RESEARCH ARTICLE

European Journal of Development Studies
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Environmental Sustainability under E-Commerce: A Holistic Perspective

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ABSTRACT

Following COVID-19 there was a transformation in how individuals purchase products and services, with a major shift and dependency. Websites such as Amazon, eBay, and Alibaba have changed the way products are sold and allowed for-profit companies to reach a much broader market. The most important effect of the rising use of e-commerce in green marketing is the increased need for research on the environmental consequences of e-commerce. This article addresses environmental sustainability in e-commerce with the aim of understanding changes in sustainable logistics, green packaging, and recycled products, as well as identifying issues such as reducing carbon emissions in a holistic manner by exploring the literature on secondary sources, which primarily served as a source of information for academics and practitioners (including conference papers, articles, and book reviews). According to Lin *et al.* (2020), most academic research in green marketing has focused on the environmental implications of e-commerce over the last several years. The Green Revolution has been a global movement for several years. E-commerce is part of the revolution. Some researchers suggest that e-commerce is more environment-friendly than traditional retail sales, whereas others support the opposite. Literature on e-commerce environmental sustainability proposes a holistic perspective aimed at contemplating environmental sustainability under the impact of e-commerce. In the future, companies should consider trade-offs in various dimensions to achieve e-commerce sustainability, thus facilitating the discovery of maximum benefits from integrating environmental aspects in e-commerce. In 2016, 194 parties (193 states and the European Union) around the world signed the Paris Agreement, which aims to reduce global warming and CO_2 emissions.

Keywords: Environmental Sustainability, E-Packaging, Sustainable Delivery, Sustainable E-Commerce.

Published Online: May 01, 2023

ISSN: 2736-660X

DOI: 10.24018/ejdevelop.2023.3.3.252

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I. Introduction

Through e-commerce, today, businesses are able to reach every home, and goods and services can be advertised, bought, and paid for without human involvement (Lin *et al.*, 2020). As content can be changed almost instantly, sites can be managed to stay current with the newest products and services to match consumer expectations. In contrast, environmental concerns must be considered by e-commerce enterprises, which is now much more crucial given the tremendous expansion of these businesses.

As society has become more environmentally conscious, businesses have begun to change their behavior to address these new societal concerns. Modern e-commerce businesses are trying to fulfill their environmental responsibilities through pollution reduction, sustainable delivery, product packaging, customer consciousness, and product recycling. The main goal of the Paris Agreement is to reduce carbon emissions by 45% by 2030 and to reach net-zero emissions by 2050; e-commerce is a part of this goal. According to Oláh *et al.* (2018), to preserve the environment and maintain economic viability, green marketing denotes an organization's attempts to summarize, push, evaluate, and communicate items that do not damage the environment. Companies should keep in mind that this is even more important now because of the widespread use of e-commerce businesses and that complete development in management is liable to find, forestall, and sustain the requirements of the consumers, businesses, and society, both commercially and environmentally.

The key aspects of environmentally friendly e-commerce are:

- Lessening the requirement for distribution centers to store items close to retail locations, which saves energy in warehouses.

European Journal of Development Studies
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- The promotion process should have an open and long-term perspective, highlighting environmental sustainability, and social acceptability.
- New complete and mutually dependent viewpoint of the correlation between the market, culture, environment, and economy.
- For zero-emission fleets, the impact of electronic vehicles' impact on last-mile delivery is known.
- Create an environmental sentiment and highlight recycling and paper for packaging for environmental sustainability.
- Create awareness among in consumers about local delivery from local e-retail shops to minimize carbon emissions.

To explore the current environmental dynamics of e-commerce businesses, this study provides a comprehensive state-of-the-art review of environmental e-commerce sustainability from a holistic contemplation perspective so as to obtain lessons and insights from various practices to guide future implementations. This study also aims to bridge the gap by highlighting previously proposed solutions and minimizing adverse environmental impacts by comparing user preferences.

