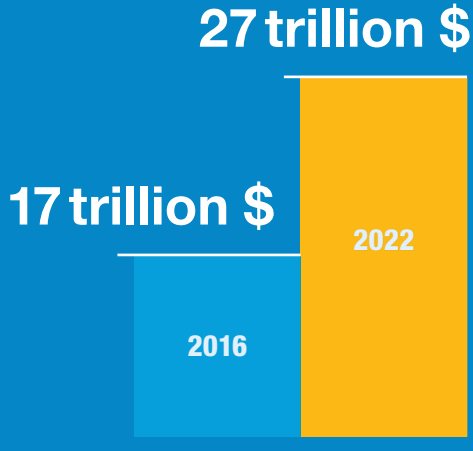
Chapter V

E-commerce and environmental sustainability

While the preceding chapters focused on the three phases of the life cycle of digitalization, this chapter discusses a specific application of digital technologies, namely e-commerce.

Attention is turned to the indirect implications of digitalization on the environment, which can be both positive and negative. As stressed in chapter I, assessing these indirect effects is even more challenging than measuring the direct environmental footprint of digitalization.

This chapter has a particular focus on business-to-consumer (B2C) e-commerce, and explores how it can be as sustainable as possible.



E-commerce sales
by businesses in 43 developed and developing economies surged between 2016–2022

Based on info in figure V.2

A. Introduction

Digitalization has had a major impact on domestic and international commerce. Boosted by the COVID-19 pandemic, more people and businesses are going online to look for the goods and services they wish to purchase (UNCTAD, 2021e, 2022c).

"E-commerce" refers to all transactions in which goods or services are ordered over a computer network (e.g. over the Internet) (UNCTAD, 2021f). Any economic entity, whether a business, household, government unit or non-profit institution, can engage in e-commerce as a buyer or seller. E-commerce transactions often cross international borders, with the seller being in a different economic territory from the buyer. Business-to-business (B2B) e-commerce plays an important role in global value chains and often involves electronic data interchange and online versions of traditional transactions for goods, which are then sold to consumers through retail outlets. B2C e-commerce involves sales by "pure play" e-commerce enterprises that only sell through their single online presence (such as Alibaba or eBay) to consumers, as well as sales by traditional bricks-and-mortar firms that operate through an additional online sales channel. Consumer-to-consumer (C2C) e-commerce refers to buying and selling transactions between individual consumers and households (UNCTAD, 2015, 2023g).

The shift to e-commerce brings both opportunities and challenges. It can transform economic processes, trade and consumption patterns and open up new trade and business opportunities for entrepreneurs and small businesses that would otherwise have a limited geographic footprint. E-commerce can improve export opportunities and offer better access to suppliers abroad. Consumers also stand to benefit from access to greater choice, convenience and lower prices. At the same time, various factors – including obstacles relating to ICT infrastructure and services, trade logistics, payment solutions and legal frameworks – pose critical challenges to engaging in and benefiting from e-commerce, especially in low-income countries (UNCTAD, 2021e, 2021g). For countries with low levels of readiness, the growth of international e-commerce may expose local firms to increased import competition and thereby impact on employment and growth prospects.

E-commerce has potential implications for environmental sustainability that are both positive and negative. For example, under certain conditions, buying a product online can be more energy efficient than driving to a physical store to purchase the same product and can lead to reduced GHG emissions. Today, some physical products can be obtained in digital formats, such as films and music that can now be streamed, thereby enabling dematerialization. On the other hand, online marketing and enhanced convenience for consumers, together with lower prices, can boost consumption, which may lead to more production and different methods of land use, as well as increased transportation and waste – both domestically and across borders. High return rates of online purchases can lead to returned goods being thrown away; this also represents an inefficient use of energy and materials and adds to waste generation. Environmental impacts differ for e-commerce relating to goods and services. In both cases, however, e-commerce increases the demand for and use of various digital devices, transmission and data centre services,[1] contributing to the direct environmental effects discussed in previous chapters.

E-commerce has potential implications for environmental sustainability that are both positive and negative

[1] For example, according to China Communications Services (2023), a State-owned enterprise, e-commerce accounts for a considerable portion of the energy consumption and carbon footprint of data centres in China.

The primary emphasis of this chapter is on the indirect effect of digitalization through the environmental impact of e-commerce related to goods, specifically for those that are physically delivered to buyers. This environmental impact is linked to increased CO_2 emissions and energy usage across the logistics supply chain – from retailer warehouses and distribution centres, to transport, product packaging, returns and consumer behaviour.

While this chapter extensively delves into the environmental implications of B2C e-commerce (which have also been more widely studied), occasional references are made to B2B and C2C transactions. Section B presents recent trends in e-commerce. Section C provides a comparative review of the environmental impact of B2C e-commerce with that of traditional bricks-and-mortar retail. Section D turns to measures that have been taken, and could be further leveraged, to reduce negative environmental impacts and build more sustainable and inclusive e-commerce. Section E discusses the potential for e-commerce business models to help enable circular and sharing economies. The final section provides specific recommendations to relevant stakeholders on how to make B2C e-commerce more environmentally sustainable.

B. E-commerce trends, opportunities and risks

The proliferation of the Internet has rapidly and fundamentally transformed business and trade practices. In 1991, the Internet had less than 3 million users around the world and e-commerce was non-existent. By 1999, an estimated 250 million users were accessing the Internet and about one quarter of them made purchases online from e-commerce sites, worth an estimated $110 billion (OECD, 2000). Just over two decades later, the number of people shopping online has surged.

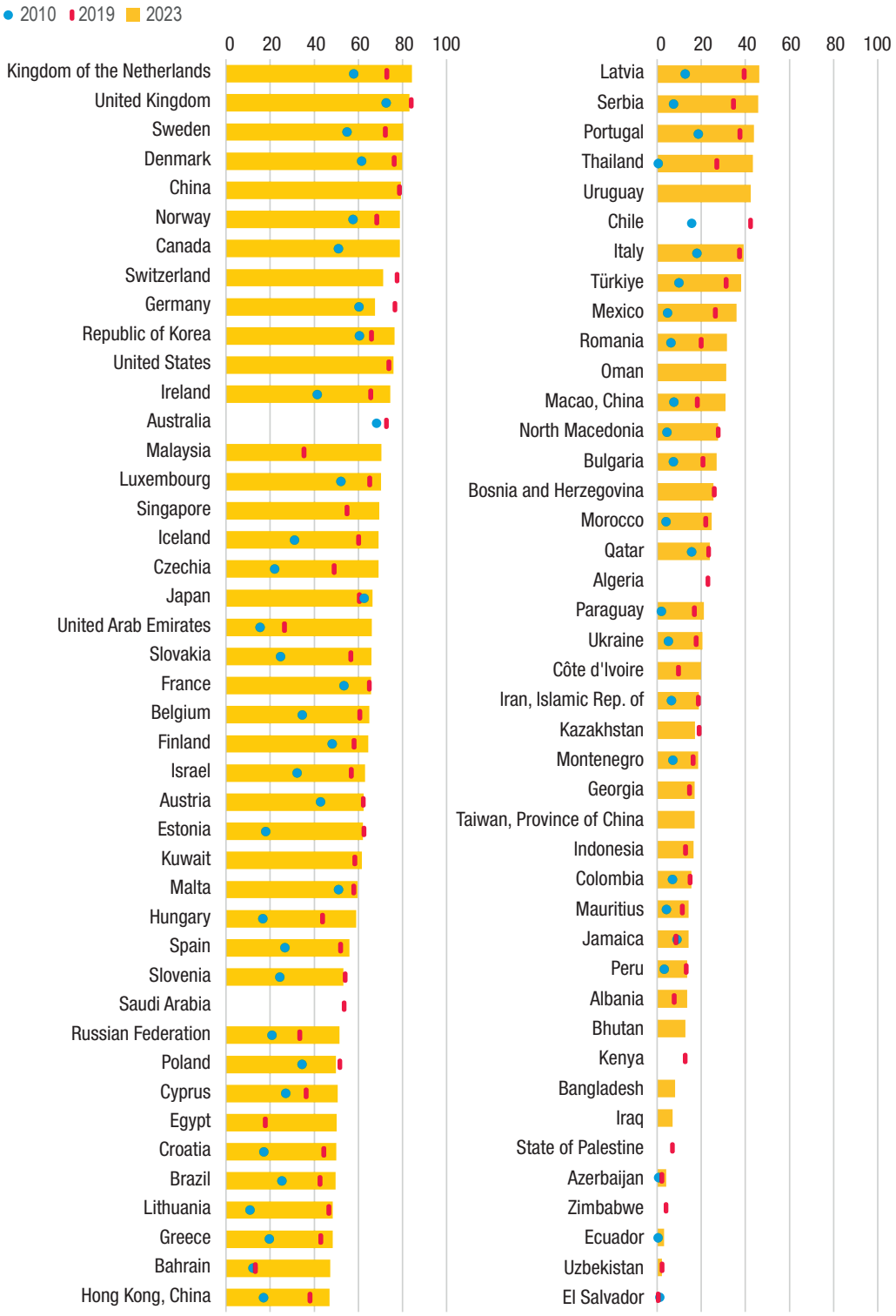
According to the Global Findex Database (World Bank, 2021), an estimated 2.3 billion people shopped online in 2021. Since 2010, e-commerce has greatly increased in many countries, further boosted by the COVID-19 pandemic (figure V.1). At the same time, the extent to which people engage in e-commerce still varies considerably. In countries reporting the highest uptake, more than 80 per cent of the population shop online; in most LDCs, that share remains below 10 per cent.

UNCTAD estimates that the value of e-commerce sales by businesses in 43 developed and developing economies, representing three quarters of global GDP, was close to $27 trillion in 2022, up from around $17 trillion in 2016 (figure V.2). For example, in China, sales almost tripled from $1.6 trillion in 2016 to $4.5 trillion in 2022 and in the United States, e-commerce sales by businesses increased from $7 trillion in 2016 to an estimated $11 trillion in 2022.

E-commerce sales by businesses in developed economies far exceed those in developing economies. Furthermore, while the latter account for around 40 per cent of global GDP, their share of business e-commerce sales is at most 25 per cent, suggesting significant growth potential. It is further estimated that in 2022, cross-border e-commerce (digitally-ordered exports) was worth around $3 trillion, though based on very limited data. This value corresponds to businesses in economies that collectively account for approximately three quarters of global GDP and exports (figure V.3).

