IMPORTANCE OF ELECTRIC VEHICLES IN LOGISTICS OPERATIONS

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Abstract

Due to the significant amount of carbon emissions from vehicles that depend on fossil fuels, environmental concerns have increased as global logistical operations have grown, especially in the transportation industry. The potential of electric vehicles (EVs) to reduce emissions and advance sustainability in logistics is explored in this article. A literature review process is applied, using information from industry reports and scholarly publications. According to the research, EVs have a number of benefits, such as cheaper operating expenses, smaller carbon footprints, and increased efficiency. However, barriers to wider use include expensive initial expenses, inadequate infrastructure for charging, limited driving range, and poor performance in different weather situations. Government incentives, improvements in battery technology, and wider charging networks are suggested as solutions to these problems. In order to ensure an easy transition to sustainable logistics, the report highlights the significance of strategic investments and governmental initiatives. Future studies should examine practical uses and evaluate the long-term consequences of EV integration in logistics.

Keywords: electric vehicles, EVs, logistics, Solutions, challenges, benefits

Introduction

Logistics operations have been developing globally, the transportation sector, warehousing, supply chain and e-commerce are part of this development. Along with the development of these sectors, their impacts on the environment and society are also increasing. For instance, as per the report of the World Bank, 9 million premature deaths are happening worldwide due to air pollution (World Bank, 2024). The transportation sector in the logistics industry is one of the main contributors to the increase in the pollution rate in the global market because it relies on cars that run on fossil fuels in most countries (Mızrak, 2022). These conventional cars contribute to air pollution, climate change, and health hazards by releasing large volumes of carbon dioxide (CO_2), nitrogen oxides (NO_x), and particulate matter (Gao et al., 2023).

Transport continues to be a major sustainability issue in logistics as it contributes significantly to greenhouse gas emissions. An efficient way to lower carbon footprints, lower operating costs, and increase energy efficiency is to include electric vehicles (EVs) in logistical operations. By encouraging both environmental responsibility and long-term economic profit, the switch to EVs is consistent with global sustainability goals.

Research aim: to propose effective solutions to enhance the usage of electric vehicles in logistics operations.

Research object: electric vehicles in logistics.

The following **objectives** have been set to achieve the aim:

1. To analyze the benefits of using electric vehicles in logistics operations.
2. To find out the challenges of implementing electric vehicles in logistics operations.
3. To identify the solutions to enhance the use of electric vehicles in logistics operations.

Research object and methods

A literature review is the research method used in the article. Using a literature review, the article analyses the importance of electric vehicles in logistics operations. A comprehensive analysis is conducted using secondary resources, including published articles, journals, books and research papers on the topic of electric vehicles in logistics. The data is collected using keyword searching. Keywords including “electric vehicle”, “EV infrastructure”, “EV in logistics”, “electric vehicle market”, and “electric vehicle adoption” are used for collecting suitable resources. Boolean operators like OR and AND are used to refine the search results. For example, using the operator “AND” in searching “electric vehicles” and “logistics” helps to get the data which includes both the terms. Year filtering is also used in keyword searching. The data published between 2020 and 2025 is used for this article. The data published in English is only used to achieve the research aim and objectives. Primarily, 26 articles were collected after keyword searching. Of these articles, 21 articles were used after screening. All data is collected from Google Scholar, Scopus, IEEE Xplore, SAGE Journals, and Science Direct. Data published in journals including the International Journal of Sustainable Engineering, the International Journal of Logistics Management, the World Electric Vehicle Journal, Future Transportation, and Sustainability are used in the study. Content analysis is employed in the article to analyse the qualitative data collected from the secondary sources.

