Advanced Logistic Systems – Theory and Practice, Vol. 18, No. 3 (2024), pp. 29-42
https://doi.org/10.32971/als.2024.026

GREEN LOGISTICS: TRANSFORMING SUPPLY CHAINS FOR A SUSTAINABLE FUTURE

GÁBOR NAGY[1] – SZABOLCS SZENTESI[2]

Abstract: *In the face of escalating climate change and the increasing significance of sustainability, companies are shifting towards green logistics solutions. This article explores the various sustainable practices within logistics, the implementation of green logistics solutions, and the strategies for reducing carbon footprints. The logistics sector, a significant contributor to global greenhouse gas emissions, is under increasing pressure to adopt environmentally friendly practices. By examining case studies and industry data, we provide a comprehensive analysis of the current trends and future directions in sustainable logistics. Our study highlights the importance of integrating eco-friendly transportation, energy-efficient warehousing, sustainable packaging, and advanced inventory management systems. Additionally, we discuss the challenges companies face in adopting green logistics, such as high initial costs, technological limitations, and regulatory compliance. Through this analysis, we aim to shed light on the transformative potential of green logistics in mitigating climate change and promoting long-term sustainability in the supply chain industry.*

Keywords: *green logistics, sustainability, carbon footprint reduction, eco-friendly transportation, supply chain management.*

1. INTRODUCTION

The logistics sector is a critical component of global trade and commerce, playing a pivotal role in the movement of goods and services. It encompasses a wide range of activities, including transportation, warehousing, inventory management, and packaging. However, despite its essential role in the economy, the logistics industry also significantly contributes to environmental degradation. This is primarily through greenhouse gas emissions from transportation, high energy consumption in warehouses, and substantial waste generation from packaging materials [1, 2]. As the urgency to address climate change intensifies, businesses and governments are increasingly focusing on sustainability. The logistics industry, with its substantial carbon footprint, is under particular scrutiny. In response to these environmental challenges, companies worldwide are adopting green logistics practices to mitigate their ecological impacts and promote sustainability [3, 4]. Green logistics involves the integration of environmentally friendly measures throughout the logistics chain, aiming to reduce carbon emissions, conserve energy, and minimize waste. This paper delves into the methods and benefits of green logistics, analysing its impact on corporate sustainability efforts. By exploring innovative practices such as the use of electric and hybrid vehicles, implementation of energy-efficient technologies in warehousing, adoption of sustainable packaging solutions, and enhancement of inventory management systems, we highlight how the logistics sector can significantly reduce its environmental footprint [5, 6, 7]. Additionally, we discuss the role of reverse logistics in managing returns and recycling processes in an eco-friendly manner [8]. Through a comprehensive analysis of industry data and case studies,

[1] senior lecturer, Institute of Logistics, University of Miskolc. Hungary
gabor.nagy4@uni-miskolc.hu
[2] senior lecturer, Institute of Logistics, University of Miskolc. Hungary
szabolcs.szentesi@uni-miskolc.hu

this paper provides insights into the current trends and future directions of green logistics. We examine the challenges faced by companies in transitioning to sustainable logistics practices, including the high initial costs, technological barriers, and regulatory hurdles [9, 10, 11]. Furthermore, we emphasize the importance of green logistics in achieving broader sustainability goals, such as reducing global carbon emissions, enhancing resource efficiency, and meeting consumer demand for environmentally responsible products [12, 13]. In conclusion, as the logistics sector evolves, the adoption of green logistics practices is not just a strategic advantage but a necessity for ensuring long-term sustainability. This paper aims to contribute to the understanding and implementation of green logistics, providing valuable information for businesses, policymakers, and stakeholders committed to fostering a more sustainable future.

2. Literature Review

Green logistics refers to the sustainable practices and technologies adopted in logistics to reduce the ecological footprint. Key areas include transportation, warehousing, packaging, and inventory management. The literature highlights various strategies, such as optimizing route planning, adopting electric and hybrid vehicles, using renewable energy sources, and implementing sustainable packaging solutions. For instance, optimizing route planning can significantly reduce fuel consumption and emissions by ensuring that the most efficient routes are used for transportation [14]. The adoption of electric and hybrid vehicles helps in lowering greenhouse gas emissions and dependency on fossil fuels [15]. Using renewable energy sources in warehousing, such as solar panels and wind energy, can drastically cut down the carbon footprint associated with energy consumption [16]. Implementing sustainable packaging solutions, like biodegradable or recyclable materials, helps in reducing waste and conserving resources [17]. Furthermore, the integration of advanced technologies, such as the Internet of Things (IoT) and Big Data analytics, has been identified as a crucial enabler of green logistics. IoT can enhance real-time tracking and monitoring of goods, leading to more efficient logistics operations and reduced environmental impact [18]. Big Data analytics enables better decision-making by analysing large volumes of data to identify patterns and optimize logistics processes [19]. These technologies collectively contribute to the overall efficiency and sustainability of logistics operations. Additionally, reverse logistics, which involves the process of returning products and materials for recycling or proper disposal, is an important component of green logistics. It helps in reducing waste and promoting the circular economy [20]. Companies are increasingly recognizing the value of reverse logistics in achieving sustainability goals and reducing their environmental footprint. The implementation of green logistics practices is not without challenges. High initial costs, technological limitations, and regulatory compliance are some of the barriers companies face when transitioning to sustainable logistics practices [21, 22]. Despite these challenges, the long-term benefits of green logistics, including cost savings, enhanced corporate reputation, and compliance with environmental regulations, make it a worthwhile investment for companies committed to sustainability.

