European Research Studies Journal
Volume XXVIII, Issue 4, 2025

pp. 1101-1121

Sustainable Development in the E-Commerce Sector: Challenges and Development Directions

Submitted 19/09/25, 1st revision 14/10/25, 2nd revision 26/10/25, accepted 20/11/25

Renata Krajewska[1], Ewa Ferensztajn-Galardos[2]

Abstract:

Purpose: *The purpose of the article is to analyse the environmental and social implications of the rapidly expanding global e-commerce sector and to identify strategic directions for its sustainable transformation. The paper examines the scale of emissions, packaging waste, return logistics and consumption patterns, while also assessing the alignment of e-commerce practices with the UN Sustainable Development Goals (SDGs) and ESG frameworks.*
Design/Methodology/Approach: *The study is based on an extensive literature review and secondary data analysis from international organisations (UNCTAD, UNEP, OECD, Eurostat), industry reports, and corporate ESG disclosures of leading e-commerce companies (Amazon, Alibaba, Zalando, Allegro). Quantitative data (CO_2 emissions, packaging waste volumes, parcel flows, return rates) were compared with data from traditional retail, while qualitative data were synthesised to identify good practices, emerging trends and strategic challenges. The approach includes case studies of major market players.*
Findings: *The findings show that e-commerce generates significantly higher packaging waste and increased CO_2 emissions—particularly from last-mile delivery and return logistics—compared to traditional retail. At the same time, the sector offers strong potential for emission reductions through electrification of fleets, algorithmic route optimisation, and renewable energy adoption in data centres. All analysed platforms implement ESG initiatives, yet their maturity varies. Trends such as circular business models, second-hand markets, greener packaging and transparent ESG reporting are gaining traction. Regulatory pressures, especially the EU CSRD and PPWR, are accelerating sustainability efforts across the sector.*
Practical Implications: *The research highlights the need for industry-wide standards for reusable packaging, large-scale investments in low-emission transport, integration of ESG metrics into management systems and enhanced consumer education promoting sustainable consumption. The study offers recommendations for policymakers regarding infrastructure development, incentives for green logistics and circular economy regulations.*
Originality/Value: *The article provides a comprehensive and up-to-date synthesis of sustainability challenges and opportunities in global e-commerce, combining environmental and social dimensions with regulatory and technological trends. By comparing leading platforms, it identifies effective sustainability practices and strategic gaps relevant for both practitioners and policymakers.*

[1]*Dr., Kazimierz Pułaski University of Radom, Faculty of Transport, Electrical Engineering and Computer Science, Radom, Poland, e-mail: r.krajewska@urad.edu.pl;*
[2]*The same as in 1, e.ferensztajn@urad.edu.pl;*

Keywords: *Green logistics, environmental impact, supply chain responsibility, circular models, digital consumption, sustainability strategies.*

JEL Codes: *L81, Q56, M14.*

Paper type: *Review article.*

1. Introduction

The rapidly expanding global e-commerce sector delivers economic benefits and consumer convenience, yet simultaneously presents serious challenges from the perspective of sustainable development. E-commerce has already exceeded 20% of global retail sales, and the number of parcels is growing exponentially. In 2021, approximately 159 billion parcels were shipped worldwide, amounting to an average of 21 parcels per person annually, and forecasts indicate an increase to 200 billion parcels by 2025.

This massive scale of e-commerce activity is associated with a rising environmental footprint – from greenhouse gas emissions generated by transport and IT infrastructure to the escalating issue of packaging waste. Estimates suggest that online deliveries generate around 30% more CO_2 emissions per product than traditional in-store purchases. At the same time, packaging used in e-commerce accounts for an enormous volume of waste (UNEP, Deliver-E…, 2025).

Beyond the environmental pressures caused by the dynamic development of online retail, significant issues arise from shifting consumption patterns (including excessive purchasing and facilitated returns), impacts on working conditions (e.g., efficiency pressures in logistics centres and courier working conditions), as well as the transparency and ethics of complex, global supply chains.

Consumer expectations regarding corporate responsibility are increasing – a growing share of buyers, especially Millennials and Generation Z, express concern for sustainability. In response to these challenges, both governments and the private sector are beginning to implement initiatives aimed at mitigating the negative environmental and social impacts of e-commerce.

The aim of this article is to provide a multidimensional analysis of sustainable development within global e-commerce. It presents current data from 2022 to 2025 concerning the environmental impact of online retail (CO_2 emissions, packaging waste, IT infrastructure, last-mile logistics) and its societal effects (sustainable consumption, product returns, responsible supply chains).

The paper discusses linkages with the United Nations Sustainable Development Goals (SDGs) and ESG initiatives in the context of e-commerce. It also offers an overview of the major challenges and best practices based on selected platforms, including Amazon, Alibaba, Zalando and Allegro, as well as development directions and strategic recommendations – from green logistics and circular packaging systems to ESG reporting transparency and circular economy models.

The article is a review paper based on secondary data analysis from industry and international institutional reports, as well as case studies of leading market players.

2. Literature Review

Sustainable development is a concept that has evolved over the years, encompassing various elements and approaches – ecological, economic, and social – as indicated by Nakonieczna-Bartosiewicz (2022). According to Wiśniewska (2011), it refers to the need to ensure persistent economic growth founded on capital resources that do not diminish.

Roszkowska, Misiewicz and Karwowska (2014) define sustainable development as managing natural resources in a way that acknowledges their limited availability and ensures their use in accordance with long-term social and economic needs. Trzepacz (2012) argues that sustainable development focuses on human quality of life and health, whilst Drabarczyk (2017) emphasises its economic dimension, relating it to economic growth and broad access to goods and services, and its environmental dimension, centred on protecting the natural environment.

