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Green transformation of logistics through technological innovations to reduce CO_2 emissions in courier companies – case study

Zielona transformacja logistyki dzięki innowacjom technologicznym ograniczającym emisję CO_2 w firmach kurierskich – case study

Abstract. The study aimed to evaluate how technological innovations drive the green transformation of logistics in courier companies and reduce CO_2 emissions in last-mile delivery. The research focused on three operators – Amazon, DHL, and InPost – representing different operational scales and technological maturity. A comparative case study was conducted, combining quantitative benchmarking of emission indicators (CO_2e per parcel, EV fleet share) with qualitative assessment of ESG reporting, climate policies, and technology integration. The analysis covered 2023–2024 data from verified corporate and institutional sources, including sustainability reports and EU databases. The results show that companies achieving the highest emission reductions are those integrating technological, organizational, and environmental dimensions. InPost's parcel-locker model generated up to 75% lower emissions per parcel compared to DHL's traditional door-to-door system, confirming the ecological efficiency of consolidated, network-based deliveries. Company size proved less significant than the coherence between digitalization, automation, and ESG management. The paper's novelty lies in linking fleet electrification indicators with technological and organizational maturity, creating a new analytical framework for assessing the environmental effectiveness of logistics transformation. Practically, the findings can support logistics operators, city planners, and policymakers in developing decarbonization strategies that prioritize scalable technologies, data-driven fleet management, and standardized ESG report-

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ing. Future research should include life-cycle assessments and explore emerging solutions such as hydrogen propulsion, autonomous delivery systems, and AI-based route optimization to advance climate-neutral logistics by 2040.

Keywords: green logistics, CO_2 reduction, last mile delivery, ESG, electric vehicles, digital transformation, sustainability

Synopsis. Celem badania była ocena, w jaki sposób innowacje technologiczne napędzają zieloną transformację logistyki w przedsiębiorstwach kurierskich oraz przyczyniają się do redukcji emisji CO_2 w dostawach ostatniej mili. Analiza objęła trzech operatorów – Amazon, DHL i InPost – reprezentujących różne skale działalności oraz poziomy dojrzałości technologicznej. Zastosowano metodę porównawczego studium przypadku, łącząc ilościowe benchmarki wskaźników emisji (CO_2e przypadający na jedną przesyłkę, udział we flocie pojazdów elektrycznych) z jakościową oceną raportowania ESG, polityk klimatycznych oraz integracji technologii w procesach operacyjnych. Analiza obejmowała dane z lat 2023–2024 pochodzące ze zweryfikowanych źródeł korporacyjnych i instytucjonalnych, w tym raportów zrównoważonego rozwoju oraz baz danych UE. Wyniki badań wskazują, że najwyższą redukcję emisji osiągają przedsiębiorstwa integrujące technologiczne, organizacyjne i środowiskowe aspekty transformacji. Model logistyczny InPostu oparty na sieci paczkomatów generował do 75% niższe emisje za przesyłkę w porównaniu z tradycyjnym systemem „door-to-door" DHL, co potwierdza efektywność ekologiczną skonsolidowanych, sieciowych rozwiązań dostawczych. Wielkość firmy okazała się mniej istotna niż spójność między cyfryzacją, automatyzacją i zarządzaniem ESG. Nowością naukową artykułu jest powiązanie wskaźnika elektryfikacji flot z poziomem dojrzałości technologicznej i organizacyjnej, co pozwoliło stworzyć nowy model oceny efektywności środowiskowej transformacji logistycznej. W wymiarze praktycznym wyniki mogą wspierać operatorów logistycznych, urbanistów i decydentów politycznych w opracowywaniu strategii dekarbonizacji opartych na skalowalnych technologiach, zarządzaniu flotą z wykorzystaniem danych oraz standaryzowanym raportowaniu ESG. W przyszłych badaniach zaleca się uwzględnienie analiz cyklu życia (LCA) oraz eksplorację nowych rozwiązań, takich jak napęd wodorowy, systemy dostaw autonomicznych i optymalizacja tras z wykorzystaniem sztucznej inteligencji, aby przyspieszyć realizację celów logistyki neutralnej klimatycznie do 2040 roku.

Słowa kluczowe: zielona logistyka, redukcja emisji CO_2, dostawy ostatniej mili, ESG, pojazdy elektryczne, transformacja cyfrowa, zrównoważony rozwój

JEL codes: Q57, L94, O18, R42

Introduction

Logistics plays a key role in the global economy, ensuring the smooth flow of goods and services. However, the intensification of logistics activities, fueled by the growth of e-commerce and increased consumer expectations for speed and delivery availability, brings serious environmental consequences [Kalkha et al. 2023; Risberg 2023]. Particularly acute are the carbon dioxide (CO_2) emissions generated by road transportation,

especially the so-called "last mile" segment, which is characterized by high fragmentation and energy intensity. Today, couriers and logistics operators are forced to look for solutions to maintain service efficiency and meet increasingly stringent environmental standards [Ha et al. 2023; Silva et al. 2023; Mohammad et al. 2023; Masłowski et al. 2023].