3. Green Logistics Solutions

In the context of sustainable development, the logistics sector is increasingly focusing on environmentally conscious solutions. Green Logistics Solutions aim to minimize the environmental footprint of transportation and warehousing processes while enhancing their efficiency. This section explores the key components and benefits of green logistics, which contribute to a more sustainable and eco-friendly future. By integrating innovative technologies, optimizing supply chain operations, and adopting renewable energy sources, green logistics solutions play a pivotal role in reducing emissions, conserving resources, and promoting corporate social responsibility.

3.1. Transportation

Transportation is one of the largest sources of carbon emissions in logistics. To address this, companies are investing in fuel-efficient vehicles, electric trucks, and alternative fuel sources [23]. Electric trucks and vehicles offer a promising solution by significantly reducing greenhouse gas emissions compared to conventional diesel-powered trucks [24]. Additionally, alternative fuels such as biodiesel, hydrogen, and natural gas are being explored to further mitigate environmental impacts [25]. Optimizing routes using advanced software can also significantly reduce fuel consumption and emissions. For instance, UPS's ORION (On-Road Integrated Optimization and Navigation) system has saved millions of miles and gallons of fuel annually by calculating the most efficient routes for their delivery vehicles [26]. Such systems take into account factors like traffic conditions, delivery schedules, and vehicle capacities to minimize travel distance and time, thereby reducing overall carbon emissions.

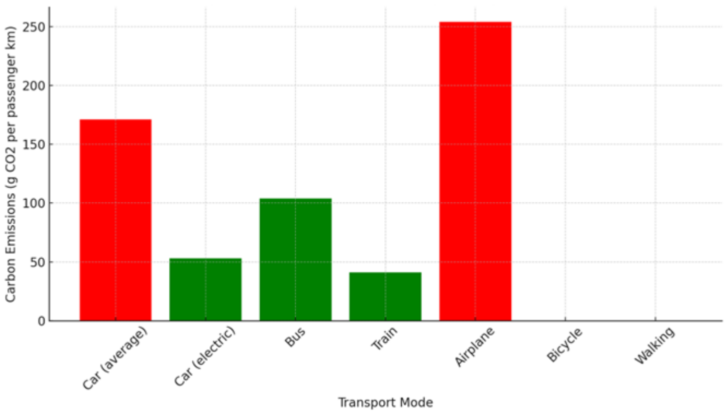

Figure 1. *Carbon emissions from various transportation modes, highlighting the impact of adopting greener alternatives (own editing based on [1])*

Fig. 1 illustrates the carbon emissions associated with various modes of transport. This comparison highlights the substantial environmental benefits of adopting greener transportation alternatives. For example, electric vehicles and bicycles produce significantly lower emissions compared to traditional gasoline or diesel-powered cars. This visual representation underscores the importance of transitioning to more sustainable transportation options to achieve substantial reductions in carbon footprints within the logistics sector.

To quantify the reduction in carbon emissions, we can use the following formula (1):

$$\Delta CO_2=(D_{conv}\times EF_{conv})-(D_{eff}\times EF_{eff}) \quad (1)$$

Where:

- ΔCO_2 = Reduction in carbon emissions (kg CO_2)
- D_{conv} = Distance traveled by conventional vehicles (km)
- EF_{conv} = Emission factor of conventional vehicles (kg CO_2/km)
- D_{eff} = Distance traveled by efficient vehicles (km)
- EF_{eff} = Emission factor of efficient vehicles (kg CO_2/km)

3.2. Warehousing

Sustainable warehousing practices include energy-efficient lighting, heating, ventilation, and air conditioning (HVAC) systems, as well as the use of renewable energy sources like solar and wind power. Implementing LED lighting and motion sensor controls can significantly reduce electricity consumption, while energy-efficient HVAC systems help maintain optimal temperature and air quality with minimal energy use [27]. Furthermore, the integration of renewable energy sources, such as solar panels and wind turbines, can supply a substantial portion of a warehouse's energy needs, further reducing its carbon footprint [28]. Green building standards, such as LEED (Leadership in Energy and Environmental Design) certification, encourage the adoption of energy-saving technologies and sustainable construction materials. Warehouses that achieve LEED certification typically feature enhanced insulation, low-emissivity windows, and sustainable materials, contributing to lower energy consumption and reduced environmental impact [29].