Woźniak (2011) views it as eco-development – a model that incorporates environmental protection while meeting consumer needs and safeguarding the right to live in a clean environment. Gawor (2006) highlights the necessity of meeting the needs of both present and future generations, while Leśniak-Łebkowska (2006) points to its multidimensional nature, comprising economic, social and ecological objectives, applicable to all entities in the economy.

According to Koszel and Weinert (2013), applying this concept within the e-commerce sector can create competitive advantage. Grosseck, Tiru and Bran (2019) argue that in a globalised world facing severe environmental issues and rising social, economic and political inequalities, sustainability requires more sustainable societies and economies, making the concept highly relevant to the rapidly growing e-commerce sector.

The diversity of solutions and data within e-commerce necessitates close examination of the conditions shaping its development in the context of sustainability, manifested in several elements identified by Zhang (2023) and Pinto (2023), including the nature of packaging in last-mile deliveries, transport issues, and the sale of second-hand goods.

It is also important to note that consumer expectations are changing, linked with additional services associated with e-commerce, such as last-mile delivery, as emphasised by Kolasińska-Morawska (2022).

3. Methodology

The analysis is based on a literature review and secondary data obtained from reliable sources. Reports from international organisations (UNCTAD, 2024; UNEP, Deliver-E…, 2025; UNEP, E-commerce…, 2025; OECD, 2024) were used to provide up-to-date information on the impact of digital trade on sustainable development.

For example, relevant findings from the Digital Economy Report 2024 (UNCTAD, 2024) concerning e-commerce's environmental footprint were incorporated, along with UNEP analyses of emissions from urban courier deliveries, and Eurostat data on packaging waste. An essential part of the material also includes ESG and sustainability reports of e-commerce companies for 2023-2024.

Recent environmental reports from Amazon, Alibaba, Zalando and Allegro were analysed to identify their declared emissions, climate targets and initiatives (e.g., low-emission logistics, packaging reduction, circularity programmes). Quantitative data (such as CO_2 emission levels, waste volumes, return rates) were compared to assess the environmental footprint of e-commerce versus traditional retail. Qualitative information (ESG strategies, examples of pro-environmental solutions) was used to develop case studies and recommendations. The analysis was conducted in accordance with academic standards of reliability, with citations and a comprehensive bibliography.

4. Development of the E-Commerce Market

The global e-commerce market remains one of the most dynamic segments of the digital economy. According to UNCTAD data (Digital Economy Report 2024), the global value of electronic commerce, encompassing both the B2B and B2C segments, reached nearly USD 27 trillion in 2022, confirming the crucial role of online sales in global supply chains.

This upward trend continued throughout 2023–2024, particularly in emerging markets, where growth is driven by the widespread adoption of mobile devices and improved access to logistics services.

In the B2C segment, global market reports (IMARC, 2024) indicate that the value of online retail is measured in the tens of trillions of dollars, with double-digit growth rates observed in many regions, especially Southeast Asia, Africa and South America.

China remains the strongest market, dominated by platforms such as Alibaba,

JD.com and Pinduoduo, while Amazon maintains significant global influence, with operations expanding far beyond retail to include logistics, financial services and advanced cloud solutions.

One of the key indicators of sectoral growth is the number of parcels delivered worldwide. The Pitney Bowes Global Parcel Index (2023) reports that approximately 161 billion parcels were shipped globally in 2022, with forecasts predicting an increase to more than 225 billion parcels per year in the coming years. This illustrates not only the expanding scale of e-commerce logistics but also the increasing environmental challenges associated with transport and packaging.

Poland is among the fastest-growing e-commerce markets in Europe. According to the Gemius report (E-commerce in Poland, 2024), 75–78% of Polish internet users shop online, representing a stable level of market penetration compared with recent years. Consumers increasingly prefer marketplace platforms, which dominate traditional online shops due to greater convenience, broader product offerings and transparent review systems.

The leader of the Polish market is Allegro, which – according to Reuters (E-commerce…, 2025) – holds approximately 38.8% of the e-commerce market, while other players capture only single-digit market shares. Amazon, Alibaba, AliExpress and Temu are expanding their presence in Poland; however, their market share remains significantly smaller than that of Allegro, largely due to Poland's advanced logistics infrastructure and the strong brand recognition associated with Allegro.

An additional advantage of the Polish market is its highly developed parcel locker infrastructure, which, according to various analyses, is one of the largest in Europe and even globally. InPost is the dominant operator, but Allegro is expanding its One Box network, and additional players (DPD, Orlen Paczka) are increasing the availability of collection points. This represents a key competitive strength of the Polish market, contributing to reduced last-mile emissions through delivery consolidation.

5. Environmental and Social Impact of E-Commerce

The dynamic growth of e-commerce directly contributes to increased greenhouse gas emissions, particularly CO_2, associated with order transport and the operation of IT infrastructure. Last-mile logistics – the delivery of a product from the warehouse to the customer – is currently one of the largest sources of emissions within the sector.

It is estimated that a single parcel delivery generates on average between approximately 0.5 and 1.0 kg of CO_2, depending on distance and mode of transport (Alami *et al*., 2022). A sample carbon footprint of an online order is presented in Table 1.

Table 1. *Carbon footprint of a single online order*

Element	**Average CO_2 emissions (per 1 order)**
Transport/delivery	500–1000 g
Packaging	100–200 g
Digital operations (servers)	20–50 g
Product return	+500–1000 g
Total	~1.2 – 2.3 kg CO_2

Source: *Authors' conclusions.*

In densely populated urban areas, vans and courier vehicles significantly contribute to air pollution and congestion. Without targeted intervention, emissions from urban e-commerce deliveries may increase by approximately 60% by 2030, accounting for around 13% of total CO_2 emissions in city centres.