Consumers can engage in e-commerce through a range of online channels. Sellers may use their own dedicated

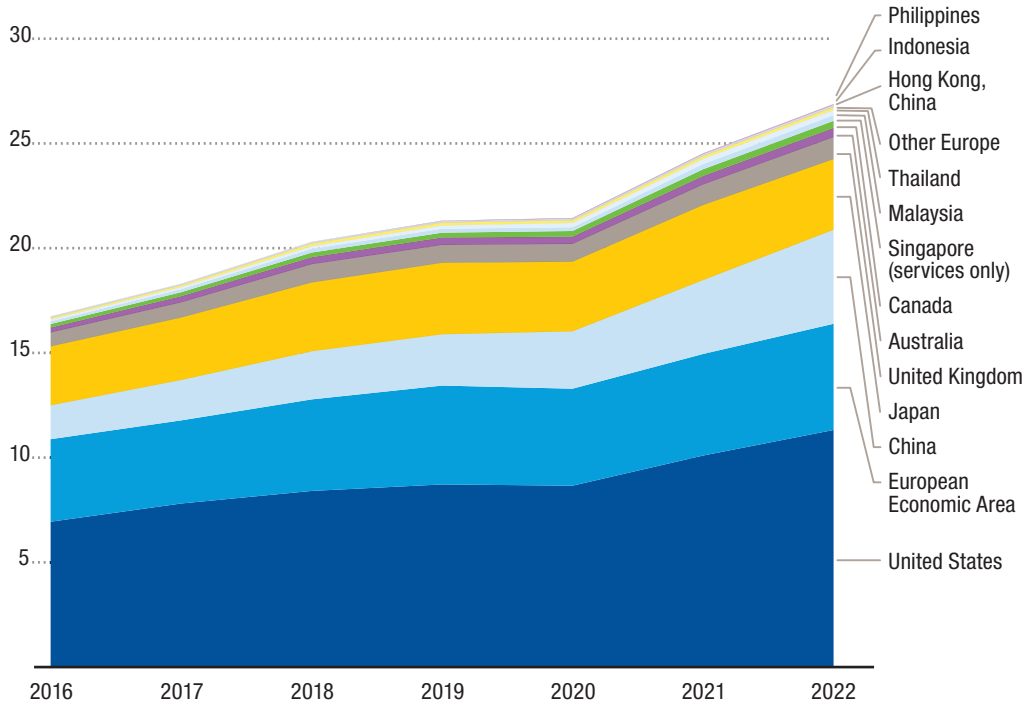
Figure V.1
Share of Internet users making online purchases, selected economies and years
(Percentage)



Source: UNCTAD (2024).

Notes: The statistics reflect online shopping reported by individuals during the three months prior to the survey, although recall periods of up to 12 months apply for some economies.

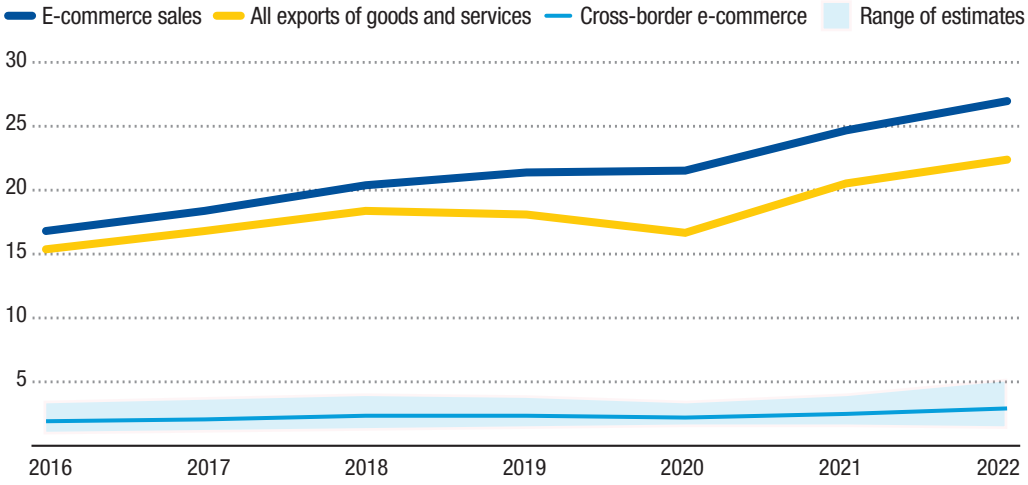
Figure V.2
E-commerce sales by businesses, selected economies and country groupings, 2016–2022
(Trillions of dollars in current prices)



Source: UNCTAD (2024), based on national sources.

Notes: 2022 data are estimates. Economies included account for three quarters of global GDP. See source for more information on economies included and methodology. "European Economic Area" consists of the 27 European Union countries plus Iceland, Liechtenstein and Norway. "Other Europe" includes Bosnia and Herzegovina and Serbia.

Figure V.3
E-commerce sales, exports and cross-border e-commerce sales, selected economies, 2016–2022
(Trillions of dollars in current prices)



Source: UNCTAD (2024), based on national sources.

Notes: 2022 data are estimates. See source for more information on economies included and methodology.

e-commerce websites and third-party online marketplaces (such as Alibaba, Amazon, eBay and Jumia), as well as various social media platforms. Rather than relying on going to a traditional bricks-and-mortar store or placing an order online from home, many retail companies offer combinations of the two, for instance, ordering online and using a drive-in option for food supplies. In some countries, this type of "omnichannel" commerce has become increasingly important to meet consumer demand.[2]

Online platforms have emerged as key players in the e-commerce landscape (UNCTAD, 2019a). They act as market makers, facilitating transactions between multiple buyers and sellers who communicate through the platform. In some cases, the platform owner (e.g. Amazon) also sells its own branded products (e.g. Amazon Basics) on the same marketplace. Some platforms provide ancillary products such as payment, logistics and financial services (e.g. loans).

During the pandemic, the value of transactions through the largest online platforms sharply increased, from around $2.6 trillion in 2019 to $4 trillion in 2021 (figure V.4). Growth continued in 2022 but at a slower pace. The landscape is dominated by a small number of well-known platforms that facilitate vast amounts of transactions; just six platforms facilitate about 80 per cent of the gross merchandise value, as shown in figure V.4. While this market concentration raises questions about potential abuse of market power and other competition issues, it is crucial that these companies act as leaders when it comes to taking action to make e-commerce environmentally sustainable.

There is significant room for improving the capabilities of many developing countries to deal with opportunities and challenges related to e-commerce. Many Governments, including with support from UNCTAD and members of the "eTrade for all" initiative, are fostering enabling environments to better harness e-commerce for development and to assist businesses of all sizes to tap into national and international markets and supply chains, reduce trade costs, drive efficiency through competition and contribute to economic growth and social well-being (UNCTAD, 2018, 2022d).

E-commerce can also offer women opportunities for flexible entrepreneurship and the possibility to earn additional income (International Finance Corporation, 2021a).[3] Online platforms provide new ways of overcoming traditional gendered barriers to trade, such as lack of access to trade finance, trade costs associated with physical distance and entry into male-dominated sectors and distribution networks. Closing gender gaps in sales performance on e-commerce platforms between 2025 and 2030 could yield an additional $280 billion in platform revenues in South-East Asia, while in Africa, additional gains of $14.6 billion have been foreseen (International Finance Corporation, 2021a, 2021b).

Nevertheless, opportunities for development gains from e-commerce must be viewed against a backdrop of highly uneven levels of digital readiness (see chapter I). Future trajectories and the ability of developing countries and LDCs to unlock the potential of e-commerce for all depends on policy actions that address the root causes of the digital divide (box V.1). These policy actions can strengthen the capabilities of domestic enterprises to cope with digital disruption and competition from abroad.

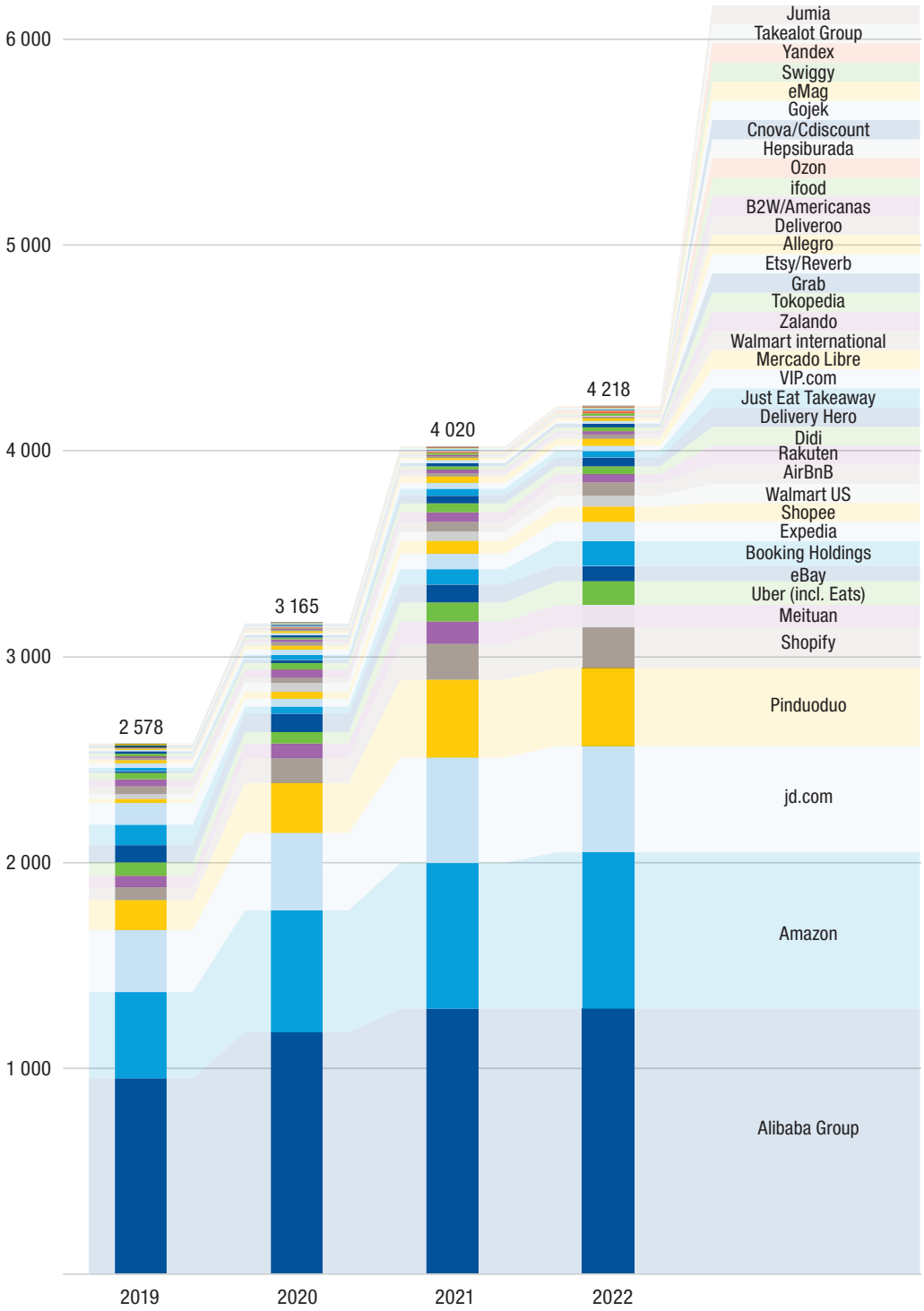
In addition, there is a knock-on effect of these opportunities, namely the implication for the environment. The impact varies depending on the type of e-commerce. B2B

It is crucial that the **dominant platforms** take the lead in making **e-commerce environmentally sustainable**

[2] See, for example, https://www.economist.com/special-report/2021/03/11/the-importance-of-omnichannel-strategies.