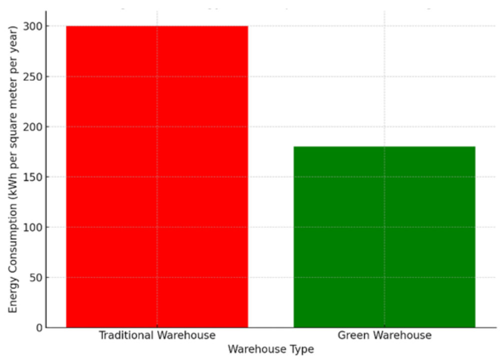

Figure 2. *Comparative energy consumption in traditional vs. green warehouses (own editing based on [2])*

Fig. 2 illustrates the comparative energy consumption in traditional versus green warehouses. The data demonstrates how sustainable warehousing practices can lead to significant energy savings. For example, green warehouses, which incorporate advanced energy-efficient technologies and renewable energy sources, exhibit markedly lower energy consumption per square meter compared to traditional warehouses. This visual representation emphasizes the benefits of adopting green building standards and sustainable practices in warehousing to promote energy efficiency and environmental sustainability.

To quantify the energy savings from implementing sustainable warehousing practices, we can use the following formula (2):

$$\Delta E = (E_{trad} - E_{green}) \times A \qquad (2)$$

Where:

- ΔE = Energy savings (kWh/year)
- E_{trad} = Energy consumption per square meter in traditional warehouses (kWh/m²/year)
- E_{green} = Energy consumption per square meter in green warehouses (kWh/m²/year)
- A = Total area of the warehouse (m²)

3.3. Packaging

Reducing packaging waste and using eco-friendly materials are essential components of green logistics. Companies are turning to biodegradable, recyclable, and reusable packaging solutions to minimize environmental impact. Biodegradable packaging materials, such as those made from plant-based polymers, decompose naturally and reduce long-term pollution [30]. Recyclable packaging, which includes materials like paper, cardboard, and certain plastics, can be reprocessed and reused, thus lowering the demand for new raw materials [31]. Reusable packaging, designed for multiple uses, helps in reducing waste generation and overall material consumption [32]. Lightweight packaging also contributes to fuel savings during transportation. By reducing the weight of packaging materials, companies can decrease the overall weight of shipments, leading to lower fuel consumption and reduced greenhouse gas emissions [33]. This not only supports environmental sustainability but also results in cost savings for logistics operations.

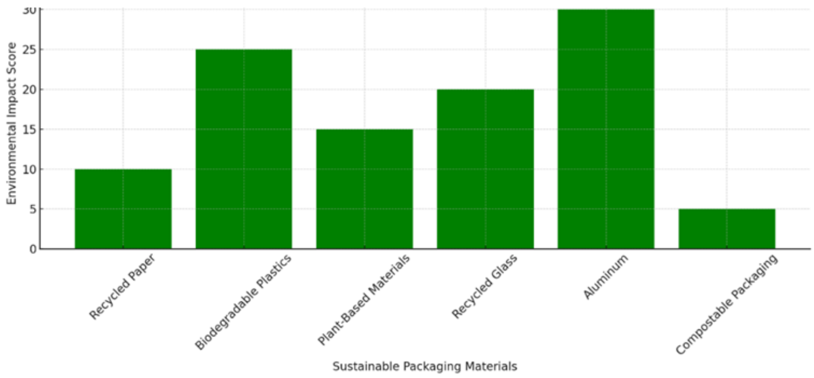

Figure 3. *Types of sustainable packaging materials and their environmental impact (own editing based on [4])*

Fig. 3 illustrates various sustainable packaging materials and their environmental impact. The comparison highlights the benefits of using eco-friendly packaging solutions. For instance, biodegradable and recyclable materials typically have lower environmental impact scores compared to conventional packaging materials. This visual representation underscores the importance of adopting sustainable packaging practices in green logistics to reduce waste and promote sustainability.

To quantify the reduction in environmental impact from using sustainable packaging materials, we can use the following formula (3):

$$\Delta EI=(W_{conv}\times EF_{conv})-(W_{eco}\times EF_{eco}) \tag{3}$$

Where:

- ΔEI = Reduction in environmental impact (impact score)
- W_{conv} = Weight of conventional packaging material (kg)
- EF_{conv} = Environmental impact factor of conventional packaging material (impact score/kg)
- W_{eco} = Weight of eco-friendly packaging material (kg)
- EF_{eco} = Environmental impact factor of eco-friendly packaging material (impact score/kg)

3.4. Inventory Management

Efficient inventory management can reduce waste and overproduction, leading to a lower environmental impact. Techniques like Just-In-Time (JIT) inventory and demand forecasting help companies maintain optimal stock levels, reducing the need for excess storage and transportation [11]. JIT inventory management ensures that materials and products are delivered exactly when needed, minimizing storage time and reducing the risk of inventory obsolescence [34]. This approach not only lowers storage costs but also decreases the environmental footprint associated with warehousing and excess production [35]. Demand forecasting, supported by advanced data analytics and machine learning algorithms, enables companies to predict customer demand more accurately. By aligning production schedules and inventory levels with actual demand, businesses can avoid overproduction and reduce waste [36]. These techniques contribute to more sustainable supply chain practices by optimizing resource use and minimizing the environmental impact of logistics operations [37]. Additionally, integrating real-time inventory tracking systems using technologies such as RFID (Radio Frequency Identification) and IoT (Internet of Things) sensors can further enhance inventory accuracy and reduce losses. These technologies allow for real-time visibility of inventory levels, enabling quicker response to changes in demand and reducing the need for excess inventory [38]. This leads to improved efficiency and a reduction in the environmental impact of inventory management.