II. Literature Overview

A. Green Last-Mile Logistics

Green innovation has been perceived as a significant factor for financial development and natural assistance (Ranjan & Jha, 2019), and e-commerce functions as a tool, from the perspective of service, which considers the desires of customers, management, and businesses to reduce service costs while simultaneously boosting service delivery speed and product quality. Green last-mile delivery is the process of integrating sustainable environmental methods into product delivery for buyers. This can include a variety of steps, including reducing carbon dioxide emissions from delivery vehicles and making delivery routes more efficient. According to the WEF (2020), the use of electric vehicle (EV) delivery by electric vehicles in cities, delivery at night or before or after working hours, and value-brand parcel lockers could reduce CO_2 emissions by 30%, traffic congestion by 30%, and delivery costs by 25% by 2030. IKEA Group aims to convert its online delivery services into 100% electronic or zero-emission options in all 30 markets worldwide by 2025, and the report of IEA (2021) also shows that there were 10 million electric vehicles on the world's roads by the end of 2020, which is a 41% increase in electric vehicle registrations, and that electric vehicles saved more than 50 Mt CO_2-eq of greenhouse gas emissions globally. In most cases, the use of light EVs, drones, UAVs, and cargo bikes constitute a solution that can reduce fossil-fuel requirements.

The most understandable benefit of green last-mile delivery is the reduction in excess fabrication and utilization. According to Sievering (2020), delivery by parcel services to the customer's home could be made more climate-friendly by pooling the consignments, in comparison to the situation in which each customer drives into town individually by car to a stationary retailer. The report showed that in e-commerce, compact storage per product unit has a substantial impact on energy consumption, even when returns are considered.

TABLE I: Last-Mile CO_2 Emission (with & without return)

Purchase Behaviour	CO_2 Emission
Online orders without a return	660 g CO_2
Online order with the return	1030 g CO_2
Purchase from the local dealer by bicycle	1270 g CO_2
Purchase from the local dealer: by public transport	1710 g CO_2
Purchase from the local dealer by car	3270 g CO_2

Challenged by the growing sizes of goods moving inside municipalities, the stakeholders of urban logistics have come together to combat the inefficiencies and negative effects of urban freight through various means, including stakeholder collaboration and consultation, piloting new operating models and technologies, and exploring various forms of regulation on traffic and parking.

According to Boysen *et al.* (2020), a process chain is initiated, that consists of one or multiple transport and storage process steps moving the shipments closer to the customer, until the handover of a parcel to its dedicated customer is processed. The logistics concept indicates the method by which goods are moved and stored when using the last-mile solution, which specifies the means of transportation used in combination with a solution such as an electric vehicle (EV) or cargo bicycle. The handover method states whether the delivery of goods is done through human interaction (handed by courier to the recipient) or as self-service, such as picking up a parcel from a parcel point. Table II shows a sustainable, green, and last-mile alternative delivery service.

TABLE II: GREEN LAST-MILE DELIVERY

Storage	Transportation	Handover
Consolidation center	Truck, E-truck, E-Van	Direct Delivery (at home)
City Hub	Truck, E-truck, E-van, Cargo Bikee	Direct Delivery (at home), Self-service at home
Parcel Locker	Van, E-Van, Cargo Bike	Self-service at home

Lockers or pickup points for parcels are self-service, unattended distribution machines that allow sending and receiving parcels or packs, which are usually related to e-commerce. These systems are usually located in easy-to-reach public spaces or within stores, and customers access their deliveries by identifying themselves with a unique pin code that is input into a keypad attached to the pickup point. City hubs allow last-mile deliveries, where the centers act as a point of transfer between transport modes. Hubs are feasible in closely located areas where there is sufficient demand for small package deliveries to achieve cost-effective operations using more environmentally friendly delivery vehicles, such as electric vans or cargo bicycles, to deliver directly to the customer or to parcel lockers (Bayliss *et al.*, 2022).

B. Green Packaging

With the rapid development of e-commerce and continued expansion of online shopping worldwide, the packaging of products has several levels and many different types of logistics containers such as different materials and structures typical of trays, containers, container bags, corrugated boxes, cans, buckets, and other utensils. Both loaded and logistics packages consume a large number of resources and produce large amounts of solid waste. Thus, packaging has a significant impact on the environment. The rapid growth of the fast delivery industry has led to huge waste and pollution concerns caused by overpackaging (Lu *et al.*, 2020). Many enterprises use packaging as part of their marketing strategy and invest in packaging features to enhance consumer experience (Escursell *et al.*, 2021). Overpackaging not only hinders environmental sustainability but also affects supply chain costs (Meherishi *et al.*, 2019). Overpackaging results in increased energy consumption and carbon dioxide emissions (Fan *et al.*, 2017). To protect products from damage during the distribution process and avoid negative feedback from consumers, merchants often become guilty of overpackaging (Wang *et al.*, 2016) Sometimes merchants make it easier for transport, storage, loading, and unloading, sometimes requiring secondary packaging or even packaging several times. Due to the use of degradation-resistant materials, overpackaging can endanger the health of users, pollute land, and threaten the lives of marine animals. However, an increase in the product supply chain and protective materials can increase supply chain costs.