[3] On Jumia's e-commerce platforms in Africa, over one third of businesses in Côte d'Ivoire and over half in Kenya and Nigeria are owned by women, while in South-East Asia, women own about one third of businesses in Indonesia and two thirds of business in the Philippines on the Lazada platform (International Finance Corporation, 2021b).

Figure V.4
Gross merchandise value reported by selected companies operating online platforms, 2019–2022
(Billions of dollars)



Source: UNCTAD (2024), based on company reports.

Notes: For Alibaba, B2B/Americanas, Meituan and Pinduoduo figures for 2022 are not available. Their 2021 figures are used to calculate the total; the actual total for 2022 could be higher or lower. Gross merchandise value gives the total sales value for goods and services sold through a given platform. Companies vary in what they include or exclude from the value they report.

Box V.1
Progress in e-commerce in least developed countries and possible policy actions

Between 2017 and 2021, e-commerce use in LDCs rose by 140 per cent. However, this still represents only 5.8 per cent of individuals making online purchases, compared to 62 per cent in developed countries.[a] Consequently, there is important scope for e-commerce to expand. Since 2017, UNCTAD has undertaken eTrade readiness assessments in 36 countries, including in 25 LDCs, identifying critical gaps that limit countries from harnessing e-commerce for economic development. Importantly, the majority of LDCs lack comprehensive e-commerce policies and ways to integrate e-commerce into national development plans.[b]

Furthermore, e-commerce readiness in LDCs is hampered due to inadequate ICT infrastructure, as only about one third of the population is online. Digital divides persist, both between urban and rural areas and across genders. Moreover, the quality of Internet services lags, with low bandwidth and high costs (monthly costs in LDCs range from 1 to 24 per cent of GNI per capita),[c] which also hinders e-commerce adoption.

Limited progress in logistics, such as underdeveloped addressing systems and scarce delivery facilities, leads to costly e-commerce operations. What is more, cross-border e-commerce in LDCs is marginal due to high costs and logistical challenges. Furthermore, trade facilitation reforms are progressing slowly, causing LDCs to fall behind developed countries in implementing digital and sustainable trade practices,[d] hampering their participation in global trade.

Legal and regulatory frameworks in LDCs for e-commerce need further development, affecting trust in digital transactions. According to the UNCTAD Cyberlaw Tracker 2022, there was some progress in this regard, yet only 70 per cent of LDCs had cybercrime laws, 63 per cent had electronic transactions laws, less than half had privacy and data protection laws, and even fewer had consumer protection laws.[e]

The share of people in developing countries using digital payments grew from 44 per cent to 57 per cent from 2017 to 2021.[f] This is due to more digital payments by public administrations and the widespread use of mobile money and e-wallets. However, a gender payment access gap persists. More efforts are needed to improve and maximize the impact of cross-border payment solutions.

Moreover, digital skills development is hindered by limited access to computers and a focus on mobile and social media use. Only 8 per cent of households own a computer, and while there are moves to embed ICT education from primary levels and support digital entrepreneurship, especially for women, these areas require further enhancement.

More than 40 per cent of MSMEs in developing countries, particularly in the digital sector, face a significant funding shortage, with a collective shortfall of $5 trillion. Traditional banking has not adjusted to the e-commerce business model, making it difficult for start-ups that lack conventional collateral to secure funding. This challenge is even greater for women-owned businesses.[g]

Overall, the pandemic-driven surge in digital activities did not translate into LDCs leveraging the full potential of e-commerce to contribute to the Sustainable Development Goals. Enhanced support is crucial for LDCs to strengthen their enabling environment and to bolster their e-commerce readiness.

Policy actions required

- Develop and implement comprehensive e-commerce strategies.
- Invest in affordable and widespread ICT and logistics infrastructure and improve trade facilitation.
- Establish clear legal and regulatory frameworks for e-commerce, including cybercrime, electronic transactions, consumer rights and digital payments.
- Promote digital skills through education reform and support for digital literacy.
- Create financial products suited to the needs of e-commerce enterprises, with an emphasis on inclusion for women entrepreneurs.

Source: UNCTAD.

[a] Based on share of individuals who purchased something online (World Bank, 2021).
[b] UNCTAD (2023a).
[c] ITU (2023).
[d] United Nations (2023).
[e] See https://unctad.org/news/least-developed-countries-still-lag-behind-cyberlaw-reforms.
[f] World Bank (2021).
[g] International Finance Corporation (2017).

The future of e-commerce in developing countries hinges on policies that tackle the root causes of the digital divide

e-transactions typically involve larger orders, which can result in more efficient last-mile delivery and less packaging per item, as goods are packed and transported in bulk. In contrast, B2C and C2C e-commerce often require multiple, smaller deliveries and more packaging and yield higher returns per order. E-commerce may provide opportunities to support a circular and sharing economy by enabling the reuse, reselling and lending of products and services to individuals. The environmental impact is also product specific. For instance, items requiring refrigeration, commonly sold online, have a substantial carbon footprint due to the need for specialized packaging and its disposal.

Impacts also depend on whether e-commerce is domestic or international, and whether it consists of goods that are delivered over traditional transit routes through ports, airports and land border crossings (UNCTAD, 2021g). The impact is potentially higher for international e-commerce, especially where air transport is used, as emissions per flight and item are many times higher than those of domestic e-commerce last-mile delivery (European Commission, 2022a).

Each component of the e-commerce logistics supply chain carries potential environmental risks that can have adverse impacts on biodiversity, food and water security and local livelihoods. Research, data and information that consider such environmental and social impacts are mainly available in developed countries. Yet, in view of the significant growth of e-commerce, a better understanding of its environmental footprint is of growing relevance for countries at all levels of development.

C. Environmental effects of online and offline retail: A comparative analysis

Various factors related to warehousing, transportation, packaging and consumer behaviour affect the environmental footprint of e-commerce

How has the shift from traditional retail sales to e-commerce impacted the environment? To respond to this question, the following section reviews the findings of academic studies that have empirically assessed the environmental sustainability of online and offline retail options, with a special focus on GHG emissions, packaging waste, energy use and consumption patterns based on data mostly from developed countries. Only a few studies have been undertaken in developing countries to date. The section identifies key variables and influencing factors with potentially positive and negative implications for the environment. However, some findings may not necessarily apply to countries with less advanced digital environments. The results are of general relevance for enhancing understanding of how the shift to online retail may affect the environment.

1. Factors impacting the environmental sustainability

Different parameters and influencing factors related to warehousing, transportation, packaging and consumer behaviour all affect the environmental footprint of both retail channels (Buldeo Rai, 2021; Pålsson et al., 2017; van Loon et al., 2015; Weideli, 2013). Studies reviewed in this chapter cover different timespans, countries and sectors, while no standardized approach is applied. Some assessments rely on econometric models and simulations that use a range of parameters and variables, while others are

based on case studies. The most commonly used indicator of environmental impact is related to the carbon footprint. Other environmental impact indicators include energy efficiency per unit fulfilled, calculated on the basis of energy consumption per unit, as well as water use, land use and road traffic arising from e-commerce (Collini et al., 2023). Unsurprisingly, findings of different studies are often not consistent. In short, the jury is still out when it comes to determining what is more desirable – online or offline retail – from an environmental perspective.

As the two sales channels (online and offline) do not differ in their environmental footprint of production, use, repair and disposal of the goods sold, most studies tend to exclude these factors (Collini et al., 2023; van Loon et al., 2015).[4] This comparative analysis is structured along the key stages of the fulfilment process, initiated by the sale of a product which triggers the movement of the good from the retailer warehouse to the final consumer. The focus is on stock replenishment, order picking and assembly, delivery and post-sale activities as well as on specific components that influence the environmental impact of online and offline fulfilment processes (Mangiaracina et al., 2016; Siragusa and Tumino, 2022). Both the size and the nature of environmental impacts vary by phase and are influenced by other factors, such as consumer behaviour. Figure V.5 presents the different stages and components that influence the environmental footprint of online and offline fulfilment processes.

a. Warehousing and distribution centres

Online and in-store retail both rely on warehouses and distribution centres for stock replenishment. These centres are essential for ensuring that products are available for purchase and can be delivered to customers in a timely and cost-effective manner. For online retail, stock replenishment consists of transferring goods from a central warehouse (upstream) to a dedicated warehouse to fulfil online orders (downstream). In the case of bricks-and-mortar retail, stock replenishment orders are managed in a central warehouse and subsequently transported to various retail outlets (Siragusa and Tumino, 2022).

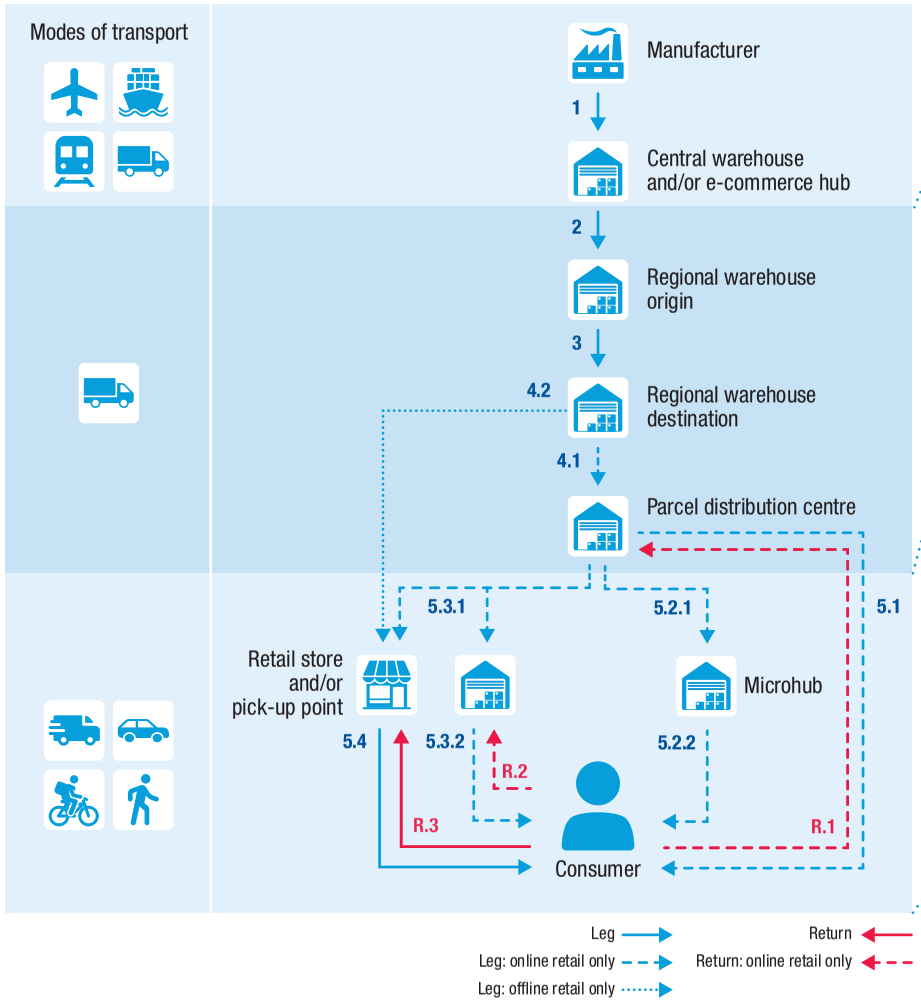
The order picking, assembly and packing phase is specific to online purchases and takes place in a dedicated warehouse (Mangiaracina et al., 2016; Siragusa and Tumino, 2022). In the case of traditional retail, it is performed by the customer at the store. Important aspects of the environmental footprint in this phase include packaging, land use, energy consumption and CO_2 emissions. While "pure-play" e-commerce companies just require a warehouse to store their products, e-commerce omnichannel operations can require three times the warehouse space compared to traditional retail (Prologis, 2016). Bricks-and-mortar stores also need physical space for consumers to browse and make purchases and, in many cases, park their vehicles (Collini et al., 2023). Greater physical space implies increased energy use for lighting, heating and cooling systems. It could also entail occupying more land, which might otherwise have been kept as green space.