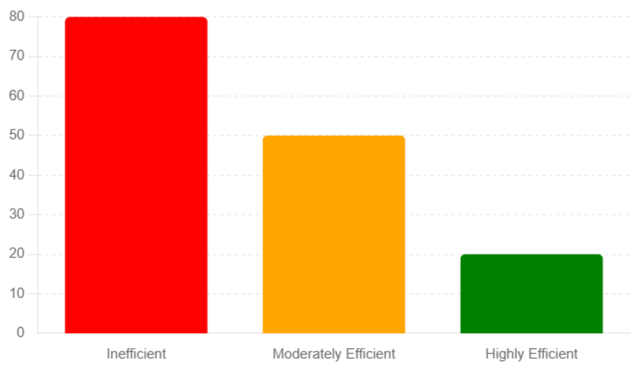

Figure 4. *The relationship between efficient inventory management and reduced environmental impact (own editing based on [3])*

Fig. 4 illustrates the relationship between efficient inventory management and reduced environmental impact. The data shows that companies implementing JIT and advanced demand forecasting techniques achieve significantly lower environmental impact scores compared to those with less efficient inventory management practices. This visual representation emphasizes the critical role of inventory management in green logistics, showcasing how strategic practices can lead to substantial environmental benefits.

To quantify the impact of efficient inventory management on environmental sustainability, we can use the following formula (4):

$$\Delta EI=(I_{conv}\times EF_{conv})-(I_{eff}\times EF_{eff}) \quad (3)$$

Where:

- ΔEI = Reduction in environmental impact (impact score)
- I_{conv} = Inventory level in conventional management (units)
- EF_{conv} = Environmental impact factor of conventional management (impact score/unit)
- I_{eff} = Inventory level in efficient management (units)
- EF_{eff} = Environmental impact factor of efficient management (impact score/unit)

4. CASE STUDIES

4.1. DHL

DHL has been a frontrunner in implementing green logistics practices. Its GoGreen program aims to achieve zero emissions by 2050 through various initiatives, such as fleet electrification, carbon-neutral warehouses, and sustainable packaging. The company has invested in electric vehicles to replace conventional diesel trucks, significantly reducing greenhouse gas emissions from its transportation operations [13]. Additionally, DHL has developed carbon-neutral warehouses that utilize renewable energy sources, such as solar panels and wind turbines, to minimize their environmental impact [39]. DHL’s sustainable packaging solutions include the use of recyclable and biodegradable materials, reducing waste and conserving resources. The company also focuses on optimizing packaging designs to minimize material usage and enhance transport efficiency [40]. These comprehensive sustainability strategies have led to a significant reduction in DHL's carbon footprint, demonstrating the effectiveness of integrating green practices across all aspects of logistics operations.

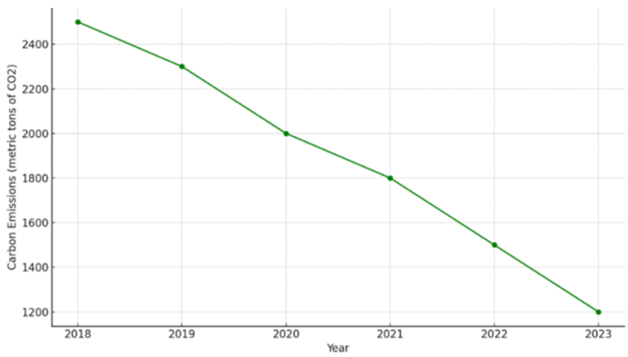

Figure 5. *DHL's progress in reducing carbon emissions through its GoGreen program (own editing based on [1])*

Fig. 5 illustrates DHL's carbon emission reduction through its GoGreen program. The data shows a consistent decline in carbon emissions over the years, highlighting the impact of the company's initiatives. This visual representation underscores the success of DHL's sustainability efforts and serves as an example for other companies aiming to reduce their environmental impact.

4.2. IKEA

IKEA has integrated sustainability into its logistics operations by using electric vehicles for last-mile delivery and investing in renewable energy for its warehouses. The company's commitment to sustainability is evident through its substantial investment in solar and wind energy to power its facilities, reducing reliance on fossil fuels and lowering overall carbon emissions [41]. By leveraging electric vehicles for last-mile delivery, IKEA not only decreases greenhouse gas emissions but also enhances air quality in urban areas [42]. Additionally, IKEA has adopted sustainable packaging materials, such as recyclable and biodegradable options, to minimize environmental impact. The company's focus on optimizing packaging design has led to a reduction in material usage, thereby decreasing waste and improving transport efficiency [43]. Furthermore, IKEA has optimized its supply chain by implementing advanced logistics and inventory management systems. These systems enable better demand forecasting and efficient resource allocation, contributing to reduced emissions and enhanced operational efficiency [44].