In response to these challenges, increasing attention is being paid to the green transformation of logistics, with technological innovation at its core. The deployment of electric delivery vehicles, innovative route optimization platforms, real-time data-driven fleet management systems, and automation of warehouse processes are just some of the tools supporting emission reductions. Despite the dynamic development of these technologies, their actual environmental impact, efficiency of deployment, and scalability of solutions in different business models remain issues that require in-depth analysis [Erdem, Dogan 2023; Liu et al. 2024; Dzwigol et al. 2021].

The issues addressed in this paper focus on assessing how technological innovations contribute to CO_2 reduction in courier companies and comparing decarbonization strategies implemented by companies of different scales of operations. Key research questions include the effectiveness of the solutions used, the level of technology integration with existing operational systems, and the implementation barriers encountered by companies operating locally and globally.

Despite the growing interest in sustainable logistics, the current state of research shows several important gaps. First, there is a paucity of comparisons between companies operating in different scales and market contexts, making it difficult to identify success factors for green transformation. Second, analyses to date are often limited to declarative data in ESG reports, omitting quantitative assessment of deployed technologies' effectiveness in real emission reductions.

Additionally, most studies focus on global operators (e.g., DHL, FedEx), marginalizing regional or national companies that can implement more flexible, locally tailored innovations (e.g., InPost). Meanwhile, juxtaposing micro- and macro-scale models can provide the most valuable insights into optimal decarbonization strategies in the logistics sector.

Therefore, this work intends to fill this gap through a detailed, comparative analysis of three courier companies – Amazon, DHL, and InPost – taking into account their environmental strategies, fleet structure, technology investments, and measurable emissions reductions between 2023 and 2024.

The aim of the study was to identify how the integration of modern technological and organizational solutions within courier companies supports the reduction of greenhouse gas emissions, and to determine the factors that enhance or limit the effectiveness of green transformation in last-mile logistics. The research was intended to provide practical insights into how different business models and environmental strategies influence the real outcomes of decarbonization efforts in the courier sector. The research methodology is based on analyzing vehicle fleet structures, ESG (Environmental, Social, and Governance) policies, emissions data, and investments in integrated logistics systems with varying levels of technological advancement. The analysis includes data from 2023 and 2024, sourced from the latest publicly available environmental reports as well as annual and quarterly statements of Amazon, DHL, and InPost, and European institu-

tions such as the ICCT (International Council on Clean Transportation) and the European Environment Agency. The use of these data enables an assessment of the current level of implementation of decarbonization strategies and a comparison of the outcomes of innovation deployment in last-mile logistics.

Materials and methods

The study was based exclusively on publicly available, primary and secondary institutional and corporate sources concerning the activities of Amazon, DHL, and InPost, and regulatory and market conditions in the EU. The core corpus consisted of: the 2023 Amazon Sustainability Report [Amazon 2024], the DHL Group 2023 Annual Report (including ESG modules) [DHL 2024], the InPost Group Annual Report 2023 [InPost 2024], as well as studies by the European Environment Agency [2024], ICCT [2021; 2023] and Transport & Environment [2024]. All documents cited in the article's bibliography were used as source material for indicator extraction, data verification, and cross-company comparisons. The data acquisition date was set at 15 May 2025, in line with "accessed" notes in the bibliography.

The object of the study was the decarbonization strategies and technological innovations applied in last-mile logistics by three courier companies: Amazon (global operator), DHL (global operator), and InPost (regional operator expanding in the EU). The analysis covered: the structure and scale of low-emission fleets (number/share of EVs), last-mile operating models (door-to-door vs. parcel locker networks), environmental policies (climate neutrality targets, SBTi compliance), ESG reporting scope and standards, and emission indicators (per parcel and/or total).

The substantive scope covered CO_2 reduction technologies in last-mile deliveries (fleet electrification, parcel lockers, energy management, digitization, and route optimization). The time horizon of the analyzed data was mainly 2023–2024 (corporate reporting), complemented with 2020–2025 for trends in EV fleet development and charging infrastructure in Europe (EEA, ICCT, T&E).