At the same time, a substantial rise in delivery vehicles is projected: in the world's 100 largest metropolitan areas, their number may increase by 36% by 2030 (compared with 2020), driven by the continued expansion of online retail (UNEP, As e-commerce…, 2025). The pursuit of ever-faster deliveries – such as same-day delivery services – further amplifies the carbon footprint, as it often requires air transport, which is significantly more emission-intensive than ground transport.

Another important component of the e-commerce carbon footprint is digital infrastructure: the operation of websites and mobile applications, transaction processing, and, above all, the handling of vast datasets relating to customers and logistics in data centres. Although emissions associated with IT infrastructure are less visible to the end user, globally the ICT (information and communication technology) sector already accounts for approximately 2–4% of GHG emissions – comparable to the emissions of the entire aviation sector (OECD, 2024).

Maintaining e-commerce servers, particularly with the increasing use of energy-intensive AI algorithms and big-data analytics, adds further pressure to this balance. Large platforms are investing in mitigating this impact, for instance by purchasing electricity from renewable sources. Despite such initiatives, the growing demand for digital services requires further innovation – such as the design of more energy-efficient servers or website code optimisation – to reduce the digital carbon footprint of e-commerce.

Packaging represents another area in which e-commerce exerts substantial environmental pressure. Every product ordered online is individually packaged – usually in cardboard, plastic film, and filler materials (air pillows, foams, paper). Consequently, online shopping generates several times more packaging waste than traditional retail, where most goods are delivered to stores in bulk and consumers often require no additional retail packaging.

Studies indicate that online shopping generates up to 4.8 times more packaging waste

per product compared with brick-and-mortar purchases, consisting largely of single-use cardboard, plastics and fillers, a significant portion of which is not recycled (UNCTAD, 2024). Such volumes of waste pose major challenges: resource depletion (paper, plastics) and environmental contamination (e.g., plastic packaging entering oceans).

In recent years, many companies have begun implementing measures to reduce their packaging-related carbon footprint. Firstly, packaging design is being optimised – reducing size and weight and eliminating unnecessary components. Secondly, the share of recycled and recyclable materials is increasing. A third direction is the development of reusable packaging and return-packaging systems – although still a niche, pilot initiatives are emerging, such as parcel lockers enabling customers to return used cardboard for reuse, or returnable packaging (including special courier bags sent back to the sender) (Ecological Packaging…).

Nevertheless, despite progress in eco-design and recycling, the global problem of packaging waste from e-commerce remains a significant challenge – particularly in the context of rising sales volumes and in countries with less developed waste-management systems.

The convenience of online shopping – including the ease of returning unwanted products – also carries a negative sustainability dimension. High return rates in e-commerce generate additional parcel movements (reverse logistics), increased packaging use and product wastage.

The average global return rate in online retail is estimated at several-teen per cent, yet in some categories (such as apparel and footwear) it may reach 20–30%, as customers frequently order multiple variants (sizes, colours) with the intention of returning part of the order. By contrast, return rates in traditional retail are significantly lower (typically single-digit), as consumers can inspect or try products before purchase.

The environmental consequences of such high online return volumes are substantial. It is estimated that global e-commerce reverse logistics generates more than 20–24 million tonnes of CO_2 annually (CleanHub, 2025) – equivalent to the emissions of several million passenger vehicles. This results from the fact that returned products often travel long distances (sometimes back across borders to central warehouses), require re-packaging and, in some cases, cleaning or repair.

Furthermore, not all returned goods are resold – some (particularly low-value items) are sent directly to landfills or incineration due to the unprofitability of reintroducing them to the market. In 2022 alone, companies disposed of approximately 9.5 billion pounds (4.3 million tonnes) of returned products instead of reselling them, as this was cheaper than processing them further (CleanHub, 2025). Such wastefulness contradicts the principles of sustainable consumption and the circular economy.

Responses to excessive returns involve initiatives from both companies and consumers. Online retailers are investing in improving product descriptions and online presentation (more accurate sizing charts, 360° photos, virtual fitting rooms) to reduce purchase errors. Artificial intelligence is also used to personalise recommendations and improve product matching.

A further trend is limiting "free returns" or redesigning them to be more sustainable. Some companies have begun charging fees for returns to parcel lockers or via couriers, while encouraging in-store returns, which consolidate the transport of returned items. Innovative brands are also developing programmes for repurposing returns, where returned or used items are refurbished and sold as second-hand goods, reducing waste and emissions related to producing new products (IISD, 2025).

Platforms in the fashion sector, such as Zalando, have introduced sections dedicated to pre-owned clothing to extend product life cycles and reduce pressure on continuous new production.

From the consumer perspective, education and behavioural change are crucial. This includes promoting conscious consumption, purchasing fewer but higher-quality items, and opting for environmentally friendly delivery choices (e.g., consolidated delivery on a single date instead of multiple express shipments).

High return rates pose both environmental and economic challenges, but appropriate business practices and informed consumer behaviour can significantly mitigate their negative impact.

6. Comparison of the Environmental Footprint of E-Commerce and Traditional Retail

Consumers worldwide are increasingly shifting away from the traditional brick-and-mortar retail model. Data from recent reports (European E-Commerce Report, 2024; UNCTAD, 2025) indicate a growing share of mobile commerce as well as rising interest in cross-border purchases.

At the same time, consumer environmental awareness is increasing, although the so-called "attitude–behaviour gap" remains clearly visible.

While customers declare willingness to choose more sustainable options, price and delivery speed continue to be the dominant decision-making factors. This requires companies to balance customer expectations with climate objectives.

Table 2 presents a comparison of key environmental aspects of the e-commerce model against those of traditional in-store retail.