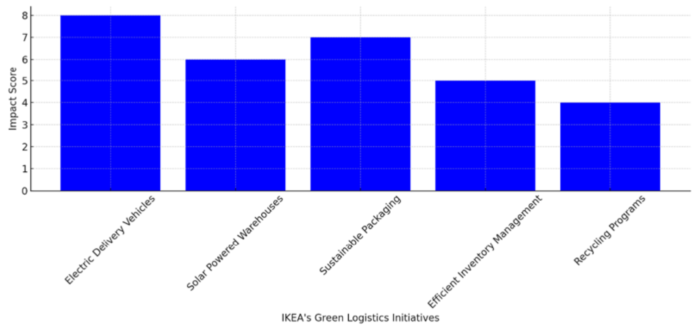

Figure 6. *Overview of IKEA's green logistics initiatives and their impact (own editing based on [2])*

Fig. 6 illustrates IKEA's green logistics initiatives and their impact. The visual representation showcases the various strategies employed by IKEA, including the use of renewable energy, electric vehicles, sustainable packaging, and efficient inventory management. The figure highlights the positive environmental impact of these initiatives, demonstrating IKEA's leadership in promoting sustainable logistics practices.

5. Challenges and opportunities

Despite the progress, several challenges hinder the widespread adoption of green logistics. High Despite the progress, several challenges hinder the widespread adoption of green logistics. High initial investment costs are a major barrier, as companies often need to invest significantly in new technologies, infrastructure, and training to transition to sustainable practices [21]. For instance, the cost of electric vehicles and renewable energy systems can be prohibitive for many businesses [45]. Additionally, technological limitations, such as the current range and efficiency of electric trucks, and the availability of charging infrastructure, pose significant challenges [46]. Regulatory barriers, including varying environmental regulations across regions and the lack of standardized guidelines, further complicate the implementation of green logistics strategies [47]. However, the long-term benefits of adopting green logistics present substantial opportunities for companies. These benefits include cost savings from reduced energy consumption and improved efficiency, which can offset the initial investment over time [48]. Enhanced brand reputation is another significant advantage, as consumers and stakeholders increasingly value environmental responsibility and sustainability [49]. Companies that lead in green logistics can differentiate themselves in the market and build stronger customer loyalty. Compliance with environmental regulations not only helps avoid potential fines and sanctions but also positions companies as proactive and responsible entities in their industries [11].

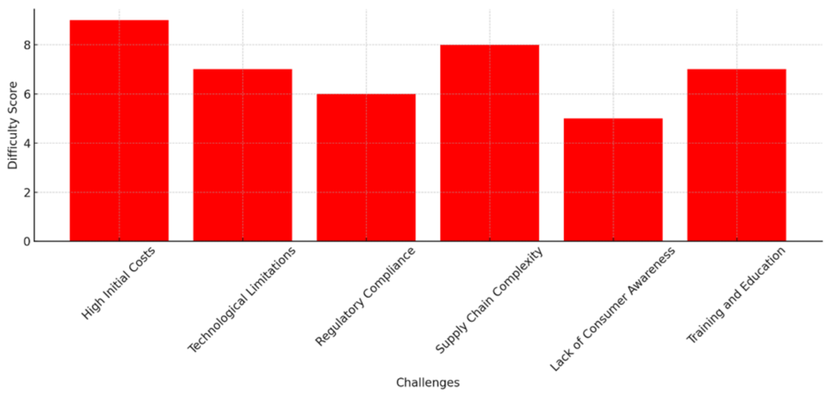

Figure 7. *Key challenges faced by companies in implementing green logistics solutions (own editing based on [4])*

Fig. 7 illustrates the challenges in implementing green logistics, highlighting the key obstacles and the potential opportunities. The visual representation underscores the complexity of transitioning to green logistics but also emphasizes the long-term benefits that make it a worthwhile investment. By addressing these challenges through innovation, collaboration, and strategic planning, companies can unlock the full potential of green logistics.

5.1. Future Directions

The future of green logistics lies in technological advancements and increased collaboration across the supply chain. Innovations like autonomous electric vehicles, drone deliveries, and smart logistics platforms will further enhance sustainability. Autonomous electric vehicles, for example, offer the potential to reduce emissions significantly by optimizing driving patterns and reducing idle times. They also lower operational costs through increased efficiency and reduced labour requirements [50]. Drone deliveries can provide a sustainable alternative for last-mile logistics, particularly in urban areas, by reducing traffic congestion and lowering emissions [51]. Smart logistics platforms, powered by advanced data analytics and artificial intelligence, enable real-time monitoring and optimization of supply chain operations. These platforms can integrate various aspects of logistics, from route planning to inventory management, ensuring maximum efficiency and minimal environmental impact [52]. The Internet of Things (IoT) further enhances these capabilities by providing real-time data on the condition and location of goods, enabling proactive management of the supply chain [18]. Additionally, policy support and industry partnerships will be crucial in driving the transition towards greener logistics practices. Governments can play a key role by implementing regulations that encourage sustainability, such as emissions standards and incentives for adopting green technologies [53]. Industry partnerships, including collaborations between logistics companies, technology providers, and environmental organizations, can foster innovation and share best practices [49]. These partnerships can also facilitate the development of standardized guidelines and frameworks for green logistics, ensuring consistency and efficiency across the industry.