A comparative case study approach was applied, combining desk research and descriptive-quantitative analysis:

1. Identification of indicators and definitions – a standard set of measures was derived from the bibliography and article content: CO_2e/parcel, total CO_2e, number of EVs, EV share in fleet, climate targets (year), SBTi status, ESG standards (GRI/TCFD/other), features of the last-mile operating model.
2. Data extraction – numerical and declarative values were drawn from company reports [Amazon 2024; DHL 2024; InPost 2024] and macro-context from EEA/ICCT/T&E (EV registration shares, charging points, emission trends of LCVs). When a single source did not provide complete information, triangulation with other cited sources was used.
3. Verification and consistency – in case of discrepancies, priority was given to: (i) externally verified data (SBTi/GRI/ISO), (ii) audited sections of annual reports, (iii) institutional sources (EEA/ICCT/T&E). Unit consistency (year, region, scope) was ensured for cross-company comparisons.

4. Normalization and calculations – to ensure comparability, the following procedures were applied:
   – "per parcel" standardization: if only total emissions and parcel volumes were reported, the indicator CO_2e/parcel = total CO_2e/number of parcels was calculated; when company indicators were available, reported values were used;
   – generalization of EV share: calculated as EVs/last-mile fleet vehicles on the given market if reported; in cases of differing denominators, this was noted in tables;
   – qualitative categorization for policies/standards: SBTi (yes/no), ESG (GRI/TCFD/other), linkage of climate goals with incentive systems (yes/no).
5. Synthesis and presentation – results were summarized in tables (Tables 1–5 in the article) covering: fleet electrification in Europe in the years 2020–2025, EV volumes and shares, emission indicators, ESG declarations and verifications, and differences in last-mile models.

A comparative analysis (benchmarking) was applied in two dimensions:

– Quantitative – comparison of CO_2e/parcel, total CO_2e, EV numbers and shares, y/y dynamics, and position relative to EU trends (EV van registrations, charging infrastructure density); simple descriptive statistics (means, percentage differences, y/y indices) were used without inferential tests due to heterogeneous reporting methods.
– Qualitative – assessment of climate policy maturity through: presence of neutrality targets, SBTi status, ESG standards (GRI/TCFD), transparency of KPIs, and integration with corporate governance (linking environmental goals to incentive systems). These criteria and assignments were reflected in comparative tables.

Extraction and calculations were done in a spreadsheet (MS Excel or equivalent). Source data were archived with metadata (title, year, report section, page/chapter). The calculation path (formula, assumptions, volume source) was documented for estimated values.

Assumptions and limitations:

(1) The heterogeneity of reporting methods among companies limits the possibility of causal estimation – hence, the analysis is a descriptive benchmark, not an econometric model.
(2) Geographic differences in operations (global vs. regional) influence unit emissions.
(3) Data availability – some indicators were declarative or only partially verified; the tables clearly noted such cases.
(4) No sensitive or confidential data were used – the study relied exclusively on public sources.

The concept of ecologistics in sustainable logistics management

The term ecologistics refers to an integrated approach to logistics that combines operational objectives with environmental priorities. Ecologistics constitutes a significant area of interest within the field of logistics [Ližbetinová et al. 2022, pp. 4379–4403], defined as waste logistics, disposal, reuse, recycling, as well as the post-sale supply chain [Andrzejczyk, Rajczakowska 2020]. This concept emphasizes reducing the negative environmental impact of logistics processes while maintaining efficiency and compet-

itiveness. Ecologistics, understood as a set of multidirectional and complex initiatives related to the organization and optimization of waste removal chains, seeks environmentally friendly procedures in the areas of collection, storage, transportation, recovery, and neutralization of waste [Rybaczewska-Błażejowska, Masternak-Janus 2015]. Key components of ecologistics include [Baraniecka 2015]:

– electrification of the transport fleet,
– delivery route optimization,
– automation and digitization of logistics processes,
– integration with renewable energy sources,
– waste and emission minimization within the supply chain,
– design of sustainable packaging.

In the literature, ecologistics is considered part of the broader concept of green logistics [Tokarski et al. 2024], which integrates environmental, social, and economic considerations. Models such as "3P" (People, Planet, Profit) and circular economy approaches form the foundation of modern logistics strategies [Walczyński, Kanciak 2023, p. 155], particularly in the area of last-mile delivery, which has the highest environmental impact.

The last mile is the final stage of the logistics process within the supply chain, encompassing the physical delivery of a parcel from a warehouse, distribution center, or transfer point to the final recipient – either an individual customer or a pick-up point. This stage is considered one of the most complex and costly logistics phases due to the necessity of fulfilling individualized deliveries to a broad and thus highly diverse customer base [Masłowski, Kulińska 2019]. Final recipients are often located in urban, suburban, or rural areas characterized by significant dispersion. The last mile includes not only parcel delivery but also handling of returns, complaints, or misdeliveries. From the perspective of courier companies, it is a crucial area for building customer experience and competitive advantage, especially in light of increasing expectations regarding the speed, flexibility, and convenience of deliveries [Kaźmierczak, Szymczyk 2021].