Table 2. *Comparison of selected environmental footprint aspects in e-commerce and traditional retail*

Aspect	E-commerce	Traditional retail
Transport (to customer)	Courier deliveries, often individual (frequent CO_2 emissions, especially in express deliveries)	Customer transport by private vehicles (emissions depend on distance travelled)
Warehousing	Large, optimised logistics centres (energy-efficient but centralised)	Local stores – smaller scale, often higher energy use per unit of product
Packaging	Large amount of additional packaging (cardboard boxes, plastic film, fillers)	Minimal – typically only bags or original producer packaging
Product returns	High return rates (fashion: 30–50%) – additional transport, emissions, waste	Returns less common, product often evaluated before purchase
Consumerism	Ease of purchase + ease of return → excessive shopping, fast fashion	Physical barrier – more conscious shopping
CO_2 emissions (average)	Potentially lower per product (route optimisation), but increasing due to fast deliveries and returns	Higher emissions associated with customer travel
Water and resource footprint	Depends on the type of packaging and logistics model	Less packaging waste, but energy consumption in the shop
Potential for implementing sustainable innovations	High – AI, route optimisation, eco-packaging, green certificates	Limited – dependent on local practices, in-store technology
Circular economy	Facilitates the sale of used items (platforms such as Vinted, OLX), eco-shops	Repair options, local second-hand shops, but with a smaller reach
Access to sustainable products	Large online selection, easy verification of certificates	Limited to the range offered by a given shop

Source: *Authors' conclusions.*

7. United Nations Sustainable Development Goals and E-Commerce

The engagement of the e-commerce sector in the implementation of the United Nations Sustainable Development Goals (UN Agenda 2030) is becoming increasingly important in the context of global efforts to create a more sustainable economy. Many of the challenges described above are directly reflected in specific SDG targets.

Table 3. *Sustainable Development Goals in the E-commerce Sector*

E-commerce objective	**Related SDGs**	**Justification**
Reducing emissions and carbon footprint	7, 9, 13	Measures such as fleet electrification, use of renewable energy and logistics optimisation reduce greenhouse gas emissions.
Sustainable logistics and mobility	9, 11, 12	Initiatives such as parcel lockers, delivery consolidation and green warehouses support sustainable urban development and reduce environmental pressure.
Circular economy	12, 13	Measures such as recycling, repair systems and product reuse reduce resource consumption and waste.
Eco-friendly packaging and waste	12, 14, 15	Reducing plastic and designing environmentally friendly packaging protects aquatic and terrestrial ecosystems.
Responsible supply chain	8, 10, 16	Respecting workers' rights, working conditions and legal compliance throughout the supply chain contributes to fair and ethical trade.
Education and conscious consumption	4, 12	Educating customers about the impact of their purchasing decisions and enabling them to make informed choices increases the social impact of e-commerce.
ESG reporting and transparency	16, 17	Clear reporting of environmental and social impact, cooperation with regulators and investors increase trust and support the development of sustainable institutions.
Equality and diversity	5, 8, 10	Creating inclusive work environments, anti-discrimination policies and supporting equal access to management positions have a positive impact on corporate social responsibility.

Source: *Authors' conclusions.*

Leading e-commerce platforms are increasingly making public commitments to the SDGs. In its ESG report, Alibaba Group states that its sustainability strategy aligns with the company's so-called "Seven Petals" ESG framework, which is linked to the 17 UN Goals and integrates environmental and social priorities into the company's long-term strategy (Alibaba Group, 2024).

This includes, for example, actions related to climate (Goal 13), innovation and infrastructure (Goal 9 – e.g., investments in green data centres), sustainable consumption (Goal 12 – promoting green products), but also quality education (Goal 4 – digital skills training), gender equality (Goal 5 – a high share of women in Alibaba's workforce), and partnerships (Goal 17 – cooperation with diverse stakeholders).

Such a comprehensive approach illustrates the sector's growing understanding that sustainable development is a prerequisite for long-term business success. Companies increasingly perceive the SDGs not only as governmental obligations but also as a framework through which they can demonstrate responsibility and innovation.

8. ESG Initiatives in the E-Commerce Sector

Parallel to the UN agenda, the importance of ESG standards – environmental, social and governance criteria – is rising across the business world (Lament and Bukowski, 2022; Ferensztajn-Galardos *et al*., 2025). Investors, consumers and regulators are increasingly demanding transparency and credible action from companies, including e-commerce giants. In response, many online platforms publish annual sustainability or ESG reports, providing information on their carbon footprint, resource use, working conditions, product safety and business ethics.

Legal regulation is becoming an increasingly important driver of ESG action. The European Union introduced new reporting requirements in 2024 – the Corporate Sustainability Reporting Directive (CSRD, 2022) – which obliges large enterprises (including global platforms operating in the EU market) to report ESG data in detail according to unified ESRS standards.

This means that e-commerce companies listed on EU stock exchanges or conducting significant business activity in Europe will be required, from 2025 onwards, to publish verified information on, among other things, CO_2 emissions (Scope 1, 2 and 3), climate strategy, resource use, employee and supplier policies, respect for human rights, governance structures and oversight of ESG-related risks.

As part of their ESG initiatives, e-commerce companies increasingly extend their efforts beyond their own operations to include supply chains and customers. Supplier codes of conduct are being developed – covering environmental standards and labour rights – and compliance is often verified through audits.

Furthermore, companies involve consumers in their ESG activities through "green customer choice" initiatives, such as labelling environmentally friendly products, offering carbon-neutral delivery options, or implementing loyalty schemes that incentivise lower-impact delivery choices (e.g., consolidated delivery in exchange for reward points).

All these measures form part of a broader trend: the e-commerce sector is maturing in its approach to ESG, shifting emphasis from solely sales growth to sustainable growth that acknowledges environmental and social costs.

To illustrate how the theory of sustainable development translates into practice, it is useful to examine the actions of the largest e-commerce platforms. Amazon, Alibaba, Zalando and Allegro – despite differing in business models and market reach – face similar environmental and social challenges. Analysing their strategies makes it possible to identify key issues as well as pioneering solutions that serve as benchmarks for the entire sector.