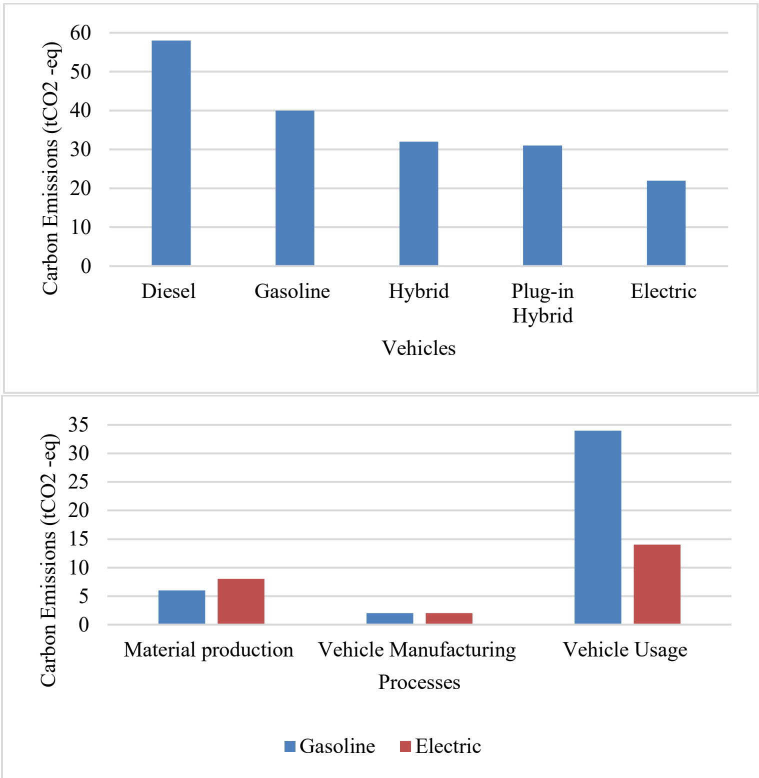
Research results and discussion

Benefits of using electric vehicles in logistics operations

Electric vehicles provide multiple benefits when integrated into logistics operations, making them an essential tool for improving the sustainability and effectiveness of the supply chain. Adopting EVs helps save costs, enhance operational performance, and lessen environmental concerns because logistics heavily depends on mobility (Alanazi, 2023). In addition to being an ecological need, the shift to electric transportation is a calculated move that will increase long-term corporate viability (McQueen et al., 2020). Significant industry transformation is being driven by the benefits of electric vehicles in logistics, which span environmental, economic, and operational aspects (McQueen et al., 2020). The significant decrease in carbon emissions is a major benefit of EV adoption in logistics. Large volumes of carbon dioxide (CO_2), nitrogen oxides (NO_x), and particulate matter are released by conventional fuel-powered vehicles, which increases air pollution, contributes to climate change, and poses health issues (Dong et al., 2021). As per Fig. 1., it is highlighted that the carbon emission in electric vehicles is much lesser than the vehicles which use diesel, gasoline or hybrid.

The cost-effectiveness of EVs is another important advantage in logistics. Long-term savings are significant even if the initial cost of electric trucks and delivery vans may be higher than that of traditional vehicles. Since electricity is often less expensive than fossil fuels, electric vehicles have lower energy expenses than cars fuelled by petrol or diesel (Mızrak, 2022). Additionally, because of its simpler mechanical design, EVs require less maintenance because they do not require regular brake replacements, exhaust system repairs, or oil changes. The adoption of EVs is a cost-effective alternative for logistics organisations because of the substantial financial benefits that come from these lower maintenance and fuelling costs over time (Gao et al., 2022). In addition to saving money, EVs improve logistics operating efficiency. Intelligent battery management systems and real-time tracking are features of contemporary electric trucks and delivery vehicles (He et al., 2022). Logistics operators may increase fleet performance, reduce downtime, and optimise route planning with the use of these technologies. Moreover, EVs' silent operation enhances driver comfort and drastically lowers noise pollution, which makes them ideal for last-mile deliveries and urban logistics (Suganya et al., 2025). Since many cities impose noise limits on transportation-related activities, EVs provide a practical way to comply with regulations while guaranteeing seamless and effective delivery processes.

