, A., Akhila, P., Vern, P., & Mor, R. (2023). Adoption barriers to green logistics in the indian food industry: a circular economy perspective. *International Social Science Journal, 74*(252), 519-538. https://doi.org/10.1111/issj.12466

Parlato, M., Valenti, F., Midolo, G., & Porto, S. (2022). Livestock wastes sustainable use and management: assessment of raw sheep wool reuse and valorization. *Energies, 15*(9), 3008. https://doi.org/10.3390/en15093008

Sağlam, Y. (2023). Does green intellectual capital matter for reverse logistics competency? the role of regulatory measures. *Journal of Intellectual Capital, 24*(5), 1227-1247. https://doi.org/10.1108/jic-07-2022-0147

Savini, F. (2019). The economy that runs on waste: accumulation in the circular city. *Journal of Environmental Policy & Planning, 21*(6), 675-691. https://doi.org/10.1080/1523908x.2019.1670048

Simane, B., Malcolm, R., O'Meara, N., Oremo, F., Geleta, Y., & Ahmedin, A. (2024). Knowledge, attitudes, and practices on circular economy among senior managers of ethiopian textiles and agro-food processing companies. *Circular Economy and Sustainability, 4*(4), 3093-3117. https://doi.org/10.1007/s43615-023-00342-6

Su, Z., Zhang, M., & Wu, W. (2021). Visualizing sustainable supply chain management: a systematic scientometric review. *Sustainability, 13*(8), 4409. https://doi.org/10.3390/su13084409

Tetteh, F., Mensah, J., & Kwateng, K. (2024). Understanding what, how and when green logistics practices influence carbon-neutral supply chain performance. *International Journal of Productivity and Performance Management, 74*(6), 2211-2244. https://doi.org/10.1108/ijppm-08-2024-0517

Verma, A. (2024). Green logistics practices toward a circular economy: a way to sustainable development. *Management and Production Engineering Review*. https://doi.org/10.24425/mper.2024.151136

Wang, M., Liu, P., Gu, Z., Hong, C., & Li, X. (2019). A scientometric review of resource recycling industry. *International Journal of Environmental Research and Public Health, 16*(23), 4654. https://doi.org/10.3390/ijerph16234654

Wong, Y., Mak, S., & Ho, K. (2022). Green solutions for the logistics and transportation industry: a case study of a leading global 3pl headquartered in hong kong. https://doi.org/10.3233/atde220352

Ya, C., Masukujjaman, M., Sobhani, F., Hamayun, M., & Alam, S. (2023). Green logistics, green human capital, and circular economy: the mediating role of sustainable production. *Sustainability, 15*(2), 1045. https://doi.org/10.3390/su15021045

Yaqot, M., Menezes, B., & Al-Ansari, T. (2022). Roadmap to precision agriculture under circular economy constraints. *Journal of Information & Knowledge Management, 22*(05). https://doi.org/10.1142/s0219649222500927

Yoshino, M., Sadlek, B., Yarime, M., & Ali, A. (2023). Knowledge absorption pathways for eco-innovation: an empirical analysis of small and medium-sized enterprises in the european union. *European Journal of Innovation Management, 28*(2), 426-453. https://doi.org/10.1108/ejim-02-2023-0136

Zhou, B., Siddik, A., Zheng, G., & Masukujjaman, M. (2023). Unveiling the role of green logistics management in improving smes' sustainability performance: do circular economy practices and supply chain traceability matter?. *Systems, 11*(4), 198. https://doi.org/10.3390/systems11040198