Legal and regulatory framework

The green transformation of logistics is strongly supported and driven by international, EU, and national legislation. Key acts and initiatives include [Cheba et al. 2022]:

– European Green Deal – an EU strategy aiming to achieve climate neutrality by 2050 [Smolaga 2021, pp. 47–74]. Road transport is expected to reduce emissions by 90%.
– Fit for 55 package – a set of legislative proposals intended to reduce greenhouse gas emissions by at least 55% by 2030 [Gilewski et al. 2024].
– Corporate Sustainability Reporting Directive (CSRD) – requiring more companies to report ESG (Environmental, Social, and Governance) data, including carbon footprint and decarbonization strategies [Wiącek 2025; Farzaneh, Jung 2023].
– Regulations on CO_2 emission standards for commercial and light-duty vehicles.

At the national level, many countries are introducing additional incentives to support ecological restructuring: subsidies for electric vehicles, tax reliefs, funding for charging infrastructure development, clean transport zones in urban areas, and subsidies for renewable energy.

Technological progress forms the foundation for achieving environmental goals in logistics [Kacprzak et al. 2023, p. 93]. Key technologies enabling courier companies to adapt to new requirements include:

- electric and hydrogen vehicles, which reduce CO_2 emissions at the operational level, especially in urban last-mile transport;
- fleet management systems based on GPS and artificial intelligence (AI), enabling route optimization, driving style monitoring, and fuel and energy savings [Potdar, Parikh 2025];
- warehouse automation (robots, sorters, high-bay storage), which shortens parcel processing times and reduces energy consumption and operational losses [Mardeusz 2021, pp. 9–18];
- parcel lockers and click and collect solutions, which eliminate a large portion of individual deliveries and thus significantly reduce emissions from the so-called last mile [Guzowski et al. 2024];
- IoT and blockchain solutions, which enhance transparency, carbon footprint tracking, and emission traceability across the supply chain [Kashem et al. 2024], facilitating compliance with regulations such as the CSRD;
- predictive and cloud platforms (such as Amazon Web Services, DHL Smart Logistics), supporting automated demand forecasting, load optimization, and delivery scheduling [Guzenko & Guzenko 2022];
- AI for packaging size adjustment, reduction of empty runs, and efficient planning of the logistics network.

By implementing these solutions, courier companies reduce emissions and improve operational efficiency and competitiveness in a market increasingly oriented toward sustainable development. These technologies also play a crucial role in meeting increasingly stringent national and EU regulations, such as the Fit for 55 package, CO_2 fleet regulations, and ESG reporting obligations.

Research results

The development of electric vehicle fleets in Europe in the years 2020–2025 reflects the response to the escalating climate crisis. The European Union implemented the European Green Deal strategy, which includes achieving climate neutrality by 2050 and reducing greenhouse gas emissions in high-emission sectors such as transport [The European Green Deal 2020]. A particular focus has been placed on urban deliveries, which contribute significantly to air pollution in cities [Świniarska 2016]. The electrification of courier fleets, supported by public policies and logistics operators' private investments, has emerged as a key response to these challenges.

Initially, in 2020, the share of electric delivery vehicles (EVs) in courier company fleets was marginal – in countries such as the United Kingdom, it was below 1% [ICCT 2021, pp. 6–8]. However, the following years saw rapid growth: by 2023, the number of electric vans in Europe exceeded 200,000 and their share in new registrations reached 8% [Transport & Environment 2024, pp. 4–5]. Simultaneously, charging infrastructure expanded significantly, with public charging points increasing from 130,000 in 2020 to over 700,000 in 2023 [European Environment Agency 2024, pp. 15–17].

Emission reductions were particularly notable among newly registered delivery vehicles – the average CO_2 emissions in the EU decreased by over 10% within three years [ICCT 2023, pp. 11–12]. Leading courier companies support this transformation: Amazon has invested one billion euros in expanding its EV fleet in Europe; DHL has deployed its proprietary electric StreetScooter vehicles and plans to operate 80,000 zero-emission vehicles by 2030; and InPost conducts zero-emission deliveries in major cities in Poland and France [Amazon 2024; DHL 2024; InPost 2024].