Tables 4–6 present how these four platforms (Zalando, Amazon, Alibaba and Allegro)

currently act in the ESG area, what best practices they have implemented, and what changes or future plans they communicate in order to meet sustainability requirements.

Table 4. *Environmental (E) Dimension – good practices, plans and their links to the SDGs*

Platform	Good environmental practices – current activities	Plans and directions for development (E)	Supply chain and customer engagement (E)	Link to SDGs
Amazon	• 100% renewable energy in operations by 2024. • Electrification of logistics: 31,000 EVs already delivering parcels. • 16% reduction in plastic packaging (plastic air cushions phased out). • Ship in Own Container packaging optimisation programme (no additional cardboard box).	• Purchase of 100,000 Rivian electric vans. • Further neutralisation of 'last mile' emissions. • Development of drones and cargo bike transport. • Reduction of empty space in parcels through AI.	• Amazon Supplier Code of Conduct. • Supplier environmental audits. • Amazon Frustration-Free Packaging – requirements for manufacturers. • Amazon Climate Pledge Friendly – engaging customers in 'green choices'.	SDGs 7, SDGs 9, SDGs 11, SDGs 12, SDGs 13
Alibaba Group (Cainiao)	• 39% of energy from clean sources (2024). • Smart packaging algorithms – 15% less material used. • Cardboard recycling – 47.6 million boxes reused. • Green cloud – data centres powered by 56% renewable energy.	• 100% renewable energy in data centres and logistics by 2030. • 50% reduction in emissions across the value chain. • '1.5 gigatonnes' target – avoiding global emissions by 2035.	• Extensive Supply Chain Responsibility Programme – supplier environmental audits. • Ant Forest – an app that rewards users for eco-friendly behaviour. • Consolidation of deliveries at Cainiao Post.	SDGs 7, SDGs 9, SDGs 12, SDGs 13, SDGs 17
Zalando	• 78% reduction in emissions (Scope 1+2) compared to 2017. • 100% electricity from renewable	• 25% GMV from sustainable products by 2025.	• Transparency requirements for brands (Higg Index, material data).	SDGs 12, SDGs 13, SDGs 9

	sources in operations. • 100% packaging free of single-use plastic. • Pre-owned programme (6.3 million items of clothing extended in circulation).	• Circular fashion design (easy recyclability). • Aiming for 100% sustainable materials in own brands.	• Sustainable product labels. • RePack reusable packaging pilot programme..	
Allegro	• 49% sustainable packaging (2023). • 5% reduction in Scope 1+2 emissions. • Sustainable delivery: One Box, parcel machines, delivery consolidation. • Development of re-commerce (Allegro Lokalnie).	• 100% sustainable packaging by 2028. • Increasing the share of renewable energy in operations. • Expansion of the network of collection points.	• Allegro Academy – educating sellers about product ecology. • Labelling of sustainable offers. • OdZyskaj programme – refurbishing electronics.	SDGs 11, SDGs 12, SDGs 13

Source: *Authors' calculations based on Amazon, 2024; Alibaba Group 2024; Zalando, 2023; Allegro, 2023.*

Table 5. *Social (S) Dimension – good practices, plans and their links to the SDGs*

Platform	**Good social practices – current activities**	**Plans and directions for development (S)**	**Supply chain and customer engagement (S)**	**Link to SDGs**
Amazon	• Upskilling programme – hundreds of thousands of employees trained. • Fund for the construction of housing for local communities. • Diversity programmes – increase in the representation of women in leadership positions.	• Further improvement of working conditions in warehouses. • Expansion of global education programmes. • Greater transparency of HR indicators..	• Community support – support for local NGOs. • Programmes for sellers (training, compliance). • Amazon Smile (charity).	SDGs 4, SDGs 5, SDGs 8, SDGs 10, SDGs 11
Alibaba	• Digital inclusion training – e-	• Strengthening the role of SMEs in	• Ant Forest – mass	SDGs 1, SDGs 4,

	commerce education for rural residents. • 47% of employees are women; high proportion of women in management. • 260,000 hours of employee volunteering (2024).	the digital economy. • Increasing equality and accessibility of digital services.	engagement of users in pro-social activities. • Ethical audits of suppliers.	SDGs 5, SDGs 8, SDGs 10
Zalando	• 40% of management positions are held by women. • Additional care days for employees (work-life balance). • Programmes for refugees and the digitally excluded.	• Development of diversity & inclusion policies. • Continuous improvement of working standards and benefits.	• do.MORE programme – ethical requirements for partner brands. • Consumer education on sustainable fashion.	SDGs 5, SDGs 8, SDGs 10
Allegro	• Pay gap <3%. • All For Planet Foundation – pro-social projects. • Allegro Charity (donations, auctions).	• Expansion of CSR activities at the local level (local governments, NGOs). • Digital education for salespeople and customers.	• Allegro Academy – training for sellers. • Charity programmes engaging users.	SDGs 4, SDGs 5, SDGs 8, SDGs 11

Source: *Authors' calculations based on Amazon, 2024; Alibaba Group 2024; Zalando, 2024; Allegro, 2023.*

Table 6. *Corporate governance (G) Dimension – good practices, plans and their link to SDG goals*

Platform	**Good corporate governance practices – current activities**	**Plans and directions for development (G)**	**Supply chain and customer engagement (G)**	**Link to SDGs**
Amazon	• Sustainability Committee. • Public emissions methodology (GHG Protocol). • Reports covering diversity, health and safety, ESG performance.	• Greater integration of ESG objectives with management bonuses. • Compliance with CSRD on the EU market.	• Supplier Code of Conduct. • Ethical audits and inspections.	SDG 12, SDG 16
Alibaba Group	• Sustainable Development	• Integration of AI and cloud	• Ethical and environmental	SDG 9,