Because of global warming, humanity has become more conscious of environmental change and its harmful impacts on the globe and the environment, and every person has been charged with the responsibility of trying to reduce their carbon footprint in every way possible. Packages should be made from as little material as possible to reduce material and energy use, solid waste production, and CO_2 emissions (Escursell *et al.*, 2021). The impact of environmental change has become more noticeable with increased flooding, excessive heat waves, endangered ecosystems, and the rapid disappearance rate of species from the environment.

With increasing awareness of the environment/ climate change and its effects, people are becoming more practical about their consumption choices. According to Petruzzi (2022), the global green packaging market between 2016-2021 increased by 6.5%, 9.96%, and 15.5% for recyclable, reusable, and degradable packaging, respectively (under CAGR). According to VanHurley's survey in Statista (Paper packaging in Europe, 2018), 70% of the respondents indicated anti-plastic packaging, and 72% of shoppers preferred products with environmentally friendly packaging.

New production processes such as additive manufacturing and 3D printing may help optimize package volume and shape, thereby facilitating more sustainable production through, reduced CO_2 emissions. The currently available technology can be useful for rethinking the entire e-commerce packaging paradigm, which has changed little over the past few decades (Escursell *et al.*, 2021). Previous studies have highlighted the necessity of developing packaging solutions based on complementary materials to ensure that energy is used economically, and waste is reduced. Overpackaging continues to cause overuse of resources and energy, thus impacting the production and transportation process (Lu *et al.*, 2020).

Customer satisfaction is the ultimate goal of e-commerce businesses, and customers will shop online again if they are awarded premium packaging. For example, Amazon began offering incentives to vendors that converted their packaging to Frustration-Free Packaging (FFP) and encouraging more vendors to adopt these best-in-class standards. By the end of 2021, more than two million products will qualify under Amazon's FFP programs. According to Petruzzi (2022), in 2019, statistics show that the global market value of green packaging amounted to 178.60 billion U.S. dollars and is forecasted to reach 246.30 billion U.S. dollars by 2025.

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III. Challenges and Future Directions

A. Challenges

In the 21st century, the connection between e-commerce operations and consumer reliability has become stronger. Thus, there are many challenges to environmental sustainability in e-commerce, and the market structure has changed significantly due to population growth and the widespread use of the Internet. E-commerce also influences consumer habits and behavior. Urban environments, such as the number of vehicles, noise and air pollution, artificial intelligence, excess packaging, price, reliability, and efficiency of freight transport, impact residents' health and quality of life, and could potentially create a sustainable environment.

According to Coppola (2022), the maximum greenhouse gas emissions increased from logistics, transportation, and packaging (85% of total GHG emissions in 2020). A large proportion of plastic packaging bags are made from polypropylene (PP), used extensively to make plastic packaging. However, polypropylene (PP) is not easy to recycle compared to polyethylene (PE), which has exacerbated the adverse environmental impact of non-biodegradable materials in landfills and water sources (Moyo, 2021). However, LimeLoop used data from USPS, FedEx, and UPS to estimate that approximately 165 billion packages are shipped in the U.S. each year, and then roughly calculated that the cardboard used would equate to more than one billion trees, as online shopping continues to grow (Peters, 2018).

Recently EVs have gained popularity owing to their ability to reduce greenhouse gas (GHG) emissions. However, the driving range and battery are the major concerns of customers regarding EVs. According to Deng *et al.* (2020), most EVs take hours to fully charge, which becomes inconvenient when driving long distances. The manufacturing cost of the battery is required to reduce the overall cost of the battery system. In addition, is also, consumers spent $120 billion on EVs purchases in 2020, a 50% increase from 2019; however, government initiatives in total spending on EVs have been on a downslide, from roughly 20% in 2015 to 10% in 2020 (IEA 2021). By industry & market research (Statista, June 2022) to hinder the adoption of electric vehicles, such as - lack of infrastructure (such as charging stations), high upfront costs, lack of consumer knowledge and wrong perceptions, pressure from oil companies and the car manufacturer lobby, and the potential long-term effects of the COVID-19 pandemic. However, the previous research indicates the negative impact on the environment brought by transporting the ordered goods, which increases environmental emissions and congestion, and companies use unrecyclable packaging during deliveries, which increases environmental hazards (Cano *et al.*, 2022).