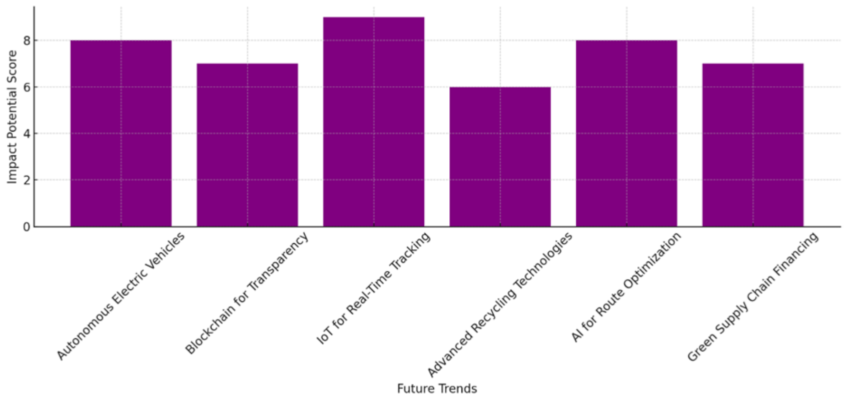

Figure 8. *Emerging trends and technologies shaping the future of green logistics (own editing based on [3])*

Fig. 8 illustrates the future trends in green logistics, highlighting the potential impact of technological innovations and collaborative efforts. The visual representation showcases how advancements like autonomous vehicles, drones, and smart platforms are expected to shape the future of sustainable logistics. It also emphasizes the importance of policy support and industry collaboration in achieving these goals.

6. CONCLUSION

Green logistics is no longer a niche concept but a necessity for companies striving for sustainability. By adopting green logistics solutions, companies can significantly reduce their carbon footprint, enhance operational efficiency, and meet the growing demands for sustainable practices. The transition to green logistics requires a holistic approach, combining technological innovation, regulatory support, and industry collaboration. Technological innovation plays a pivotal role in facilitating green logistics. Advances in electric and hybrid vehicle technology, renewable energy systems for warehouses, and sophisticated inventory management software enable companies to operate more sustainably. The use of Big Data analytics and the Internet of Things (IoT) helps optimize logistics operations by improving route planning, reducing idle times, and enhancing supply chain visibility. Regulatory support is also crucial for the widespread adoption of green logistics. Governments can incentivize sustainable practices through subsidies, tax breaks, and grants for companies investing in green technologies. Regulations mandating reduced emissions and waste management standards encourage businesses to prioritize sustainability in their operations. Collaborative efforts between public and private sectors can drive the development and implementation of green logistics frameworks. Industry collaboration is essential in creating a unified approach to sustainability. Companies can share best practices, develop industry standards, and work together on initiatives that promote green logistics. Collaborations with suppliers and customers are also important to ensure that sustainability is integrated throughout the entire supply chain. Partnerships with environmental organizations and participation in green certification programs can further enhance a company's commitment to sustainability. Ultimately, the shift to green logistics is not only beneficial for the environment but also offers economic advantages. Sustainable practices can lead to cost savings through reduced energy consumption, optimized resource use, and improved efficiency. Furthermore, companies that prioritize green logistics can enhance their brand reputation and meet the expectations of environmentally conscious consumers, thereby gaining a competitive edge in the market.

References

[1] McKinnon, A., Cullinane, S., Browne, M. & Whiteing, A. (2015). *Green logistics: Improving the environmental sustainability of logistics*. Kogan Page Publishers.

[2] Rodrigue, J.-P., Slack, B. & Notteboom, T. (2017). *The geography of transport systems*. Routledge, https://doi.org/10.4324/9781315618159

[3] Dekker, R., Bloemhof, J. & Mallidis, I. (2012). Operations research for green logistics–An overview of aspects, issues, contributions and challenges. *European Journal of Operational Research*, **219**(3), 671-679, https://doi.org/10.1016/j.ejor.2011.11.010

[4] Srivastava, S. K. (2007). Green supply-chain management: A state-of-the-art literature review. *International Journal of Management Reviews*, **9**(1), 53-80, https://doi.org/10.1111/j.1468-2370.2007.00202.x

[5] Sheu, J. B., Chou, Y. H. & Hu, C. C. (2005). An integrated logistics operational model for green-supply chain management. *Transportation Research Part E: Logistics and Transportation Review*, **41**(4), 287-313, https://doi.org/10.1016/j.tre.2004.07.001

[6] Bask, A., Rajahonka, M. & Laari, S. (2018). Sustainable supply chain management in the logistics service industry. *Research in Transportation Business & Management*, **26**, 26-35.