A study of eight European countries found that e-commerce warehouses occupy less than 0.3 per cent of artificialized land (natural land that has been converted into artificial land surfaces, ranging from urban green spaces to industrial zones) and that, when factoring in logistics, selling and parking space, overall land use was considerably higher for physical retail. At the same time, e-commerce warehousing experiences higher CO_2

> The jury is still out if online or offline retail is more desirable from an environmental perspective

[4] This is justified by the fact that products sold are the same between retail channels and therefore should not be included as a basis for comparison. There is limited information on how much of the energy consumption in the production and use of products that may be attributable to e-commerce. Moreover, it is difficult to arrive at an accurate assessment of CO_2 emissions specifically associated with search engines used for online shopping (van Loon et al., 2015).

Figure V.5
Offline and online retail: An illustrative journey



Leg	From	To
Pre-carriage	1 Manufacturer	Central warehouse and/or e-commerce hub
Main-carriage	2 Central warehouse and/or e-commerce hub	Regional warehouse origin
	3 Regional warehouse origin	Regional warehouse destination
	4.1 Regional warehouse destination	Parcel distribution centre
	4.2 Regional warehouse destination	Retail store and/or pick-up point
Post-carriage	5.1 Parcel distribution centre	Home delivery, consumer (last-mile)
	5.2.1 Parcel distribution centre	Microhub (splitting last-mile)
	5.2.2 Microhub	Home delivery, consumer (last-mile)
	5.3.1 Parcel distribution centre	Pick-up point/click and collect in retail store (splitting last-mile)
	5.3.2 Pick-up point	Consumer
	5.4 Retail store	Consumer
	R.1 Consumer	Parcel distribution centre
	R.2 Consumer	Pick-up point
	R.3 Consumer	Retail store/click and collect

Source: UNCTAD, based on European Commission (2022a).

Note: Bypassing certain legs is always possible.

emissions due to the expansion of logistics centres away from cities and associated fragmentation of last-mile deliveries (Oliver Wyman, 2021).[5] Moreover, order picking and assembly activities for e-commerce warehousing have been found to generate higher CO_2 emissions than traditional retail, as a result of the handling and packing of individual items (Mangiaracina et al., 2016). On the other hand, shared warehouses that stock products for 100 online shops resulted in considerably less energy use than relying on 100 individual storage facilities (Holubar, 2022).

b. Product packaging and waste generation

Packaging is part of the order picking and assembly phase, where items are sorted and placed directly in packaging used for deliveries to limit damages during transport, returns and re-deliveries. It is a particularly important parameter in the context of e-commerce (Siragusa and Tumino, 2022; Buldeo Rai, 2021). E-commerce packaging can be distinguished from traditional retail packaging. For example, books bought online tend to be packed in small, corrugated cardboard boxes for courier shipping, whereas those sold in conventional bookstores tend to use a light paper or plastic bag. An analysis of the quantitative impact of e-commerce on packaging waste in the Republic of Korea found that e-commerce generated 4.8 times more packaging waste than goods sold in bricks-and-mortar stores, with implications for GHG emissions (Kim et al., 2022). In particular, e-commerce significantly contributes to environmental waste and carbon pollutants through the use of cardboard boxes, with the issue being exacerbated when increased packaging and low-grade, hard-to-recycle materials such as printed return forms and sticky labels are used for online returns (Escursell et al., 2020; Zhang et al., 2023).

While packaging is necessary to protect products during transportation, overpackaging in e-commerce can increase energy consumption and carbon emissions (Xie et al., 2021). In the case of book deliveries, again, packaging has been found to consume, on average, five times more energy per book in home delivery systems than in the store supply chains (Pålsson et al., 2017). Similar findings were reached in an older study in Japan (Williams and Tagami, 2003). Additional packaging for e-commerce led to considerably more energy use per book sold in densely populated urban areas. In suburban and rural areas, energy consumption of the two systems was nearly equal, as the relatively high efficiency of courier services compared to personal automobile transport balanced out the negative impact of additional packaging. Regardless of the delivery method, reducing unnecessary layers of packaging, changing box dimensions or removing boxes altogether can reduce carbon emissions by up to 36 per cent (MIT Real Estate Innovation Lab, 2020). This echoes findings for fast-moving goods in the United Kingdom, suggesting that packaging made from corrugated cardboard plus some filling material resulted in 16 times more CO_2e per item compared to the use of shopping bags in van-based home deliveries and consumer shopping trips (van Loon et al., 2015).

Due to data and measurement constraints, the global impact of e-commerce-related packaging on plastic litter found on land and the ocean floor cannot be ascertained. However, it is likely to be significant. For example, in 2020, Indonesia reported over 67 million tons of waste, with plastic waste accounting for approximately 6.8 million tons, and e-commerce sales identified as a major contributor (Florene, 2021). The proliferation of plastic pollution transcends national boundaries and disproportionately impacts the health and rights of vulnerable communities (UNEP, 2023a). Box V.2

[5] Further development concerns relate to community land rights, worker safety, health hazards as well as precarious working conditions (Palmer, 2023; The Guardian, 2023b).

Box V.2
Plastic pollution impacts on human rights and development

Plastic pollution threatens marine resources and the livelihoods of approximately three billion people living in coastal developing countries who rely on the ocean for food and income. More than an estimated 17 million tons of plastic entered the world's oceans in 2021, making up the bulk (85 per cent) of marine litter. Single-use plastic bags pose a particular threat as they account for an estimated 89 per cent of plastic litter found on the ocean floor.[a] Plastic pollution has a negative toll on the ability of countries to create jobs and revenue in sectors that depend on clean ecosystems, such as tourism and fisheries.

When plastics are burned, people are exposed to toxic fumes and particles. As a result, drinking water and the entire food chain can be contaminated. Similarly, when plastics end up in landfills, they leak toxic chemicals into groundwater and the surrounding environment. These negative impacts undermine the right to a clean, healthy and sustainable environment, and several other fundamental human rights. Persons and groups in vulnerable conditions are disproportionately exposed to the impacts of the plastics cycle, depending on factors such as age, gender, ethnicity, education, profession and poverty. In many developing countries, "waste pickers", mainly women and children, bear the brunt of plastic-related toxicity risk due to higher exposure to Bisphenol A (BPA) and phthalates, which affect reproductive capacity, among other health disorders.

Sources: UNCTAD, based on OHCHR (2019); UNCTAD (2023b); UNESCAP and the ASEAN Secretariat (2022); The SeaCleaners (2022).

[a] See https://www.un.org/sustainabledevelopment/wp-content/uploads/2019/07/14_Why-It-Matters-2020.pdf.

sets out a range of implications, both direct and indirect, of plastic pollution for human rights and development.

In terms of packaging and waste generation, studies suggest that e-commerce performance is worse than traditional retail sales

In summary, in terms of packaging and waste generation, available studies suggest that e-commerce performance is worse than traditional retail sales. This applies both to the amount and the kind of packaging used. Excess packaging related to e-commerce deliveries generates more waste than goods sold in bricks-and-mortar stores, with consequent implications for GHG emissions and energy consumption. Cardboard boxes used in e-commerce account for some of the largest carbon pollutants.

c. Transportation and delivery

Several studies have assessed the impact of the transportation of goods associated with online and conventional retail shopping in terms of energy consumption and CO_2 emissions.[6] In the case of e-commerce, the delivery process begins when items are picked up by the courier at the warehouse and ends with delivery at the consumer's home. For traditional retail, the delivery phase consists of the consumer's return trip from the store after the purchase (Mangiaracina et al., 2016). The environmental footprint of e-commerce is significantly influenced by the method used for last-mile delivery and how customers choose to travel to and from physical stores if they are collecting the goods (Edwards and McKinnon, 2009).

Last-mile delivery is the final link in the supply chain from retailer/supplier to the consumer and considered to be the most energy- and carbon-intensive segment (Buldeo Rai, 2021; Edwards and McKinnon, 2009). It may involve delivery fleets of fossil fuel-powered trucks and vans that generate relatively high CO_2 emissions (Perboli and

[6] See, for example, Cullinane (2009); Edwards et al. (2010); Wygonik and Goodchild (2012); Mangiaracina et al. (2015); Pålsson et al. (2017); Shahmohammadi et al. (2020)

Rosano, 2019). The use of alternative vehicles can significantly reduce emissions. In China, the use of electric bicycles instead of vans to deliver books was found to save up to 13 per cent of energy and cut 71 per cent of CO_2 emissions (Zhang and Zhang, 2013). Similarly, electrically assisted cargo bikes and tricycles, which make it possible to cover long distances and carry substantial loads while navigating hills, were identified as the most effective logistics vehicles for urban last-mile delivery in Brazil, China and Germany (de Mello Bandeira et al., 2019; Siegfried and Zhang, 2021).

Emissions increase with distance. The greater the distance travelled by the customer to the store, the higher the emissions, because of fuel consumed during transport (Siragusa and Tumino, 2022). It is generally more environmentally sustainable for consumers to shop online and have their goods delivered to home than to travel to the shops and back by car (Buldeo Rai, 2021; Edwards and McKinnon, 2009). For instance, in one study, CO_2 emissions from personal car-based travel were 24 times greater than those produced by a single "drop" within the average home delivery round (Edwards et al., 2010). Similar findings were made for online grocery shopping in the Helsinki metropolitan area in Finland (Siikavirta et al., 2002).[7] However, when a traditional retail consumer travels by bus instead of car and makes several purchases, emissions per item are lower compared to a home delivery van delivering just one item to an online consumer's home (Edwards et al., 2010).