	Committee on the board. • Reporting in accordance with GRI, HKEX, SASB. • Supplier code of ethics.	computing for real-time ESG monitoring. • Extension of governance to subsidiaries.	audits of Alibaba/Cainiao suppliers.	SDG 16, SDG 17
Zalando	• Reporting in accordance with GRI, SASB, EU taxonomy. • Linking ESG KPIs to executive remuneration. • Independent supervisory board.	• Full implementation of CSRD/ESRS. • Increased transparency of product data (materials, origin).	• High ESG requirements for fashion partners. • Elimination of brands that do not meet standards.	SDG 12, SDG 16
Allegro	• ESG 2023 report compliant with CSRD/ESRS (one of the first implementations in Poland). • ESG committee on the supervisory board. • Digital tools for monitoring ESG KPIs.	• Further automation of reporting and data integration. • Stronger audits of suppliers.	• Allegro Supplier Code. • Compliance training for sellers.	SDG 12, SDG 16

Source: *Authors' calculations based on Amazon, 2024; Alibaba Group 2024; Zalando, 2024; Zalando, 2023; Allegro, 2023.*

Variations in strategic approaches stem from scale and business models. Amazon and Alibaba, operating globally, invest in large-scale energy and infrastructure solutions (renewables, electric vehicles, cloud infrastructure), whereas Zalando and Allegro – both regionally and sectorally focused – emphasise solutions tailored to fashion circularity, eco-packaging, parcel locker networks and take-back schemes.

All platforms are increasing reporting transparency. Within the EU, CSRD/ESRS regulations impose higher requirements – Zalando and Allegro are already aligning their reporting practices, while Amazon and Alibaba are developing methodologies to ensure transparency across multiple jurisdictions.

9. Development Directions and Strategic Recommendations

The analysis of challenges and existing practices indicates several key directions for the sustainable development of e-commerce in the coming years. Below is a set of

strategic recommendations that may help the sector minimise negative impacts and increase its positive contribution to sustainable development:

- **Green logistics and transport decarbonisation:** Reducing emissions from last-mile deliveries is a priority. Further electrification of delivery fleets (electric vans, cargo bikes, e-scooters) is recommended – pilot projects show that this can reduce transport emissions by approximately 90%. This requires the expansion of charging infrastructure and incentives (e.g., tax relief) for companies investing in zero-emission vehicles. Route optimisation and delivery consolidation supported by AI can reduce total vehicle kilometres driven and congestion (cities can support this through designated delivery time windows, bus lanes for couriers, etc.). At the macro level, shifting as much of e-commerce transport as possible to lower-emission modes – rail (for intercity shipments) or maritime transport instead of air freight – is advisable, even at the cost of longer delivery times. Firms can also motivate consumers to choose "slower" delivery options (e.g., through loyalty programmes or the option to consolidate multiple orders into one parcel). Development of micro-fulfilment centres near customers and extensive pickup-point networks can further reduce last-mile distances. Overall, the aim is climate-neutral logistics – Amazon and other major players have already announced targets to achieve net-zero emissions in logistics by 2040, and this will require large-scale implementation of these solutions.

- **Circular packaging systems:** A fundamental shift from the linear "*produce–use–discard*" model to a circular packaging system is essential. Investments in reusable packaging for e-commerce are recommended – such as durable bags or containers that circulate between sellers and customers. This requires packaging standardisation and efficient return systems (convenient for customers), but has the potential to eliminate a significant proportion of packaging waste. Continued reductions in packaging weight and volume (eco-design), elimination of unnecessary components (e.g., separate boxes for small items, plastic inner bags), and maximisation of recycled content are also needed. A key component is the development of the recycling market – e-commerce companies can collaborate with packaging producers and waste-management firms to improve recycling technologies for plastics or paper (e.g., recycling polyolefins, which are currently seldom processed). Standardising packaging materials – reducing the number of different plastics – would further facilitate recycling. Governments can support these efforts through regulation – for example, the EU's proposed PPWR Regulation (Regulations (EU) 2025/40) aims to require 25% reusable packaging in e-commerce by 2040, compelling firms to build practical return systems. Implementing circular packaging systems will not only reduce waste and emissions (the production of new packaging also has a large carbon footprint), but will lower costs in the long term (reusable packaging spreads cost over many shipments).

- **Transparency and integration of ESG into strategy:** As noted earlier, ESG reporting is becoming an essential element of business operations. E-commerce companies are advised to prepare early for new standards by building internal systems for collecting ESG data (emissions, energy use, waste, employee turnover, occupational health and safety, diversity, etc.) and integrating these into the company's main ERP system. As a result, sustainability reports will not be separate "PR documents" but genuine management tools that identify improvement areas. Digitalisation of reporting – for example, using blockchain to track supply chains and verify product-origin data – will increase the reliability and accuracy of information available to consumers. Furthermore, companies should incorporate ESG criteria into risk assessment and business decision-making at every level: from supplier selection (e.g., prioritising those with low carbon footprints and strong ethical practices) to investment decisions (e.g., expanding infrastructure only if it meets defined energy efficiency standards). Integrating ESG data with financial reporting – as required under the CSRD – will make non-financial results as important as traditional financial indicators. Finally, firms should ensure full transparency for consumers by providing information on the environmental footprint of products (e.g., carbon labels, water footprint), and clearly communicating climate targets and progress (or setbacks). Transparency builds trust and encourages meaningful action – hence the guiding principle "measure, disclose, reduce" should apply across the sector.