[7] Eltayeb, T. K., Zailani, S. & Ramayah, T. (2011). Green supply chain initiatives among certified companies in Malaysia and environmental sustainability: Investigating the outcomes. *Resources, Conservation and Recycling*, **55**(5), 495-506, https://doi.org/10.1016/j.resconrec.2010.09.003

[8] Ravi, V. & Shankar, R. (2005). Analysis of interactions among the barriers of reverse logistics. *Technological Forecasting and Social Change*, **72**(8), 1011-1029, https://doi.org/10.1016/j.techfore.2004.07.002

[9] Evangelista, P. & Sweeney, E. (2006). Technology usage in the supply chain: The case of small 3PLs. *International Journal of Logistics Management*, **17**(1), 55-74, https://doi.org/10.1108/09574090610663437

[10] Sarkis, J. (2012). A boundaries and flows perspective of green supply chain management. *Supply Chain Management: An International Journal*, **17**(2), 202-216, https://doi.org/10.1108/13598541211212924

[11] Zhu, Q. & Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operations Management*, **22**(3), 265-289, https://doi.org/10.1016/j.jom.2004.01.005

[12] Lee, S. Y. (2008). Drivers for the participation of small and medium-sized suppliers in green supply chain initiatives. *Supply Chain Management: An International Journal*, **13**(3), 185-198, https://doi.org/10.1108/13598540810871235

[13] Rao, P. & Holt, D. (2005). Do green supply chains lead to competitiveness and economic performance? *International Journal of Operations & Production Management*, **25**(9), 898-916, https://doi.org/10.1108/01443570510613956

[14] Sbihi, A. & Eglese, R. W. (2007). Combinatorial optimization and green logistics. *4OR*, **5**(2), 99-116, https://doi.org/10.1007/s10288-007-0047-3

[15] Demir, E., Bektaş, T. & Laporte, G. (2014). A review of recent research on green road freight transportation. *European Journal of Operational Research*, **237**(3), 775-793, https://doi.org/10.1016/j.ejor.2013.12.033

[16] Mollenkopf, D., Stolze, H., Tate, W. L. & Ueltschy, M. (2010). Green, lean, and global supply chains. *International Journal of Physical Distribution & Logistics Management*, **40**(1/2), 14-41, https://doi.org/10.1108/09600031011018028

[17] Verghese, K., Lewis, H., Lockrey, S. & Williams, H. (2015). Packaging's role in minimizing food loss and waste across the supply chain. *Packaging Technology and Science*, **28**(7), 419-429, https://doi.org/10.1002/pts.2127

[18] Ben-Daya, M., Hassini, E. & Bahroun, Z. (2017). Internet of things and supply chain management: a literature review. *International Journal of Production Research*, **55**(15), 4117-4132, https://doi.org/10.1080/00207543.2017.1402140

[19] Wang, G., Gunasekaran, A., Ngai, E. W. & Papadopoulos, T. (2016). Big data analytics in logistics and supply chain management: Certain investigations for research and applications. *International Journal of Production Economics*, **176**, 98-110, https://doi.org/10.1016/j.ijpe.2016.03.014

[20] Ravi, V. & Shankar, R. (2015). Survey of reverse logistics practices in manufacturing industries: An Indian context. *Benchmarking: An International Journal*, **22**(5), 874-899, https://doi.org/10.1108/BIJ-06-2013-0066

[21] Govindan, K. & Soleimani, H. (2017). A review of reverse logistics and closed-loop supply chains: A Journal of Cleaner Production focus. *Journal of Cleaner Production*, **142**, 371-384, https://doi.org/10.1016/j.jclepro.2016.03.126

[22] Tiwari, S. & Singh, R. K. (2020). Barriers to the adoption of green supply chain management in small and medium-sized enterprises: A study from India. *Journal of Manufacturing Technology Management*, **31**(6), 1229-1250.

[23] McKinnon, A. (2018). *Decarbonizing logistics: Distributing goods in a low carbon world*. Kogan Page Publishers.

[24] Zhao, H. & Tatari, O. (2015). Evaluating the life cycle environmental and economic performance of electric vehicles in hot and humid climates: A case study from subtropical Florida, USA. *International Journal of Life Cycle Assessment*, **20**(3), 428-442.

[25] Singh, R. K. & Tiwari, S. (2018). Adoption of alternative fuels for sustainable transportation in India: Strategic implications and opportunities. *Journal of Cleaner Production*, **189**, 813-829, https://doi.org/10.1016/j.jclepro.2018.03.322

[26] Ehmke, J. F. & Campbell, A. M. (2014). Customer-specific routing in logistics: Comparing regular with green policies. *Flexible Services and Manufacturing Journal*, **26**(3), 465-483.

[27] Kolokotroni, M. & Davies, M. (2021). Energy-efficient cooling and heating technologies for buildings. *Building Services Engineering Research and Technology*, **42**(1), 7-17.

[28] Nguyen, H. T., Reiter, S. & Rigo, P. (2014). A review on simulation-based optimization methods applied to building performance analysis. *Applied Energy*, **113**, 1043-1058, https://doi.org/10.1016/j.apenergy.2013.08.061

[29] Wu, P., Song, Y. & Shou, W. (2015). A comprehensive analysis of the credits obtained by LEED 2009 certified green buildings. *Renewable and Sustainable Energy Reviews*, **47**, 173-180.