A study comparing CO_2 emissions from the use of personal vehicles to shared-use vehicles for grocery shopping in Seattle, Washington (United States), concluded that emissions were most reduced when the delivery service served a cluster of customers in close proximity to each other (Wygonik and Goodchild, 2012). In this case, a delivery service reduced CO_2 emissions by 80–90 per cent, compared with 17–75 per cent when customers were randomly assigned to a driver's route. Similarly, while delivery vehicles tend to have higher rates of GHG emissions per mile than private vehicles, they were able to transport more items and use route optimization to travel directly from one destination to another, as opposed to private trips that required unique round trips (Wygonik and Goodchild, 2018; Zimmermann et al., 2020; Klein and Popp, 2022).

The number of items purchased per shopping trip is another important factor, as emissions are allocated based on the number of items transported (Siragusa and Tumino, 2022). For both e-commerce and in-store retail, the higher the number of items in a basket, the lower the CO_2 emissions per item. In the United Kingdom, on average and subject to several qualifications, when a customer purchased fewer than 24 non-food items in one standard car-based trip, home delivery was likely to generate less CO_2 emissions per item purchased (Edwards et al., 2010).

Emissions and energy use from e-commerce may also exceed those generated from in-person shopping if consumers order more online and opt for fast delivery. Demands for the convenience of being able to have products delivered on the same or next day greatly increases the carbon footprint (Roberts et al., 2023). Expedited shipping – same-day, bullet-speed or express deliveries – produces almost 0.75 kg of CO_2e per shopper, more than twice that of regular delivery methods (Mohamed Zein, 2021). This is especially the case if goods need to be shipped by air, which is more energy- and carbon-intensive than transportation by rail or road.[8]

[7] Online grocery shopping was found to produce more environmentally friendly outcomes than when customers visited the store using their own cars, reducing the distance driven by 54–93 per cent and GHG emissions by 18–87 per cent.

[8] In a life cycle assessment in the United States in 2009, e-commerce generally produced more environmentally friendly outcomes than on-site shopping, but when air-only delivery was involved, the probability that in-store shopping would have a lower carbon footprint was about 50 per cent (Weber et al., 2009).

Failed deliveries that occur when no one is at home to receive the goods ordered online generate additional emissions and kilometres, either by delivery companies having to redeliver to another place, by redelivery to the same place at another time or by consumers making trips to collection points (Buldeo Rai et al., 2022). In the United Kingdom, a 25 kilometre round-trip by car to pick up a missed parcel emitted approximately 5.2 kg of CO_2 (or the equivalent of 16 redelivery attempts by a delivery van), while collecting the item by bus incurred about 3.6 kg of CO_2 emissions (equivalent to 11 redelivery attempts) (Edwards and McKinnon, 2009).

In conclusion, last-mile delivery is the most costly and polluting element of online retail, as well as the most energy- and carbon-intensive. E-commerce in most cases implies lower environmental footprints at this stage than traditional retail. The impact greatly depends on the kind of vehicles used for delivery. Failed deliveries result in additional vehicle kilometres and higher emissions, while parcel consolidation in delivery vans as well as route optimization reduces emissions. Emissions and energy use from e-commerce are especially likely to exceed those from in-person shopping if consumers order more online and choose faster delivery options involving air transport.

Emissions from e-commerce are likely to exceed those from in-person shopping if consumers order more online and choose faster delivery options

d. Returns

Returns are part of the post-sale phase. Activities linked to the return of a purchased item have environmental impacts that are affected by the use and choice of return packaging and labelling, reconditioning, storing, order picking, repackaging and new deliveries. Returns in this phase for bricks-and-mortar retail entail the customer's trip to the store, with the intention of returning (Mangiaracina et al., 2016). The growth of e-commerce has been accompanied by a rise in product returns, the rates of which tend to be much higher for online shopping than for in-store purchases (Roberts et al., 2023). In the United States, for example, 30 per cent of all products ordered online in 2018 were returned, compared to 9 per cent in the case of bricks-and-mortar stores (Saleh, 2019). In-store returns can significantly cut warehouse and transportation costs, but consumers may decide against driving to a bricks-and-mortar store as this may not be the most convenient option (Peinkofer, 2023).

One reason for the high rate of returns in e-commerce is that the consumer cannot see or try out the products before buying them (Pålsson et al., 2017; Ghezzi et al., 2012). Free returns also influence customer purchase decisions, sometimes resulting in buyers ordering more products with the clear intention of returning some or most of them. Higher return rates for e-commerce are also associated with more packaging waste than returns to bricks-and-mortar stores (Zhang et al., 2023). Similarly, the repackaging and transportation of items to a retailer's dedicated returns warehouse increases CO_2 emissions, as trucks and planes carry items over long distances (Peinkofer, 2023). In some cases (e.g. Boozt.com), returns from customers in Sweden are sent to a third country for repackaging, before being resent to the main warehouse in Sweden for resale. This involves more international transportation and more emissions. Often, returned items are not reconditioned or repackaged for sale and may end up as waste. The environmental harm associated with the wilful destruction of returned products is especially problematic from a sustainability point of view (Roberts et al., 2023). While there is little evidence on the amount of waste generated by returns in Europe, the Middle East and Africa (Owens and Pynadath, 2022), in the United States, e-commerce returns produced about 14 per cent more landfill waste than bricks-and-mortar returns in 2020 and an estimated 24 million tons of CO_2 emissions (Optoro, 2020, 2022).

The environmental impact of returns from online purchases is strongly influenced by the method used. For instance, there will be little net increase in energy use and emissions when parcel carriers collect returned items as part of their

planned delivery rounds. In one study, CO_2 emissions ranged from 416 g, when a parcel carrier collected the unwanted item on a subsequent delivery round, to as much as 4.5 kg, when the online shopper made a separate trip by car to return the item to a conventional shop (Edwards and McKinnon, 2009).

Conversely, returning the item as part of another shopping trip or by "trip chaining" significantly reduced CO_2 emissions. In one of just a few studies in developing countries, an analysis of return options in Jordan concluded that the delivery courier method of picking up unwanted goods by a delivery van that returned them to the central warehouse was an environmentally friendly and efficient return method. However, making use of the nearest post office or petrol station as both collection and delivery points, and limiting personal car trips, reduced CO_2 emissions even more (Nabot and Firas, 2016).

The carbon footprint associated with returns also depends on the products involved. A study of eight European countries found that the return of a non-food product purchased through e-commerce generated estimated emissions of 112 g of CO_2e per product compared to 68 g for products purchased in a physical retail store (Oliver Wyman, 2021).

In summary, available evidence suggests that returns are much higher for online shopping than for in-store purchases, and sometimes end up as waste, despite being new. E-commerce returns also tend to involve more packaging than returns to bricks-and-mortar stores. Returns can result in increased transportation emissions due to additional trips for product collection, sorting and redistribution, especially if return centres are far away from the customer's location.

e. Consumer behaviour

E-commerce has been found to boost consumption overall due to enhanced accessibility and convenience, lower prices and greater product variety. Furthermore, the behaviour of the online consumer greatly affects the environmental footprint of e-commerce (Buldeo Rai, 2021; Buldeo Rai et al., 2022). With omnichannel purchase behaviour, consumers have the flexibility to interact with retailers through multiple channels. On the one hand, combining online browsing with click-and-collect or delivery can optimize shopping and reduce the need for unnecessary transportation of items. On the other hand, showrooming (online purchases following an in-store visit) or home delivery of in-store purchases, may lead to negative environmental effects if they induce additional trips related to a single purchase. Similarly, behaviour which involves more frequent and fragmented purchases across different platforms and retailers, together with impulsive buying, leads to overconsumption and increased transportation emissions and (packaging) waste (European Commission, Joint Research Centre et al., 2020; Buldeo Rai, 2021). Frequent shopping trips, information-seeking and social and recreational shopping also contribute to additional transportation emissions, especially if consumers rely on private motorized vehicles for their trips.

Online advertising and marketing significantly influence consumer behaviour, fostering a culture of consumption and disposal and contributing to an increased carbon footprint. As online marketing increases and advertisements become more effective through personalization and data analytics, its influence on consumption gains new relevance from a sustainability perspective (Frick et al., 2022). Targeted advertising and personalization have also become increasingly sophisticated in e-commerce. Online businesses are harnessing vast amounts of structured, semi-structured and unstructured customer data, including critical information on demographics, browsing habits, and purchasing history. Social media has emerged as a significant data source, offering insights into consumer preferences and behaviours (Popoola and Abolarin, 2023). This personalization can lead to increased consumer engagement, potentially contributing to overconsumption.

Online advertising and marketing significantly shape consumer behaviour, promoting a culture of consumption and disposal that **increases the carbon footprint**

At the same time, targeted advertisements and other persuasive online marketing strategies, including flash sales and limited-time offers can create a sense of urgency and trigger impulsive buying behaviours, as consumers fear missing out on a great deal.[9]

Meanwhile, some studies suggest that younger consumers are more environmentally conscious when shopping online. A 2023 survey of more than 16,000 shoppers across 16 countries found that 39 per cent of shoppers born between 1997 and 2012 ("Gen Z") and 34 per cent of those born between 1981 and 1996 ("Millennials") engage in cross-border shopping 12 or more times per year. Concern for sustainability was expressed by 94 per cent for Gen Z shoppers and 93 per cent for Millennial shoppers, compared with only 77 per cent of those born between 1946 and 1964 (Ndure, 2023).

In comparing the environmental impact of online and traditional retail, the choice of travel method, e-fulfilment method and basket size also matter (van Loon et al., 2015). While a 2013 study found that traditional shopping had twice as high a carbon footprint as online shopping (Weideli, 2013), the advantage of e-commerce diminished when taking into account the entire buying process, based on fast deliveries, the customer's location (urban versus suburban) and choice of transportation (personal car versus public transport). Regionally, online shopping can reduce GHG emissions in car-reliant areas but may increase emissions in places where consumers may be more used to walking or cycling to shops (Weideli, 2013; van Loon et al., 2015; Shahmohammadi et al., 2020).

Reliable and transparent information that allows consumers to make conscious and sustainable purchase decisions is often not available, hampering the ability of consumers to make informed decisions (UNEP and ITC, 2017; Penz et al., 2019). Other consumers may have limited interest in information related to sustainable practices. In a 2019 survey of Brazilian consumers on last-mile delivery options, two thirds reported that environmental information was of "very low" to "medium" importance to them (Nogueira et al., 2021). Similarly, consumers surveyed in Belgium supported reducing vehicle kilometres for last-mile deliveries but were unwilling to pay for deliveries that used more sustainable alternatives, such as electric vehicles or cargo bicycles (Buldeo Rai, 2019). Consumers may also doubt the credibility of sustainability information, and this stems from concerns related to greenwashing, a practice that may become increasingly prevalent in e-commerce (One Planet Network and adelphi, 2022).

In summary, as consumer behaviour has a major impact on environmental outcomes, it is important to improve the availability of reliable and transparent information that can enable consumers to make conscious and sustainable purchase decisions.