Logistics firms may greatly reduce greenhouse gas emissions by using EVs, which will help them meet corporate sustainability goals and global climate targets. Businesses may meet environmental requirements and improve their reputation as environmentally conscious companies by switching to electric vehicles when governments impose strict emissions regulations (Dong et al., 2021).



Source: According to Gao et al. (2023)

Fig. 1. Comparison of carbon emission in vehicles using diesel, gasoline, hybrid, plug-in hybrid and electric

Energy efficiency and resource utilisation are also enhanced by the use of EVs in logistics. Compared to internal combustion engines (ICEs), electric motors are substantially more efficient since they transform a larger percentage of energy into motion as opposed to heat (Veza et al., 2023). This maximises overall energy utilisation, decreases dependency on fossil fuels, and increases mileage per unit of energy used. Additionally, charging EVs using green energy supports environmental initiatives as renewable energy sources like solar and wind power become more widely available (Kashem et al., 2024). The sustainable governmental and regulatory backing for EV adoption in logistics is another important benefit. To develop the switch to electric vehicles, several nations and localities provide tax breaks, subsidies, and incentives. Additionally, governments are funding the construction of infrastructure for charging EVs and offering financial assistance to companies that incorporate EVs into their fleets (Qadir et al., 2024). By reducing the high initial investment costs, these financial incentives facilitate businesses' transition to electric logistics solutions (Gao et al., 2022). Additionally, electric cars are essential for supporting corporate social responsibility (CSR) initiatives. Businesses that integrate EVs into their fleets demonstrate a strong commitment to environmental responsibility since sustainability is becoming a deciding factor for both consumers and businesses when choosing logistics suppliers (Patel et al., 2022). This builds consumer trust in addition to improving brand reputation. Adoption of EVs is also essential for attaining long-term contracts and business ties because many international firms now impose strong environmental regulations on their logistical partners.

Challenges of implementing electric vehicles in logistics operations

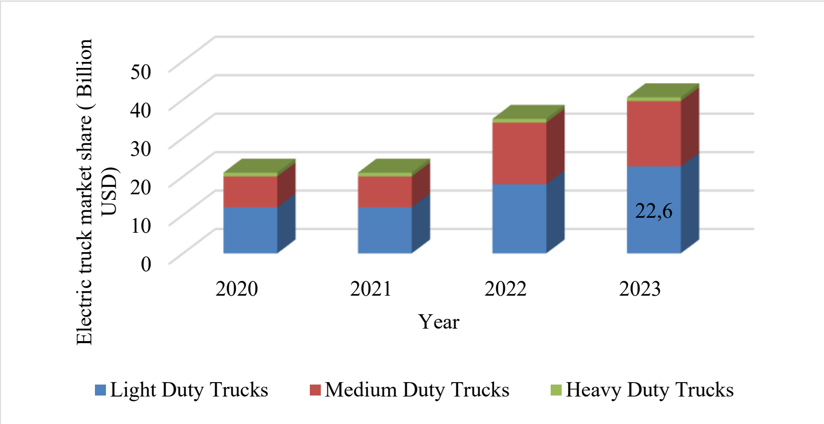
Implementing electric vehicles in logistics provides many benefits. However, using electric vehicles and sustaining this usage face challenges. The significant initial cost is one of the main obstacles to EV adoption in logistics. Electric trucks, vans, and delivery vehicles are more expensive than traditional internal combustion engine (ICE) vehicles, mostly because of the high cost of battery technology. Even while battery prices are steadily going down, they still account for a sizable amount of the overall cost of an EV (Akram and Abdul-Kader, 2021). It may be expensive for logistics firms with sizable fleets to switch from fuel-powered cars to electric vehicles. The initial cost commitment is further increased by the transition's requirements for investments in fleet management software, specialised maintenance training, and charging infrastructure (Akram and Abdul-Kader, 2021). The restricted accessibility and availability of charging facilities are another major obstacle. According to Rimal et al. (2022), in many places, EV charging stations are still in their beginning stage compared to conventional gasoline stations, which are widely available and well distributed. For logistics firms that rely on dependable and effective charging systems to maintain continuous operations, this poses a significant challenge.