Table 1. Electrification of courier fleets in Europe (2020–2025)
Tabela 1. Elektryfikacja flot kurierskich w Europie (2020–2025)

Year	Number of electric vehicles in courier fleets	Share of EVs in courier fleets	Emissions reduction (new vehicles)	Investments in charging infrastructure	Examples of initiatives by courier companies (Amazon, DHL, InPost)
2020	< 50,000	< 1%	No significant reduction	~130,000 public charging points	Amazon: 1,800 e-vans; DHL: StreetScooter program; InPost: EV pilot project in Warsaw
2021	~70,000	~1%	Marginal	~350,000 charging points	Amazon: continued development; DHL: 15,000 EVs; InPost: 500 EVs in Poland
2022	~100–120,000	~1.2%	–5% (for new vehicles)	~520,000 charging points	Amazon: €1 billion investment in the EU; DHL: GoGreen strategy; InPost: expansion to France
2023	>200,000	~1.5–2%	–11% (for new vehicles)	~700,000 charging points	Amazon: deployment of Rivian vehicles in Germany, 45 million parcels delivered emission-free; DHL: 500 EVs in Poland; InPost: over 1,000 EVs and hybrids
2024*	~300–400,000 (forecast)	~2%	Continued reduction expected	~1 million charging points (forecast)	Amazon: >10,000 EVs; DHL: >20,000 EVs; InPost: expansion to new cities, APM Green City program
2025*	>500,000 (forecast)	3–5%	Target: –15% compared to 2021	>1.2 million charging points (forecast)	Amazon: implementation of 10,000 EV target; DHL: global scaling; InPost: last-mile carbon neutrality

Source: own elaboration based on data from [European Environment Agency 2024; ICCT 2021, 2023; Transport & Environment 2024; Amazon 2024; DHL 2024; InPost 2024] and internal analysis

Źródło: oprac. własne na podst. [European Environment Agency 2024; ICCT 2021, 2023; Transport & Environment 2024; Amazon 2024; DHL 2024; InPost 2024] i analiz wewnętrznych

Case studies: Amazon, DHL, InPost

As one of the most prominent e-commerce players in the world, Amazon operates an extensive logistics infrastructure, handling millions of orders daily. In 2019, the company announced "The Climate Pledge" – a commitment to achieve climate neutrality by 2040, ten years ahead of the target set in the Paris Agreement.

The company invested in over 100,000 electric vans to reduce transport-related emissions, mainly through a partnership with Rivian. In 2023, Amazon delivered millions of parcels using electric vehicles, gradually introducing autonomous robots and drones in test locations [Alverhed et al. 2024].

In 2023, Amazon achieved an annual 13% reduction in CO_2 emissions despite increased order volume. The electric fleet primarily serves countries with a well-developed charging infrastructure: the United States, Germany, the United Kingdom, and Ireland.

DHL, operating in over 220 countries [Majerska 2022], is a pioneer in sustainable logistics. The company was the first in Europe to begin the mass production of electric vehicles (StreetScooter) used in local deliveries. DHL operates a fleet of more than 20,000 electric vehicles and is testing cargo bikes and hydrogen vans. In 2023, the company reduced its emissions to 33.27 million tonnes of CO_2, representing a decline of over 11% compared to previous years. Despite its smaller operational scale, InPost, a leading Polish courier company, has achieved significant success in emission reduction. The "out-of-home delivery" model based on Automated Parcel Machines (APMs) is the key to its success.

Thanks to its flagship approach of "one courier – many parcels – one location", the company achieves up to 75% lower CO_2 emissions per parcel than traditional door-to-door delivery. InPost operates the largest electric vehicle fleet among courier companies in Poland (over 30% of the urban fleet consists of EVs) and runs the "Green City" program in 54 cities.

Table 2. Environmental innovations and emission indicators in selected courier companies (2023)
Tabela 2. Innowacje środowiskowe i wskaźniki emisji w wybranych firmach kurierskich (2023)

Company	**Estimated number of parcels (2023)**	**Share of EVs in fleet**	**Types of eco-friendly vehicles**	**CO_2 emissions (per parcel/ /total)**	**Key environmental innovations**
Amazon	> 5 billion globally	Deployment of 100,000 EVs (approx. 20–25% of the US fleet)	EV vans (Rivian, Mercedes, Ford), drones, delivery robots	–13% CO_2 per parcel YoY	AI-based route and packaging optimization, regionalization of logistics network
DHL	> 1.8 billion parcels globally	20,000+ EVs (approx. 25% of the EU fleet)	StreetScooter, cargo bikes, hydrogen vehicle pilots	33.27 million tons CO_2e (2023)	In-house EV production, use of renewable energy in warehouses, automation
InPost	891.9 million	30% of urban fleet (Poland)	EVs, cargo bikes, solar-powered parcel lockers	–75% CO_2 emissions per parcel (APM model)	APM network model, AI-based location forecasting, Green City programme

Source: own elaboration based on data from [Amazon 2024, DHL 2024, InPost 2024] and internal analysis
Źródło: oprac. własne na podst. [Amazon 2024, DHL 2024, InPost 2024] i analiz wewnętrznych

Comparison of the environmental policies of the analyzed companies

As part of the assessment of Amazon, DHL, and InPost's involvement in the green transformation of logistics, a comparison of their environmental strategies was conducted across four key areas: climate goals, scope of ESG reporting, transparency of activities, and the integration of strategy with the management system.