B. Future Direction

Researchers have analyzed the factors that define the purchase decisions for green-packaged products. For example, some authors consider that purchasing choice is closely related to the origin of the products, price, delivery, and packaging typology, while others conclude that the customer's willingness to buy sustainable products can differ according to the packaging format (Wandosell *et al.*, 2021). According to Bladelius *et al.* (2021), e-commerce requires less energy and also emits less CO2 making it more environmentally friendly with 30% less energy consumption and emission compared to the traditional method of retailing. The difference can be attributed to the last mile, consumer transport, and packaging.

Technologies such as autonomous vehicles (AGV) and drones, improve last-mile operations and accelerate the benefits of sustainable urban freight transport (Kelly, 2017). Design decisions can improve the global environment and protect ecosystems. All these technologies are available to reduce packaging waste, including recycling, reuse, innovative polymers, and zero-waste initiatives.

Amazon co-founded 'The Climate Pledge', pledging that they will achieve total zero CO_2 emissions across their businesses by 2040. This challenging commitment demonstrates a commitment to improving the world's climate. In addition, Amazon's commitment to improving the global climate is divided into six parts: Renewable Energy, Shipment Zero, Net-Zero Carbon, Electric Delivery Vehicles, Right Now Climate Fund, and Climate Pledge Fund 27(Amazon Sustainability Report 2021).

Table III shows that the relationship between global emissions associated with international shipping is expected to reach 709 million metric tons of CO_2 emissions by 2025 if the current use of fuels continues. However, using a sustainable method of fuel, such as ammonia, hydrogen, and shipping, can significantly affect the data used, which means that it may be deficient in the coming decades. If the trend of sustainability is used by 2070, emissions from the international shipping sector can generally decrease to 120 million metric tons (Tiseo, 2021).

TABLE III: Global International Shipping for CO_2 from 2019-2070

Year	2019	2020	2025	2030	2040	2050	2060	2070
Worldwide emissions in Metric tons for CO_2	710	648	709	658	469	324	197	120

Properly packaged goods have a better chance of arriving intact, reducing the number of returns and the overall environmental footprint (Oláh *et al.*, 2018). DHL will train and certify 80% of its employees as Go Green specialists by 2025, actively involve them in its environmental and climate protection activities and announce that it will reduce all logistics-related emissions to zero by the year 2050 29(DHL). According to the OECD (2023), the annual export weight of plastic scrap and waste fell by 50% over the past 4 years, from around 12.4 Mt/year in 2017 to 6.2 Mt/year in 2021. Preliminary data indicated a continuing trend.

The Swiss company Climework's announced that the carbon removal plant in Hellisheidi, Iceland was the first to successfully carbon dioxide from the atmosphere, put it underground to be permanently locked away, and deliver permanent carbon removal to a paying customer. The second construction of a commercial plant in Iceland will capture and store 36,000 MT of CO_2 per year (Clifford, 2023). According to the IEA tracking report of September 2022, the carbon capture, utilization, and storage (CCUS) suite of technologies involve the capture of CO_2 from large point sources, such as power generation or industrial facilities that use fossil fuels, biomass, or directly capture CO_2 from the atmosphere. Currently, approximately 35 commercial capture facilities in operation globally capture almost 45 Mt of CO_2 p.a. (IEA 2022). Local authorities and governments also attempt to address such challenges through policies, such as pricing initiatives, licensing and regulation, and parking and unloading incentives (Rai *et al.*, 2017).

IV. Conclusion

Based on the discussion above, sustainable green e-commerce is an emerging area of interest for scholars, researchers, and practitioners worldwide. This study presents a holistic analysis of the importance of green packaging and green last-mile logistics from an environmental perspective. Moreover, packaging made from sustainable materials (reusable materials) and sustainable last-mile delivery further reduces the environmental impact, carbon emissions, and waste, while demonstrating to customers that the company uses ethical and thoughtful practices.

Fig. 1. Environmental Sustainability through E-commerce.

This article highlights new materials that are appropriate from an environmental point of view, while striving to sustain the market, and influences the development of environmental sustainability through e-commerce (Fig. 1).

Acknowledgment

I am appreciative of my supervisor Professor Dr. Anssi Öörni's invaluable support and advice. I also want to express my gratitude to the Indian government (Ministry of Social Justice) for funding my research.

It is also that without the support of my parents and family, it is not possible for me.

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