- **Circular economy and new consumption models:** In the long term, sustainable e-commerce requires a shift from the paradigm of "more sales" to "better, longer product use". E-commerce platforms are encouraged to develop circular business models: second-hand sales, product rental services, repair and refurbishment services, and buy-back programmes. For example, "wear, rent, return" models in the fashion industry – renting garments for a limited period – can significantly reduce clothing overproduction if adopted on a large scale. E-commerce is an ideal channel for scaling such services, as it enables convenient customer access and efficient reverse logistics. Another direction is offering spare parts or repair accessories (consistent with the "right to repair" initiative) – platforms can become places where consumers not only purchase new goods but also find support to extend the life of existing ones. Consumer education is equally important: online retailers can suggest more sustainable alternatives (e.g., a more durable item instead of a cheaper disposable equivalent) or highlight environmental impacts (e.g., carbon footprint), allowing customers to make eco-aligned choices. Companies should also cooperate with manufacturers to design products for circularity – ensuring that what is sold is durable, repairable, and easy to recycle. EU regulations – such as the planned expansion of Extended Producer Responsibility (EPR) or mandatory product carbon footprints – will accelerate these changes. For platforms, this means adapting their offerings – perhaps fewer low-quality products and more certified, environmentally friendly ones

– but it is an investment in long-term loyalty among increasingly conscious consumers.

A sustainable development strategy for e-commerce must be based on innovation and collaboration. No single company can solve emission or waste challenges on its own – common standards (e.g., for reusable packaging), industry alliances (such as joint investments in EV charging networks or recycling programmes), and dialogue with authorities are essential. The directions outlined above chart a path towards an e-commerce sector that, in the future, can become part of the solution rather than the problem – for instance, online platforms can support the transition to a sharing economy, promote the market for eco-friendly products, or accelerate the green transformation of logistics. Much is already happening, but the coming years – given the urgency of the climate crisis and rising public awareness—will be decisive for scaling these initiatives.

10. Conclusions

The global e-commerce sector stands at a crossroads: on one hand, it drives economic growth, innovation and meets the needs of billions of consumers; on the other, it generates an increasing environmental footprint and social challenges that can no longer be overlooked.

The rapid expansion of online commerce in recent years has revealed external costs in the form of CO_2 emissions from transport, mountains of packaging waste, and phenomena of overconsumption (such as mass returns). In this context, maintaining the current unsustainable model is no longer an option – both for the planet and in light of growing expectations from regulators and consumers.

The analyses conducted in this study demonstrate, however, that the e-commerce sector can evolve towards a sustainable model. Many leading companies have already made concrete commitments and taken action: from climate neutrality (Amazon, Alibaba) to the implementation of circular economy solutions (Zalando, Patagonia) and the improvement of ESG transparency.

Regulation (such as the EU's CSRD) adds additional pressure – ESG is becoming an obligatory component of business strategy rather than a voluntary supplement. This requires a shift in mindset among leadership teams: sustainability criteria must be embedded in everyday decisions and company performance metrics.

From a public policy perspective, further action is needed to support the green transition of e-commerce. Governments and cities should invest in infrastructure that enables sustainable options (e.g., electric transport networks, recycling systems), introduce financial incentives for ecological solutions (subsidies for renewable energy, incentives for electric vehicles, deposit systems for packaging), and establish standards and limits (e.g., minimum product durability, mandatory recycled content,

emission limits for delivery fleets in urban areas). Education is also crucial – both for consumers and for smaller retailers entering online markets – to ensure that sustainable practices become standard from the outset.

It is likely that in the next 5–10 years we will see the green transformation of logistics (electric and autonomous vehicles, efficient urban consolidation centres), the standardisation of reusable packaging across the industry, and the rising importance of circular platforms (second-hand and rental services).

Digital technologies – from big data to blockchain and AI – will play a key enabling role: helping track and optimise carbon footprints in real time, improving recycling (e.g., automated waste sorting), and supporting the creation of new business models based on resource sharing.

In summary, sustainable development in e-commerce is achievable, but requires collective effort: business innovation, thoughtful regulation and informed consumer choices. A sector that entered the 21st century as a symbol of convenience and speed must in the coming years also become a symbol of responsibility – for the climate, the environment and the people working across global supply chains. Only then can e-commerce continue to grow without exceeding planetary boundaries and while fulfilling the ambitions of the 2030 Agenda.

Current initiatives give grounds for cautious optimism: if the goals and practices of market leaders are replicated across the sector – and if consumers and policymakers continue to support positive change – online commerce may become a catalyst for sustainable consumption on a global scale, which would represent a significant achievement in the context of global sustainability transitions.

References:

Agenda. 2030. Sustainable development goals. Available at: https://www.gov.pl/web/rozwoj-technologia/cele-zrownowazonego-rozwoju.

Alami, M.El., Wisotzky, D., Gallon, F., Rossa, S. 2022. Delivery Decarbonization Pathways. Oliver Wyman.

Alibaba Group. 2024. Alibaba Group ESG Report 2024 – Highlights. Alibaba News / Moomoo, 22 July 2024. Available at: https://www.alizila.com/.

Allegro. 2023. Allegro ESG Report 2023. Available at: https://about.allegro.eu/esg.

Amazon. 2024. Amazon Sustainability Report 2024 – Highlights. Manufacturing Digital, 18 July 2025. Available at: https://manufacturingdigital.com.

CleanHub. 2025. The Environmental Impact of Returning Online Products, CleanHub Blog, 5 August 2025. Available at: https://cleanhub.com.

CRSD Directive (EU) 2022/2464 of the European Parliament and of the Council of 14 December 2022 amending Regulation (EU) No 537/2014. Available at: https://eur-lex.europa.eu/eli/dir/2022/2464/oj.

Drabarczyk, K. 2017. Zrównoważony rozwój województw – analiza porównawcza, Zeszyty Naukowe Politechniki Częstochowskiej. Zarządzanie, 25(1), pp. 23-34.

https://doi.org/10.17512/znpcz.2017.1.2.02.