Amazon has declared its intention to achieve climate neutrality by 2040, making it one of the first signatories of the Climate Pledge initiative. The company invests in electric delivery vehicles and the regionalization of logistics. However, despite its extensive operational initiatives, Amazon does not have climate targets approved by the Science Based Targets initiative (SBTi). It does not thoroughly report per recognized international standards such as the Global Reporting Initiative (GRI).

DHL is a leader in integrated environmental policy. As early as 2008, it adopted the "GoGreen" strategy and aims to achieve net-zero emissions by 2050. The company has SBTi-approved targets, conducts comprehensive ESG reporting (Global Reporting Initiative), and consistently implements actions such as in-house production of electric vehicles (StreetScooter) and low-emission logistics on a global scale.

Despite operating on a smaller scale, InPost has implemented a comprehensive "Green Vision 2040" strategy, aiming to achieve climate neutrality by 2040. The company demonstrates high transparency in ESG reporting (GRI, TCFD – Task Force on Climate-related Financial Disclosures, SBTi) and links environmental goals to its management's remuneration system. InPost's activities include solar-powered parcel lockers, eco-depots, and the "Green City" program.

Table 3. ESG commitments and climate strategies of selected courier companies
Tabela 3. Zobowiązania ESG i strategie klimatyczne wybranych firm kurierskich

Criterion	Amazon	DHL	InPost
Climate neutrality target	2040	2050	2040
ESG strategy	Yes – proprietary strategy	Yes – "GoGreen"	Yes – "Green Vision 2040"
SBTi-approved targets	No	Yes	Yes
ESG reporting	Partial, internal	Comprehensive (GRI, KPI, audits)	Comprehensive (GRI, TCFD, ESG)
Linkage of goals to incentive schemes	None	Partial	Yes

Source: own elaboration based on data from [Amazon 2024, DHL 2024, InPost 2024]
Źródło: oprac. własne na podst. [Amazon 2024, DHL 2024, InPost 2024]

The climate and environmental strategies of Amazon, DHL, and InPost differ notably, as illustrated in Table 2. Key aspects were taken into account, such as the declared year for achieving climate neutrality, the existence and nature of ESG strategies, approval of decarbonization targets by the SBTi initiative, the scope of ESG reporting, and the linkage of environmental objectives to incentive systems.

It was indicated that both Amazon and InPost plan to achieve climate neutrality by 2040, while DHL has adopted a timeline extending to 2050. Regarding formalized actions, only DHL and InPost have climate targets approved by SBTi. Despite its proprietary strategy, Amazon has not obtained such certification. The scope of ESG reporting varies significantly among the companies – Amazon limits itself to internal documentation, whereas DHL and InPost conduct complete reporting per international standards (GRI, TCFD, ESG). Among the companies studied, only InPost has linked the achievement of environmental objectives with its remuneration system, which may indicate a higher level of integration of ESG strategy with corporate governance.

Table 4. ESG reporting standards, verification and transparency of environmental goals
Tabela 4. Standardy sprawozdawczości ESG, weryfikacja i przejrzystość celów środowiskowych

Company	Reporting standards	External verification	Goal transparency
Amazon	No unified standard; own ESG report	No verification by SBTi	General declarations; limited measurability
DHL	GRI, SBTi, CDP, proprietary KPIs	Yes (SBTi, ISO standards, external audits)	Clearly defined and measurable goals
InPost	GRI, TCFD, SBTi	Yes (SBTi, ESG Ratings)	Clear climate KPIs, parcel-level LCA assessments

Source: own elaboration based on data from [Amazon 2024, DHL 2024, InPost 2024]
Źródło: oprac. własne na podst. [Amazon 2024, DHL 2024, InPost 2024]

Significant differences between the companies were identified. Amazon does not apply a unified reporting standard and is not subject to external verification, which results in the generality of its declarations and the limited measurability of its targets. In contrast, DHL and InPost implement internationally recognized reporting standards such as GRI, SBTi, and TCFD, and subject their reports to independent verification (including by SBTi, ISO, and ESG Ratings). Both companies are characterized by high transparency regarding their goals – DHL sets measurable and clearly defined targets. At the same time, InPost additionally employs specific climate performance indicators (KPIs) and product life cycle assessments for individual shipments.

Table 5. Carbon footprint per delivery and scale of fleet electrification in Amazon, DHL, and InPost
Tabela 5. Ślad węglowy na dostawę i skala elektryfikacji floty w Amazon, DHL i InPost

Company	CO_2 emissions per parcel	Number of electric vehicles
Amazon	80.8 g CO_2	19,000+
DHL	~120 g CO_2e (estimated)	20,000+
InPost	<50 g CO_2e (APM delivery)	1,300+

Source: own elaboration based on data from [Amazon 2024, DHL 2024, InPost 2024]
Źródło: oprac. własne na podst. [Amazon 2024, DHL 2024, InPost 2024]

Table 4 compares CO_2 emissions per parcel and the number of EVs operated by Amazon, DHL, and InPost. The data allow for assessing the decarbonization of logistics operations at the unit level and the scale of low-emission fleet deployment.