An operational challenge is also presented by electric cars' limited operating range. Long-distance transportation is limited by the reduced range of most EVs as compared to diesel-powered trucks. Even while battery technology is always improving, modern EVs still need to be charged often, which can throw off logistical plans and delay deliveries (Mızrak, 2022). For sectors that depend on constant operations, including supply chain distribution hubs and e-commerce delivery networks, this problem is especially troubling (Stamadianos et al., 2023). The limited range of EVs continues to be a major challenge to their broad integration in logistics, barring significant advancements in battery capacity and fast-charging technologies. Another issue that impacts the effectiveness of logistical operations is charging time. EVs take a lot longer to recharge than traditional fuel-powered cars, which can be refuelled in a matter of minutes (Cunanan et al., 2021). Depending on battery size and charger speed, the procedure might take anywhere from 30 minutes to several hours, even with fast-charging technology (Cunanan et al., 2021). Delays decreased fleet utilisation, and decreased overall production might result from this extended downtime. Coordinating EV charging without interfering with operations is still a challenging problem for logistics firms with tight delivery deadlines. Electric vehicles' weight and cargo capacity are further issues. Due to their significant weight, EV batteries lower the vehicle's freight-carrying capability. As a result, compared to diesel-powered alternatives, electric trucks could move less cargo, which might result in more trips being needed and higher operating expenses (Pylova, 2023). This restriction has a direct impact on productivity and profitability, making it a major problem for logistics firms that handle large cargoes (Alanazi, 2023).

The performance and dependability of EVs in logistics are further complicated by extreme weather. Battery efficiency can be lowered by cold conditions, resulting in a reduced driving range and a need for more frequent charging (Mousaei et al., 2024). On the other hand, too much heat can lead to battery overheating, which might shorten a vehicle's lifespan and performance (Mousaei et al., 2024). When using EVs, logistics businesses working in areas with diverse climates need to take these variables into account because erratic weather can affect operational efficiency and cause delays in delivery schedules. The lack of technological expertise and a trained working team needed to maintain electric fleet operations is another major obstacle. The switch to electric vehicles necessitates specific expertise in fields like battery management, vehicle maintenance, and charging infrastructure (He et al., 2022). Logistics businesses must engage in training programs and hire experienced technicians because many traditional mechanics lack the skills needed to repair and maintain EVs. The limited number of electric heavy-duty vehicles is another significant challenge that prevents their widespread use in logistics. Heavy-duty electric truck sales are still in their early stages, while electric vans and smaller delivery vehicles are becoming more widely available (Fenton and Kailas, 2021). As per the report of Grand View Research (2024), the electric truck market share in 2023 is 22.6 billion dollars, however, the number of light-duty trucks is much higher than the number of heavy-duty trucks, which is mentioned in Fig. 2.

Solutions to enhance the use of electric vehicles in logistics operations

In order to reduce carbon emissions and promote sustainable mobility, logistics must transition to electric vehicles. However, challenges including expensive initial expenditures, inadequate charging infrastructure, short driving range, and operational disturbances prevent broad use. Effective solutions must be developed via cooperation between businesses, governments, and industry stakeholders to promote the use of EVs in logistics. Overcoming technological, financial, infrastructure, and regulatory barriers might facilitate a smoother and more effective shift to electric mobility in logistics (Akram and Abdul-Kader, 2021). Increasing investment in battery innovation and technology is a significant move for encouraging EV adoption in logistics. The economics of electric vehicles and vans is greatly impacted by battery costs, therefore improvements in energy density, charging speed, and longevity are important (Veza et al., 2023). Research into technologies like lithium-sulfur and solid-state batteries can lower manufacturing costs and weight while increasing energy efficiency (Gao et al., 2022). Another essential step towards greater EV integration in logistics is improving the infrastructure for charging. Establishing an extensive network of fast-charging stations within logistical centres and along important transportation routes requires cooperation between the public and commercial sectors (Gao et al., 2022). Public-private partnerships (PPPs), which combine business investment and government incentives, can hasten this progress (Qadir et al., 2024). New technologies like ultra-fast chargers and wireless charging will further maximise charging efficiency, cutting down on delays and enhancing overall operating efficacy (Mousaei et al., 2024). Logistics firms may improve route planning by utilising data analytics and sophisticated fleet management solutions to lessen range restrictions. The most effective routes may be found using AI-driven optimisation tools, which save unnecessary travel and increase battery range (Veza et al., 2023). Furthermore, EVs with regenerative braking technology may recover energy lost during braking, which enhances battery performance (Patel et al., 2022).