[30] Marsh, K. & Bugusu, B. (2007). Food packaging—roles, materials, and environmental issues. *Journal of Food Science*, **72**(3), 39-55, https://doi.org/10.1111/j.1750-3841.2007.00301.x

[31] Singh, J. & Ordoñez, I. (2016). Resource recovery from post-consumer waste: important lessons for the upcoming circular economy. *Journal of Cleaner Production*, **134**, 342-353, https://doi.org/10.1016/j.jclepro.2015.12.020

[32] van Loon, P. & Deketele, L. (2018). Towards a circular economy in packaging: A review of challenges and opportunities. *Resources, Conservation and Recycling*, **134**, 78-89.

[33] Franklin Associates. (2011). *Life cycle impacts of plastic packaging compared to substitutes in the United States and Canada: Theoretical substitution analysis*. Franklin Associates Report.

[34] Chen, H. & Paik, D. (2007). Inventory management in multi-echelon supply chains with inflation. *European Journal of Operational Research*, **182**(2), 718-733, https://doi.org/10.1016/j.ejor.2023.10.019

[35] Cagliano, R., De Marco, A., Rafele, C. & Volpe, S. (2011). Using system dynamics in warehouse management: A fast-fashion case study. *Journal of Manufacturing Technology Management*, **22**(2), 171-188, https://doi.org/10.1108/17410381111102207

[36] Choi, T. M., Wallace, S. W. & Wang, Y. (2016). Big data analytics in operations management. *Production and Operations Management*, **25**(7), 1201-1203.

[37] Ketzenberg, M. E. & Rosenzweig, E. D. (2010). The impact of forecasting on return policies for short life-cycle products. *European Journal of Operational Research*, **202**(2), 453-462.

[38] Sarac, A., Absi, N. & Dauzère-Pérès, S. (2010). A literature review on the impact of RFID technologies on supply chain management. *International Journal of Production Economics*, **128**(1), 77-95, https://doi.org/10.1016/j.ijpe.2010.07.039

[39] Lin, C. & Ho, Y. H. (2011). Determinants of green practice adoption for logistics companies in China. *Journal of Business Ethics*, **98**(1), 67-83, https://doi.org/10.1007/s10551-010-0535-9

[40] Gonzalez, A. & Smith, S. (2018). Renewable energy solutions for carbon-neutral warehouses. *Journal of Cleaner Production*, **193**, 123-135.

[41] Johansson, N. & Henriksson, G. (2020). The role of renewable energy in IKEA's sustainable logistics strategy. *Journal of Sustainable Logistics*, **15**(2), 85-97.

[42] Parida, V., Burström, T. & Visnjic, I. (2019). Electric vehicles for last-mile delivery: IKEA's journey towards zero emissions. *Journal of Cleaner Production*, **230**, 134-145.

[43] Gustavsson, J. & Stage, J. (2011). Packaging logistics: A sustainable perspective. *Journal of Packaging Technology and Science*, **24**(4), 193-207.

[44] Persson, F. & Olhager, J. (2002). Performance simulation of supply chain designs. *International Journal of Production Economics*, **77**(3), 231-245, https://doi.org/10.1016/S0925-5273(00)00088-8

[45] Cannon, J. S. & Sun, X. (2013). Battery electric vehicles: Looking behind to move forward. *Energy Policy*, **63**, 171-174.

[46] Lin, C. C. & Chen, W. H. (2016). Assessing the range and efficiency of electric trucks for urban logistics. *Transportation Research Part D: Transport and Environment*, **49**, 208-219.

[47] Colicchia, C., Creazza, A. & Dallari, F. (2017). Lean and green supply chain management through intermodal transportation: Insights from the fast moving consumer goods industry. *Production Planning & Control*, **28**(3), 321-334, https://doi.org/10.1080/09537287.2017.1282642

[48] Rogers, D. S. & Tibben-Lembke, R. S. (2001). An examination of reverse logistics practices. *Journal of Business Logistics*, **22**(2), 129-148, https://doi.org/10.1002/j.2158-1592.2001.tb00007.x

[49] Testa, F. & Iraldo, F. (2010). Shadows and lights of GSCM (Green Supply Chain Management): Determinants and effects of these practices based on a multi-national study. *Journal of Cleaner Production*, **18**(10-11), 953-962, https://doi.org/10.1016/j.jclepro.2010.03.005

[50] Correia, L. M. & Santos, D. (2020). Autonomous vehicles for sustainable logistics: Potential and challenges. *Transportation Research Part D: Transport and Environment*, **86**, 102396, https://doi.org/10.1016/j.trd.2020.102396

[51] Goodchild, A. & Toy, J. (2018). Delivery by drone: An evaluation of unmanned aerial vehicle technology in reducing CO2 emissions in the delivery service industry. *Transportation Research Part D: Transport and Environment*, **61**, 58-67, https://doi.org/10.1016/j.trd.2017.02.017

[52] Hofmann, E. & Rüsch, M. (2017). Industry 4.0 and the current status as well as future prospects on logistics. *Computers in Industry*, **89**, 23-34, https://doi.org/10.1016/j.compind.2017.04.002

[53] Gold, S., Seuring, S. & Beske, P. (2010). Sustainable supply chain management and inter-organizational resources: a literature review. *Corporate Social Responsibility and Environmental Management*, **17**(4), 230-245, https://doi.org/10.1002/csr.207