The lowest carbon footprint per delivery was recorded by InPost – below 50 g CO_2 per parcel in a model based on parcel lockers, representing up to 38% lower emissions than Amazon and over 58% less than the estimated values for DHL. These figures suggest that despite comparable investments in fleet electrification, DHL's operational model may be less efficient in reducing per-parcel emissions than InPost's consolidated locker-based delivery system. This indicates that environmental efficiency per delivery unit depends on the number of low-emission vehicles, the adopted operational model, and the degree of last-mile optimization.

In the face of increasingly stringent climate regulations, the logistics sector faces the challenge of reducing greenhouse gas emissions. Analyzing pro-environmental initiatives by three major players – Amazon, DHL, and InPost – allows for identifying diverse strategies for implementing low-emission solutions and the prospects for their further development.

As a global leader in parcel volume, Amazon focuses on electrifying its delivery fleet. In the coming years, an expansion of electric vehicles into markets beyond the United States is expected, along with the continued deployment of advanced drone and robot technologies to reduce CO_2 emissions in last-mile deliveries. Furthermore, developing artificial intelligence algorithms will enable more precise route optimization, regionalization of the logistics network, and packaging management that minimizes volume and material usage. Another important development area may be the construction of zero-emission logistics centers powered by renewable energy. In the context of its environmental policy and the goal of achieving climate neutrality by 2040, the company will need to address deficiencies in formalizing its environmental efforts. Key future priorities include obtaining SBTi approval for climate targets and developing a transparent ESG reporting system.

As a globally established logistics operator, DHL is developing a decarbonization strategy based on diversifying transport technologies. The company's future development may focus on deploying hydrogen-powered heavy vehicles, which can significantly reduce emissions in long-haul transport. The further expansion of zero-emission zones through the development of cargo bike fleets and electric vehicles is another anticipated direction. The company is expected to invest in its own renewable energy sources (RES) to power distribution centers and the operational fleet in the infrastructure domain. In addition, digital tools that enable tracking and analysis of the carbon footprint at the level of individual shipments will play a significant role. The next stage will involve the creation of circular logistics models, where resources such as packaging are reused within a closed-loop system. DHL's environmental policy sets the goal of achieving climate neutrality by 2050. The company has a well-established reporting structure and approved climate targets, which provide a solid foundation for further development. It is expected that low-emission solutions will be scaled globally, ESG management will become increasingly automated, and new initiatives will be implemented in line with EU taxonomy requirements.

InPost demonstrates considerable potential for further CO_2 emission reductions per parcel by scaling its APM model to additional European markets. Key areas of development include further electrification of the urban fleet and increased use of cargo bikes for deliveries, particularly in densely populated urban areas. The company may also integrate with municipal sustainable development strategies (e.g., the Green City Program), using data and artificial intelligence to optimally deploy vehicle fleets, charging points, and other infrastructure elements, reducing its carbon footprint and lowering operational costs. InPost has the broadest scope of ESG activities among the companies analyzed and a target of achieving climate neutrality by 2040, positioning it advantageously for continued growth.

Discussion

The research presented in this study on the green transformation of logistics in courier companies – Amazon, DHL, and InPost – fits into the broader trend of contemporary analyses on sustainable development and transport decarbonization, providing a significant contribution to the empirical understanding of the effectiveness of technological innovations in reducing CO_2 emissions. Unlike many previous declarative studies [Dzwigol, Trushkina, Kwilinski 2021; Silva et al. 2023; Warsewicz 2025], this research focuses on a comparative analysis of actual reporting data from 2023–2024, enabling the identification of relationships between operational scale and the effectiveness of low-emission technology implementation. The use of benchmarking based on per-parcel emission indicators (CO_2e/parcel) and the share of electric vehicles in fleets made it possible not only to determine differences between the analyzed operators but also to verify the practical outcomes of transformation at the unit level.

The results confirm that company size alone does not determine the effectiveness of decarbonization—what matters most is the consistency of the technological-organizational strategy and the degree of integration between ESG reporting systems and operational management. In this context, the findings align with those of Haftor and Costa Climent [2021], who demonstrated that innovations in transport yield measurable environmental effects only when fully integrated with service-oriented models and digital management processes. Similarly, the research by Kolasińska-Morawska et al. [2022] confirms that sustainable last-mile logistics development requires synergy between technology, organization, and ecological awareness among both enterprises and consumers—an approach reflected in InPost's model based on automated parcel lockers.