Source: According to Grand View Research (2024)

Fig. 2. Market size of electric trucks used in logistics, by vehicle, in USD Billion

Because of this, logistics firms can have trouble locating electric vehicles that meet their operating needs. Widespread adoption in extensive logistical operations will continue to be difficult until the commercial EV industry grows to provide a wider variety of vehicle alternatives.

Financial incentives and government assistance are important for encouraging EV adoption in the logistics industry. The high upfront costs of electric fleets can be reduced with the use of subsidies, tax breaks, and low-interest loans (Gao et al., 2022). By implementing policies like emission-based toll reductions, grants for EV purchases, and incentives for growing charging networks, policymakers may further encourage fleet electrification (Gao et al., 2022). The restricted market availability of appropriate electric trucks makes it difficult for many operators to get them (Akram and Abdul-Kader, 2021). The development of EVs with features like greater cargo capacity and longer driving range that are suited to logistics needs might result from cooperation between manufacturers, suppliers, and fleet operators (Akram and Abdul-Kader, 2021). To give technicians, drivers, and fleet managers the know-how to effectively operate and maintain electric vehicles, extensive training programs must be implemented (Patel et al., 2022). A skilled crew will contribute to maximising vehicle performance, reducing downtime, and improving fleet efficiency as a whole (Stamadianos et al., 2023). By improving energy management, integrating smart grid technologies may greatly increase the use of EVs in logistics. Smart grids lessen the strain on electrical infrastructure by balancing the supply and demand for electricity. By using vehicle-to-grid (V2G) technology, EVs may transmit excess energy back into the grid, potentially generating income for logistics firms and enhancing grid stability (Patel et al., 2022). Furthermore, using renewable energy sources like solar or wind to power EV charging stations may reduce reliance on fossil fuels and increase sustainability (Pylova, 2023).

To establish industry standards, exchange ideas, and provide creative solutions, logistics companies, automakers, energy suppliers, legislators, and tech companies must collaborate (Patel et al., 2022). Standardizing vehicle standards, charging infrastructure, and battery technology will improve interoperability across fleets and further optimize logistical operations (Stamadianos et al., 2023). EV adoption in logistics may be greatly accelerated by raising awareness and bolstering corporate commitment to sustainability. Companies may be encouraged to embrace sustainable logistics solutions by promoting eco-friendly supply chain procedures and highlighting the long-term economic and environmental benefits of EVs. The shift to electric mobility can also be accelerated by working with partners and customers who value environmentally friendly transportation.

Conclusions

1. The research has analyzed the goal of investigating how electric vehicles might be incorporated into logistics by evaluating their impact on cost-effectiveness, sustainability, and efficiency. The study's objectives were fulfilled by examining the benefits and difficulties of EV adoption, assessing market trends, and determining implementation strategies. According to the findings, EVs are essential for reducing carbon emissions and long-term operating expenses, but there are still major barriers including a high initial cost and poor infrastructure.

2. According to the research, environmental concerns and legal requirements are the main factors driving the growing trend of EV adoption in logistics. Careful planning, infrastructure investment for charging, and scalability-ensuring government laws are all necessary for successful deployment. In order to encourage the widespread use of EVs in logistics and eventually increase sustainability and operational efficiency, the study emphasises the need of technology developments and stakeholder cooperation.

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