2. Conclusions from the comparison

As for other assessments of secondary (indirect) environmental effects of digitalization, it is hard to draw definite conclusions on whether traditional or online retail is preferable from an environmental sustainability perspective. The environmental footprint depends on many factors. Comparing results from various studies is challenging due to the absence of a common approach to assessing environmental impacts, and the fact that the studies often cover different time periods, countries and types of products. Moreover, the net impact greatly depends on the way in which the purchasing process is conducted. Mode of transport, distance travelled, speed of delivery, number of products purchased, return rates, packaging material, consumer behaviour and geography all influence the outcome.

[9] See https://www.europeanbusinessreview.com/flash-sales-frenzy-the-impact-of-limited-time-offers-on-consumer-behavior/.

Ultimately, the issue is not so much whether e-commerce is more or less environmentally friendly than traditional bricks-and-mortar retail. In many countries, buyers do not rely completely on offline or online purchases but make use of both channels. Indeed, many retailers nowadays offer alternative options for consumers to buy their products. However, in view of the observed environmental risks of e-commerce, it is essential to consider how to ensure that e-commerce is as environmentally sustainable as possible, moving forward. Given the particularly scarce evidence on the environmental impact of e-commerce in developing countries, it is important to build a stronger knowledge base for these countries.

The next section explores different policy measures, legislation and sustainable practices and technologies that may contribute to more sustainable and inclusive e-commerce.

D. Making e-commerce more environmentally sustainable

The environmental impacts of e-commerce can be influenced in a number of ways. Government policy and legislation can play a role, as can adopting more inclusive and environmentally sustainable e-commerce practices and business models and encouraging consumers to be better informed and to change their behaviour. Large e-commerce platforms also have a responsibility to foster more environmentally sustainable practices. The design of policy measures and transformative actions across the e-commerce supply ecosystem – from sourcing and production to distribution, retail and consumption – can be improved. It should aim to mitigate overconsumption, cut GHG emissions, reduce returns, lower waste and drive sustainable development.

Making e-commerce more environmentally sustainable can help create interconnected benefits across the Sustainable Development Goals, including on Goal 6 (clean water and sanitation), Goal 8 (decent work and economic growth), Goal 9 (industry, innovation and infrastructure), Goal 11 (sustainable cities and communities), Goal 12 (sustainable consumption and production patterns), Goal 13 (climate action), Goal 14 (life below water) and Goal 15 (life on land).

This section focuses on how to mitigate risks and harness opportunities for improving environmental sustainability in e-commerce. Attention is given to government policies as well as actions by e-commerce platforms and other businesses, including women-led online enterprises and consumers.

1. Reducing the impact of warehouses and distribution centres

There are multiple ways to reduce the environmental footprint of warehouses and distribution centres. One approach is to use renewable energy sources, such as solar photovoltaic panels, to power operations (Lewczuk et al., 2021). Several e-commerce companies are already taking action in this area. For example, Daraz, a leading e-commerce platform in Pakistan, has installed solar panels on the rooftops of its warehouses (*News Update Times*, 2021). In the case of Alibaba, energy generated from 30 MW of solar panels and other renewable energy sourcing led to a reported cut in emissions of 21,003 $MtCO_2e$ in 2023, while it has committed to expanding solar power to all its logistics warehouses by 2030 (Alibaba, 2023). The express courier

Making e-commerce more environmentally sustainable can create interconnected benefits across the Sustainable Development Goals

company, Fedex, uses sunlight to heat the refrigerant for its air conditioners, with significant cuts in energy demand and GHG emissions as a result (Foundation for Future Supply Chain, 2022). Warehouses that make use of energy-efficient compact fluorescent lights or LEDs and other smart lighting systems can also reduce CO_2 emissions and energy consumption even further (Füchtenhans et al., 2021).

Implementing sustainable packaging practices within warehouses as well as right-sizing packaging to minimize waste, significantly lowers their environmental footprint. For example, following the introduction of government bagging guidelines in Singapore, Lazada, a major e-commerce platform in Southeast Asia, started to exclude mandatory packaging for specific items at its fulfilment centre warehouse. This led to a reduction of plastic waste by more than half (Lazada Group, 2022). Prioritizing effective waste management practices, including recycling programmes, can reduce the amount of waste sent to landfills (Abubakar et al., 2022), while the implementation of water-efficient technologies and practices can decrease water consumption and support sustainable water management (Utilities One, 2023).

By adopting sustainable practices and optimizing logistics, **e-commerce warehouses** can **bring down their carbon footprint** and help to protect the environment

Locating warehouses closer to customers can help stem mileage and reduce fragmented last-mile transportation (Shahmohammadi et al., 2020; Oliver Wyman, 2021). Placing them near urban and residential areas facilitates faster delivery and supports the transition to more sustainable transportation modes. For instance, Jumia has built an integrated warehouse and logistics network facility in Nairobi, enabling multiple warehouses and networks to operate under one roof. According to the company, this has enabled significant cuts in truck trips per day and lowered CO_2 emissions (Jumia, 2022).

The redesign of warehouses from large, traditional centres to microhubs or microfulfilment centres that link suburban warehouses to final delivery points present additional opportunities for reducing energy consumption and transportation use. At the same time, this can also create inefficiencies that include generating more aggregate energy consumption across multiple sites and higher overall inventory levels (DHL, 2021). Integrating e-commerce warehouses into dense, mixed-use urban areas can also present other development challenges, including adverse health and environmental effects on the local population (Buldeo Rai, 2023).

By adopting sustainable practices and optimizing logistics, e-commerce warehouses can bring down their carbon footprint and help to protect the environment. From a broader sustainable development perspective, such efforts should be accompanied by measures to ensure decent work conditions of e-commerce warehouse workers (ILO, 2023c). This includes engaging with workers, local communities and civil society organizations on issues such as community displacement and supply chain transparency, as well as investing in skills development and training.

2. Minimizing the impact of product packaging and waste

E-commerce packages have been found to use up to seven types of packaging materials, including envelopes, cardboard boxes, plastic bags, woven bags, tape and buffer materials such as bubble wrap or polystyrene foam (Maraithe, 2020). In particular, single-use packaging materials such as cardboard boxes, plastic air pillows and bubble wrap are often not recycled, leading to an increase in packaging waste and environmental pollution (Oceansix, 2023). E-commerce reportedly used approximately 950 million tons of plastic packaging globally in 2019. The two largest e-commerce markets, China and the United States, each accounted for approximately one fifth of this total,

which is projected to reach an estimated 2 billion tons by 2025 (Oceana, 2020).

A few positive trends have been observed. Some consumers are becoming more conscious about their packaging footprint. In a survey on packaging sustainability trends, 66 per cent of consumers across Europe, North America and South America found it important to purchase products packaged in environmentally friendly materials (Trivium Packaging, 2022). Governments are responding to growing concerns about plastic pollution. For example, recognizing the impact of packaging waste, including from e-commerce, the Government of Indonesia and the Global Plastic Action Partnership launched a National Plastic Action Partnership in 2019, with the goal of reducing ocean plastic pollution by 70 per cent by 2025 and making the country free of plastic pollution by 2040 (Florene, 2021; WEF, 2019).

Some countries have sought to address the production of packaging waste in national legislation. Measures range from outright bans to the phasing out of single-use plastic packaging (box V.3), as well as efforts that promote a shift to more reusable, recyclable or compostable packaging for e-commerce.

Other measures include subsidizing research and development related to recyclable and degradable materials and offering subsidies for the consumption of these materials (Wang et al., 2023). The design of innovative packaging systems, such as reusable plastic crates to counter the growing use of single-use cardboard boxes, can also reduce plastic packaging waste (Coelho et al., 2020). Creating a reusable packaging system, supported by national governments and postal services could streamline the return and reuse of packaging to retailers, fostering both sustainability and responsible resource management in e-commerce.

In the private sector, some e-commerce companies in developed and developing countries alike are incorporating sustainable packaging as part of new environmentally friendly business models, including:

- A decision by Mercado Libre to ship certain products in their primary wrapping material has resulted in less packing and waste as well as savings on transportation fuel. The company uses packaging that is recyclable and has received the Forest Stewardship Council-certified or soon-to-be certified seal, guaranteeing that all manufacturing processes adhere to responsible forest practices (Mercado Libre, 2023).
- Amazon India has taken steps to achieve complete elimination of single-use plastic, including by replacing plastic packaging material, such as bubble wraps and air pillows with "paper cushion". The company has also introduced 100 per cent plastic-free and biodegradable paper tape, which is used to seal and secure customer shipments (Amazon, 2020).
- Unilever's Easy Green e-commerce sustainability partnership with Lazada aims to reduce the use of plastic packaging materials in delivery parcels. It entails using carton boxes and recycled shredded paper instead of plastic fillers (Unilever, 2022). These alternative packaging solutions are provided as "eco" (plastic-reduced) and "zero" (plastic-free options), with the latter making use of paper tape instead of plastic tape to seal packages (Lazada Group, 2022).
- Cainiao, a logistics company owned by Alibaba, has launched a green recycling programme that focuses on packaging. This initiative has established over 110,000 "pick-up, drop-off" stations, which had resulted in the recycling and reuse of 24 million packaging items as of March 31, 2023.[10] Additionally, Cainiao has pioneered the use of e-shipping labels to replace paper labels, leading to savings of over 400 billion pieces of paper and offsetting a billion kilograms of carbon emissions annually (*Time*, 2020).

Creating a publicly supported reusable packaging system could streamline the return and reuse of packaging, fostering sustainability and responsible resource management in e-commerce

[10] See https://www.cainiao.com/en/esg-environmental.html?spm=a2d524.28499376.0.0.658f55e3lBQxkY.

- Some e-commerce companies in the United States are shifting from single-use packaging to form a multi-use packaging loop, including through initiatives that offer reusable containers, envelopes and capsules for businesses to deliver products to customers (Maraithe, 2020). Once a customer receives a product, the reusable container is sent back to the company, where it is cleaned and sanitized for reuse.
- In France, certain e-commerce companies are removing additional boxes for shipment when the original packaging of the product does not require extra protection. In Switzerland, some companies are experimenting with sending certain products without any additional packaging, relying solely on the product's original box (Ecommerce Europe and EuroCommerce, 2022).

Box V.3
Government measures to minimize the environmental impact of plastic and packaging waste

As plastic and packaging waste becomes ever more visible, both on land and in the oceans, calls to tackle this escalating crisis are growing. Governments around the world have implemented various mitigating measures. While policies may not always target packaging generated from e-commerce specifically, bans on single-use plastic can help to prevent plastic and packaging waste from e-commerce as well.

China has released and implemented a series of policies and regulations on plastic pollution management. These are primarily characterized by conducting plastic pollution management by region, time and industry. A plastic ban enacted in 2020 restricts the production and use of multiple single-use plastics, including packaging from the large e-commerce sector. The use of electronic waybills instead of paper ones, and reusable courier containers have become common practices in logistics companies in the country. In 2021, the Ministry of Commerce in China issued a notice to promote the green development of e-commerce enterprises. It encourages energy savings and low-carbon development, green packaging and consumption; and requires platforms to report on their environmental protection efforts. In response, e-commerce enterprises have adopted measures to "slim" the packages of express parcels and promote more sustainable packaging solutions, including through the so-called "Feng box" – a recyclable parcel package launched by the express service delivery company, SF Express. Notwithstanding these efforts, Greenpeace in 2020 reported a substantial amount of hard-to-recycle plastic packaging still being used for delivery.