Eco-friendly packaging – a temporary trend or the norm in e-commerce?, Available at: https://www.opakowanianawrot.pl/ekologiczne-opakowania-chwilowy-trend-czy-norma-w-e-commerce/.

European E-Commerce Report 2024. Available at: https://ecommerce-europe.eu.

Ferensztajn-Galardos, E., Krajewska, R., Wojciechowski, J. 2025. Opportunities for ESG reporting in railway electric power supply enterprises based on annual reports. European Research Studies Jurnal, 28(1), 1033-1049.

Gawor, L. 2006. Idea zrównoważonego rozwoju jako projekt ogólnoludzkiej cywilizacji. Diateros.

Gemius. 2024. E-commerce w Polsce 2024. Available at: https://gemius.com.

Grosseck, G., Tiru, L.G., Bran, R.A. 2019. Education for Sustainable Development: Evolution and Perspectives of Research, 1992-2018. Sustainability, 11, 6136. https://doi.org/10.3390/su11216136.

IISD. 2024. Addressing the Environmental Footprint of E-Commerce, in: IISD Trade and Sustainability Review: A Focus on Digital Trade.

IMARC. 2024. E-Commerce Market Report 2025–2033. IMARC Group. Available at: https://imarcgroup.com.

Kolasińska-Morawska, K., Sułkowski, Ł., Buła, P., Brzozowska, M., Morawski, P. 2022. Smart Logistics – Sustainable Technological Innovations in Customer Service at the Last-Mile Stage: The Polish Perspective. Energies, 15, 6395.

Koszel, M., Weinert, A. 2013. Wykorzystanie koncepcji społecznej odpowiedzialności przedsiębiorstw i zrównoważonego rozwoju w kreowaniu innowacyjnego produktu – studia przypadków. Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania, pp. 155-168.

Lament, M., Bukowski, S. 2022. Non-fnancial Reporting as a Determinant of Financial Efficiency of Insurance Companies. The Polish Statistician, 67(7). https://doi.org/10.5604/ 01.3001.0015.9299.

Leśniak-Łebkowska, G. 2011. Wpływ wewnętrznych uwarunkowań na realizację zintegrowanej perspektywy zrównoważonego rozwoju przedsiębiorstwa. Warszawa: Oficyna Wydawnicza SGH.

Nakonieczna-Bartosiewicz, J. 2022. Zrównoważony rozwój – pojęcie i geneza, in: Drosik, A., Heidrich, D. and Ratajczak, M. (eds.) Wprowadzenie do zrównoważonego rozwoju. Warszawa: Scholar, pp. 17-18.

OECD. 2024. Digital Economy Outlook 2024 (Volume 2). Strengthening Connectivity, Innovation and Trust. Available at: https://www.oecd.org/content/dam/oecd/en/publications/reports/2024/11/oecd-digital-economy-outlook-2024-volume-2_9b2801fc/3adf705b-en.pdf.

Oceansix. 2023. From convenience to consequence: the facts of e-commerce and packaging waste, Oceansix Blog, 8 March 2023. Available at: https://oceansix.com.

Pinto, A.S., Guerra-Mota, M., Dias, I. 2023. Impact of E-commerce on Corporate Sustainability: Case Study. In: Reis, J.L. et al. (eds.) Marketing and Smart Technologies. Smart Innovation, Systems and Technologies, Vol. 337. Singapore: Springer.

Pitney Bowes. 2023. Global Parcel Shipping Index 2023 (Data for 2022). Available at: https://pitneybowes.com.

Reuters. 2025. E-commerce company Allegro goes local to stand out from Asian competitors, Reuters.

Roszkowska, E., Misiewicz, E.I., Karwowska, R. 2014. Analiza poziomu zrównoważonego

rozwoju województw Polski w 2010 roku, Ekonomia i Środowisko, 2(49), pp. 168-190. DOI 10.12846/j.em.2014.01.01.

Regulation (EU) 2025/40 of the European Parliament and of the Council of 19 December 2024 on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC (Text with EEA relevance) („PPWR").

Trzepacz, P. 2012. Geneza i istota koncepcji rozwoju zrównoważonego', in: Trzepacz, P. (ed.) Zrównoważony rozwój – wyzwania globalne. Kraków: Instytut Geografii i Gospodarki Przestrzennej UJ, pp. 11-36.

UNCTAD. 2024. Digital Economy Report 2024: Shaping an Environmentally Sustainable and Inclusive Digital Future. Geneva: United Nations.

UNEP. 2025. As e-commerce grows, electric delivery vehicles offer opportunity to cut urban emissions, United Nations Environment Programme, News Story, 14 October 2025. Available at: https://www.unep.org.

UNEP. 2025. Deliver-E Coalition Launch – Media Advisory. United Nations Environment Programme.

Wiśniewska, J. 2011. Economic Sustainability of Agriculture: Conceptions and Indicators, Acta Scientiarum Polonorum. Oeconomia, 10(1), pp. 119-137.

World Economic Forum. 2020. Urban Deliveries Expected to Add 11 Minutes to Daily Commute and Increase Carbon Emissions by 30% until 2030 without Effective Intervention. Available at: https://www.weforum.org/press/2020/01/urban-deliveries-expected-to-add-11-minutes-to-daily-commute-and-increase-carbon-emissions-by-30-until-2030-without-effective-intervention-e3141b32fa/.

Woźniak, L. 2011. Zrównoważony rozwój jako strategia definiująca nowoczesne gospodarowanie przestrzenią w Polsce, Ekonomia i Prawo, 7(1).

Zalando. 2023. Sustainability Progress Report 2022. Fibre2Fashion.

Zalando. 2024. Sustainability Progress Report 2023. Available at: https://corporate.zalando.com.

Zhang, M. 2023. Sustainability Transitions in E-commerce Research: Academic Achievements and Impediments, Circular Economy and Sustainability, 3, pp. 1725-1746.