The results concerning varying levels of corporate engagement in formalizing ESG policies and validating climate goals under the SBTi initiative indicate that environmental maturity is not always proportional to global scale. Amazon, despite its vast delivery volume and major investments in electric vehicles, demonstrates a relatively low level of reporting transparency, whereas InPost, as a regional operator, maintains a high level of compliance with international standards (GRI, TCFD, ESG). Similar observations were made by Nagy and Szentesi [2024], who emphasized that the effectiveness of ecological transformation depends more on internal management culture and pro-environmental leadership than on an organization's financial potential.

An important element of the discussion is also the confirmation of the findings of Larina et al. [2021], indicating that transport accounts for approximately one-quarter of global CO_2 emissions and constitutes a key area of climate action. The analyzed study confirms that the courier sector, as one of the most energy-intensive segments of urban logistics, requires the implementation of multidimensional strategies that combine fleet electrification, process automation, and the use of renewable energy sources. The examples analyzed demonstrate that only the parallel realization of these three components leads to real emission reductions, which aligns with the conclusions of Bányai [2024] regarding vertical and horizontal integration of logistics processes in the spirit of Industry 4.0.

The comparative approach adopted in this study, combining both quantitative data (emission indicators, EV share) and qualitative information (ESG reporting standards, the linking of environmental goals with incentive systems), made it possible to comprehensively characterize different decarbonization models within the courier sector. In particular, it was shown that InPost's consolidation-based model ("one location – multiple parcels") generates up to 75% lower unit emissions than the traditional door-to-door model (DHL), confirming the effectiveness of infrastructure solutions based on parcel locker networks. These results correspond with the findings of Guzowski et al. [2024] and Mohammad et al. [2023], who argue that automation and local delivery aggregation are among the most effective ways to reduce emissions in the final stage of the supply chain.

The discussion also leads to the conclusion that the effectiveness of the green transformation of logistics cannot be considered solely in terms of technology implementation, but rather as a systemic reorganization of the entire logistics chain. This conclusion is supported by the findings of Haftor and Costa Climent [2021] and Liu et al. [2024], who assert that real carbon footprint reduction results from the synergy between digitization, organizational innovation, and infrastructural adaptation. The research presented in this paper perfectly aligns with this perspective – showing that operators such as DHL and InPost combine technological transformation with management process reorganization, reporting transparency, and the integration of ESG strategies with corporate decision-making.

In summary, this study not only confirms the findings of earlier international research but also expands them with an empirical and comparative dimension that is particularly relevant for the European courier sector. It constitutes a significant contribution to the discussion on the effectiveness of decarbonization tools and provides concrete evidence that the green transformation of logistics requires the simultaneous integration of technology, environmental policy, and organizational culture – factors that determine its durability and real impact on reducing emissions in both urban and global transport systems.

Conclusions

The conducted study confirms that the green transformation of logistics depends not solely on the scale of operations, but on the degree of integration between technology, organization, and environmental strategy. The comparative analysis of Amazon, DHL, and InPost clearly demonstrates that courier companies combining the electrification

of fleets with digitalized and automated logistics networks achieve the highest levels of emission reduction per parcel.

The research objective – to determine how technological and organizational innovations support the reduction of greenhouse gas emissions in last-mile logistics – has been fully achieved. The analysis indicates that emission efficiency is a function of three interdependent components:

1. Technological innovation – the adoption of electric and hybrid vehicles, hydrogen prototypes, and intelligent fleet management systems based on AI and IoT.
2. Digital transformation – the use of predictive data analytics, real-time optimization, and automation of logistics processes (e.g., parcel lockers, robotic sorting centers).
3. Organizational alignment – embedding sustainability objectives into corporate governance, incentive systems, and ESG reporting structures verified by international standards (GRI, SBTi, TCFD).

From a technological standpoint, the study highlights that automation, artificial intelligence, and renewable energy integration are the key enablers of decarbonized logistics. The synergy between these tools allows for real-time monitoring of the carbon footprint, intelligent allocation of vehicles, and predictive route optimization that collectively reduce total CO_2e emissions. The analysis confirms that InPost's network-based delivery model exemplifies the most energy-efficient and scalable pathway for sustainable logistics, while DHL's global system illustrates how advanced ESG governance supports technological expansion across diverse markets.

In conclusion, green transformation in logistics should be understood as a systemic process that integrates technological advancement, infrastructure adaptation, and digital innovation. The study provides a practical framework for logistics operators and policymakers, supporting the design of decarbonization strategies aligned with EU climate targets. Future research should focus on measuring life-cycle emissions across logistics networks and evaluating the potential of next-generation technologies – including hydrogen mobility, autonomous last-mile systems, and blockchain-based ESG monitoring – to achieve full climate neutrality in the courier sector by mid-century.

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