In India, the Plastic Waste Management Amendment Rules, 2021, prohibit since 2022 the use of identified single-use plastic items which have low utility and high littering potential.

Rwanda implemented a nationwide ban on plastic bags in 2008 in its law relating to the prohibition of manufacturing, importation, use and sale of plastic carry bags and single-use plastic items, N° 17/2019 of 10 August 2019.

The European Union Packaging and Packaging Waste Directive sets out measures to reduce packaging waste. It requires European Union countries to take measures to prevent the generation of packaging waste and to minimize the environmental impact of packaging. They are also required to adopt measures to increase the share of reusable packaging placed on the market and to reuse packaging, without compromising food hygiene or consumer safety. The Directive also sets recovery and recycling targets for packaging waste.

Sources: UNCTAD, based on Greenpeace (2020) and IPEN (2022).

3. Towards more sustainable transportation and delivery

Increased pressure is being placed on the last-mile delivery system, whereby products are transported (often in fossil-fuelled trucks and vans) from distribution centres to final consumers (WEF, 2021). Contributing approximately one quarter of all energy-related GHG emissions, the transport sector is one of the largest sources of both urban and regional air pollution (UNEP, 2023a). In the context of e-commerce, short delivery windows in response to consumer demand may drive companies to compete for clients by offering faster delivery solutions (Muñoz-Villamizar et al., 2021).

Fast delivery entails more urgent and frequent deliveries, resulting in more vehicles on the road, traffic congestion, higher fuel consumption and increased CO_2 emissions (section C). Delivery companies that prioritize speed as a core component of their business models often pay less attention to the environmental impact of the deliveries; when dealing with a one- or two-day shipping window, companies are more likely to use trucks that are only half filled, generating more traffic and carbon emissions per item (Igini, 2023).

Growing demand for e-commerce is estimated to increase by 36 per cent the number of delivery vehicles within inner cities by 2030 (WEF, 2020a), with consequent environmental risks. For example, without effective intervention, urban last-mile delivery emissions and traffic congestion are on track to increase by over 30 per cent in the top 100 cities globally. With an ecosystem-wide change, however, different measures could reduce emissions and traffic congestion by 30 per cent, and delivery costs by 25 per cent, compared to a "do-nothing" scenario. Greater use of battery electric vehicles and hydrogen fuel electric vehicles could reduce CO_2 emissions by 16 per cent and 24 per cent respectively, while mobile parcel lockers could reduce delivery costs by 2 to 12 per cent, thus easing congestion by 5 to 18 per cent (WEF, 2020a).

In urban settings, last-mile delivery can be made more sustainable by employing electric L-category vehicles, such as mopeds, motorbikes and compact electric vehicles (Ranieri et al., 2018), which significantly reduce emissions when charged with renewable energy (IPCC, 2022b). Cargo bikes present notable environmental advantages. For example, in London, replacing 10 per cent of van traffic by cargo bikes could reduce CO_2 emissions by about 133,000 tons per year. A shift to cargo bikes would also reclaim around 384,000 square metres of public space currently occupied by parked vans, and decrease vehicle traffic by some 17,000 hours (about two years) each day (Possible, 2021).

Walking or biking when returning products at parcel lockers (ideally when picking up a new parcel) can result in more environmentally friendly outcomes. The introduction of drop-off and collection points can reduce the number of trips and distance travelled, leading to lower emissions (Klein and Popp, 2022; European Commission, 2022a). Other measures include optimizing routes and consolidating deliveries. Policies that facilitate innovation for more sustainable and efficient systems and services present additional environmental benefits. Examples include setting regulations for loading and unloading parking, creating projects for urban consolidation centres, testing new vehicles in pilot programmes and defining specific working hours for logistics operations (Viu-Roig and Alvarez-Palau, 2020).

In some African cities, to avoid inefficient last-mile deliveries, the Jumia Group has designed conveniently located pick-up stations that allow consumers to walk or take less carbon-intensive means of transportation to retrieve their orders. The company uses an open source technology solution called Opta Planner that helps identify the most efficient delivery routes (Jumia, 2021). In China, Cainiao saw reductions in

> Without intervention, emissions and traffic congestion from urban **last-mile delivery** are set to **rise by over 30%** in the top 100 cities globally

carbon emissions due to duplicated delivery through the use of a "smart consolidation engine", which combines multiple packages ordered by the same consumer in one shipment (Alibaba, 2021).

Some e-commerce companies are moving towards more environmentally sustainable delivery modes, with positive environmental and social impacts. Lazada, for example, has partnered with PT Smoot Motor Indonesia, to launch a specialized electric motorcycle for delivery that allows depleted batteries to be swapped for fully charged ones at exchange locations across Jakarta. For last-mile deliveries, Lazada also deploys zero-emission cargo bicycles in densely populated regions in Indonesia and electric scooters that cover up to 20 km and can deliver more than 100 parcels per charge in Viet Nam (Lazada Group, 2022). In Romania, e-commerce platform eMAG, together with Sameday, a courier company, has a "green delivery" service using only electric cars (Ecommerce Europe, 2020). In the United Kingdom, Ikea has invested $5.56 million in charging infrastructure to achieve 100 per cent zero-emission deliveries by 2025 with a renewable energy-powered fleet of 500 electric vehicles (Fleetnews, 2023).

Zypp Electric, a last-mile delivery company in India, delivers goods using a fleet of zero-emissions electric scooters and has invested in a charging network in urban centres. Similarly, in South Africa, the delivery company Green Riders makes deliveries using electric motorcycles as a viable alternative to traditional gasoline-powered delivery fleet (Green Riders, 2022). In Rio de Janiero, Pedala, an urban delivery social enterprise, employs bicycle couriers to deliver items bought online, reducing traffic congestion and pollution, while creating employment opportunities for at-risk youth from low-income backgrounds (Nesst, 2021). Around the world, women-led online businesses are pioneering sustainable transportation solutions that align with broader climate change and sustainable development goals (box V.4).

The uptake of electric vehicles offers a promising pathway for decarbonizing the transportation sector and transitioning to a more sustainable transportation system. However, the effectiveness of this shift depends in part on the source of electricity generation. The transition could exacerbate challenges facing power systems in developing countries. Potential solutions include smart charging strategies which limit negative impacts while leveraging the potential benefits of vehicle-grid integration. Other mitigation strategies include battery swapping systems to reduce the burden on the power grid during peak demand periods and reducing electric vehicle energy consumption through more efficient cooling systems (Energy Sector Management Assistance Program, 2023).

4. Reducing return rates

As noted above, return rates and costs are much higher for online shopping than for in-store purchases. In 2020, total returns in the United States resulted in over $400 billion in lost sales for retailers, and in 2022 it was twice as high ($816 billion) (National Retail Federation, 2021, 2022). In the United Kingdom, customers return an estimated $8.9 billion of purchases every year. According to a survey of British retailers, companies reimburse nearly half of the amount consumers initially spend on online clothing orders (Barclaycard, 2018).

Understanding the factors that drive returns is important for developing targeted solutions that reduce and manage returns. Multiple purchases, wrong product delivery and dissatisfaction with the product remain key drivers of online product returns (Frei et al., 2023). Return rates have been found to be particularly high for clothing and shoes, at 88 per cent and 44 per cent, respectively (Power Reviews, 2021).[11] Inconsistencies between the expected and

[11] In Australia, about 30 per cent of all online clothing purchases are returned – sometimes because people order several sizes or styles with the intention of sending most back (*Australian Financial Review*, 2019).

Box V.4
Sustainable e-commerce transport and logistics innovation: The case of TruQ in Lagos, Nigeria

Foluso Ojo, the female founder of TruQ, an online logistics and delivery company in Lagos, Nigeria, has prioritized three interventions in her company's business model to reduce the carbon footprint associated with traditional logistics and delivery methods:

- Strategically locate warehouses across Lagos to leverage the benefits of warehouse consolidation, minimize travel distances and alleviate traffic congestion, thereby helping reduce fuel consumption and transport emissions.
- Use the TruQ software that aggregates and matches orders with suitable drivers, minimizing unnecessary trips and the associated negative environmental impact.
- Apply route optimization technology to identify the shortest delivery routes, limiting unnecessary mileage, fuel consumption and CO_2 emissions.

Ms. Ojo underlines that targeted support to nurture an ecosystem of environmentally conscious, women-led e-commerce businesses is critical. Financing for online businesses that embrace environmentally friendly practices could provide the capital needed for investments, including in electric and low-emission fuel vehicles, and other eco-friendly logistics solutions.

Targeted regulations and guidelines in the logistics sector would further encourage the adoption of sustainable practices and bring the transport industry in line with broader environmental objectives. Finally, government-led public environmental awareness and education initiatives could influence the perception of sustainable transport practices and encourage behavioural change.

Source: UNCTAD, based on an interview with Foluso Ojo, founder of TruQ.

the received product, including problems with sizing, colour and resulting multiple item purchases can be linked to poorly designed product description pages and displayed images (Frei et al., 2023; Deloitte, 2019).

Free returns and free shipping influence customer purchase decisions and the likelihood of buying with the retailer again, but they also increase the return rate and, thereby, the environmental impact (Frei et al., 2023). In the United States, for 96 per cent of surveyed consumers, free shipping was the most important consideration when making an online purchase, followed by free returns (79 per cent) (Power Reviews, 2021). In the United Kingdom, flexible return policies have become the norm, with half of consumers stating that a retailer's return policy influences where they shop, and 18 per cent only choose retailers that offer free returns (Barclaycard, 2019).

There are various measures to safeguard the rights and interests of consumers in the context of online returns. Paragraph 14 (e) of the United Nations guidelines for consumer protection recommends that Member States establish consumer protection policies that encourage "a transparent process for the confirmation, cancellation, return and refund of transactions" (United Nations, 2016). Under European Union rules, a trader must repair, replace, reduce the price or provide a refund if goods bought turn out to be faulty or do not look or work as advertised (European Union, 2023): Consumers who have purchased a product or service online or outside a shop, have the right to cancel and return their order within 14 days, for any reason and without a justification. While return and refund laws and other convenient return policies seek to protect the consumer and improve customer satisfaction, they may inadvertently also lead to unnecessarily high rates of returns.

When it is expensive to restock or refurbish a product, it may be cheaper for the retailer to discard or destroy a returned item, potentially resulting in additional environmental impacts (Frei et al., 2023).

The destruction of unsold and returned goods is particularly harmful as it has been found to generate 5 to 20 times more GHG emissions than reuse (Ellen MacArthur Foundation, 2021). There have been several reports of fast fashion and luxury brands burning and shredding unused and unsold stock to prevent the reselling of stock by unauthorized vendors on the grey market or its return for cash (Lee, 2023; *Financial Times*, 2023). Some companies may have neither the time nor the technology to distinguish damaged goods from those returned (Symons, 2023). Smaller e-commerce companies may also opt to send unwanted goods to an incinerator or landfill instead of paying for the warehouses of larger platforms (European Commission, Joint Research Centre et al., 2020).

Product destruction needs to be addressed through a wide range of interventions (informative, administrative and market-based). This area is receiving increasing policy attention. On 30 March 2022, the European Commission proposed the "Ecodesign for Sustainable Products Regulation" to establish a framework for setting ecodesign requirements for sustainable products (European Commission, 2022b). This framework is intended to apply to all products on the internal market, with the aim of making them more durable, reusable, reparable, upgradable, recyclable and generally less harmful to the environment. The proposed regulation includes rules on a digital product passport, green public procurement and banning the destruction of unsold goods. As a first step, large companies would be mandated to publicly disclose the number of products they discard per year. They would need to inform on and justify the volumes of discarded products sent out for reuse, remanufacturing, recycling, energy recovery and disposal.

Banning the deliberate destruction of unsold goods can promote environmentally sustainable e-commerce

Regarding e-commerce, the regulation recognizes the role of online marketplaces in the supply chain and how these platforms allow economic operators to reach more customers. Given their role in intermediating the sale of products between economic operators and customers, online marketplaces are required to take responsibility for addressing the sale of products that do not comply with ecodesign requirements and to cooperate with market surveillance authorities (article 29). The Council of the European Union and the European Parliament reinforced the regulation, through a direct ban on the destruction of unsold and returned textiles, with an exemption for micro- and small enterprises and a transition period for medium-sized companies (Council of the European Union, 2023; European Parliament, 2023).

Some European Union countries have sought to address these issues in national legislation. France was the first country to ban the destruction of unsold non-food products as part of a 2020 anti-waste law. Companies have to reuse, donate or recycle the unsold products (France, 2020). In Belgium, value added tax (VAT) relief has been introduced on products donated to charity as an economic incentive to encourage reuse over destruction. Germany has put in place a "duty of care" legal principle for producers and retailers along with mandatory reporting requirements for the types and volumes of products being destroyed (Roberts et al., 2023). The introduction of policy instruments banning the deliberate destruction or disposal of unsold goods can promote environmentally sustainable e-commerce. However, achieving this goal requires more than legislative and regulatory measures. It is important to prioritize environmental sustainability in the design of business return practices, as well as influence consumer behaviour.

An immediate measure that businesses could adopt is to end the practice of free returns. Charging a nominal fee for online returns would help to reduce unnecessary orders and returns, while fostering more responsible online buying behaviour. Some retailers are already moving in this direction. The number of retailers in the United States charging for returns increased from 33 per cent in 2021 to 41 per cent in 2022

(Narvar, 2022).[12] Similarly, the Spanish retailer, Zara, now charges customers $2.13 for online returns, with the cost deducted from their refund (*Reuters*, 2023b), while H&M, a Swedish retailer, charges customers $2.40 since the pandemic (*BBC News*, 2023). As a way of eliminating unnecessary returns, the Swedish e-commerce company, Boozt, has introduced a fair use policy to its terms and conditions, which sets limits to the number of returns a customer can make within a specific time period. As a result, the company was reportedly able to cut emissions by approximately 791 tons of CO_2e in 2022 and to use 538 fewer delivery trucks (Boozt Group, 2022).

E-commerce companies can also take measures to reduce the risk of customers returning products. For example, they can offer customers more comprehensive and precise information about a product, including colour, weight, size and other pertinent dimensions. Ensuring consistency between the image, the description and the product empowers consumers to make more informed purchasing decisions, thereby minimizing the occurrence of online returns caused by confusion or dissatisfaction (Frei et al., 2023). In this context, digital technologies, such as augmented reality, could reduce returns of goods bought online due to misunderstandings or dissatisfaction with the product and associated GHG emissions (*Bloomberg*, 2022). So-called augmented reality virtual try-on, spatial planning, product visualization and measurement assistance apps enhance user experience and enable immersive virtual environments (box V.5 includes examples of companies making use of such applications). However, such practices raise broader security and privacy risks, including the potential loss of privacy if hackers gain access to augmented reality devices and record user behaviour (Harborth and Pape, 2021).

A market survey of over 4,000 shoppers in France, Saudi Arabia, the United Kingdom and the United States revealed

Two-thirds of shoppers who used **augmented reality technology** while shopping were less likely to return purchases

Box V.5
Use of augmented reality applications to reduce product returns

- In the United States, Disguise, a costume company, has partnered with technology company Snap to introduce an augmented reality lens that enables users to visualize the fit, style and colour of their online purchases. Snapchat users take a full body photograph and browse the Disguise store for costumes, which they can virtually "try on" and then directly order from their phones.
- Moreover, the retailer Gap has developed an augmented reality application that allows customers to select a body type and enter their height and weight to create an approximate model of themselves for online shopping.
- Zara's in-store augmented reality application allows customers to hold up their phone to designated shop windows or sensors within the store to see models wearing a selection of outfits. This experience helps customers to visualize how the clothing fits and moves.
- Ikea has introduced Ikea Place, an augmented reality application that allows customers to take a picture of a room in their house and virtually place Ikea furniture to see how well it fits the space. The application increases user engagement rates by providing features that grant consumers the ability to accurately measure room dimensions and visualize how light and shadow impact the texture of furniture. As a result of this interactive experience, the company reported a 30 per cent drop in return rates.

Sources: UNCTAD, based on Ikea (2017); Deloitte (2020); Walk-Morris (2022).

[12] For example, clothing retailer American Eagle charges $7 to return purchases; Saks Fifth Avenue, $9.95; and TJ Maxx, $10.99 (*BBC News*, 2023).

that roughly two-thirds of those who used augmented reality technology to aid their shopping decisions were less likely to return their purchases (Walk-Morris, 2022).

Investing in an environmental sustainability framework for product returns would further promote sustainability goals. This could include increased awareness, management commitment and cross-departmental coordination to achieve joint goals, collaboration with third parties and developing environmental impact assessments (Zhang et al., 2023). It should be noted that such market surveys come with the "cost" of more data use and may be difficult to implement in less digitally developed economies.

The convenience of online shopping, coupled with persuasive advertising and marketing plays a significant role in promoting overconsumption

Leveraging consolidated shipments and economy delivery services to reduce transportation and associated emissions is another way to minimize the environmental impact of returns. For example, an express return delivery service of Optoro, which provides over 1,000 drop-off locations across the United States, consolidates returned items into fewer shipments for retailers, reducing cardboard use and lowering the company's carbon footprint (Optoro, 2022). Jumia reportedly managed to avoid shipping 16,800 and 28,000 packages in 2020 and 2021 respectively, by reducing reverse shipments and allowing qualifying customers to keep certain items they wished to return, with a refund (Jumia, 2021). Other responsible practices include promoting the refurbishment or resale of returned items, rather than sending items to a landfill or to be destroyed (Vembar, 2021).

5. Influencing consumer behaviour

Different consumer needs and online purchase behaviours can have a negative environmental effect, including in relation to shopping frenzies and impulse buying. Events such as Black Friday, Cyber Monday and Singles' Day boost shopping online, as consumers rush to take advantage of discounts and promotions. Concerns have grown about the development of a "hyper-discount culture". It encourages companies to produce surplus stock in the hope of capturing every possible customer and subsequently getting rid of excess stock by trashing, donating or selling it at greatly reduced prices (Symons, 2023). In addition to fuelling excessive consumerism and overconsumption, such trends can contribute to increased GHG emissions and waste generation, with additional plastic packaging often ending up in landfills, incineration or low-quality recycling (University of Leeds, 2019). High return rates from impulse buying also contribute to environmental costs.

The ease and convenience of online shopping, coupled with persuasive advertising and marketing play a significant role in promoting overconsumption.

In order to mitigate these trends, it is relevant to consider how to encourage more responsible online consumption. For example, persuasive technologies and digital applications embedded in e-commerce platforms, such as ethical nudging, gamification, carbon footprint calculators, positive feedback loops and green activations, can support a shift in awareness and steer consumers towards more environmentally sustainable products and services (CODES, 2022). Providing consumers with sustainability information at the time of purchase can positively shape the environmental impact of e-commerce. The way in which digital nudges are applied should also take into consideration human rights, including with regard to privacy and data protection (box V.6).

When used effectively, digital nudges can help buyers make environmentally conscious purchase decisions by providing relevant information (Mirbabaie et al., 2022). E-commerce platforms, however, must employ these tools responsibly and ethically and avoid the use of so-called "dark nudges" that exploit cognitive biases, potentially leading to overconsumption. For example, dark nudges may involve obscure price changes at checkout, website

Box V.6
Digital nudges and human rights

Some digital nudges can raise human rights concerns. First, the use of behavioural science techniques to influence decision-making in digital environments may compromise individuals' autonomy and freedom of choice. Such nudges can subtly manipulate users without their full awareness or consent, potentially undermining their ability to make independent decisions.

Second, extensive data collection and personalized targeting used in digital nudges can give rise to privacy and data protection concerns. Users may not be fully aware of how their data are used, risking potential misuse or unauthorized sharing with third parties, violating their right to privacy.

Third, there is a risk of perpetuating discrimination and biases if algorithms behind the nudges are biased or trained on data reflecting societal inequalities, thereby compromising the right to equality and non-discrimination. Digital nudges that rely on gender stereotypes perpetuate harmful societal gender roles and reinforce gender-based inequalities.

Ensuring the protection of human rights in the design of digital nudges requires addressing these and other related implications as part of an inclusive digital ecosystem.

Sources: UNCTAD, based on Scott (2023a, 2023b).

designs that subtly push users towards more expensive options or preselected additional products that users must opt out of to avoid unexpected charges (Davis, 2017). E-commerce companies should facilitate more informed decision-making and foster more sustainable consumption.

Shopify's carbon calculator and carbon offset tool, for instance, estimates the carbon emissions generated by shipping orders. It allows merchants to purchase carbon offsets to neutralize the impact of emissions, while consumers are shown how their purchases get matched with carbon offsets. All offset payments are donated to forest protection efforts (Reed, 2020). Similarly, the GoTo Group in Indonesia charges a fixed amount to consumers who have activated the GoGreener Tree Collective app when ordering a GoRide or GoCar. The amount calculated is based on the number of trees needed to absorb the average CO_2 emissions from a ride (GoTo Group, 2021). Smartdrop in Belgium is another example of a digital initiative aimed at promoting sustainable consumer choices, specifically in the context of delivery. This innovative tool enables retailers to input customer, store and logistics information, providing insights into the environmental impact of different delivery options and allowing consumers to select the most sustainable delivery method. Its design facilitates informed decision-making, thereby encouraging eco-friendly practices in e-commerce logistics.[13]

Despite its potential for steering online purchasing decisions towards more environmentally sustainable outcomes, nudging can also undermine the broader goals of sustainable consumption. For instance, displaying "buy one, get one free" offers, "one-click buy" options or suggesting additional items at checkout can lead consumers to purchase items they may not need, thereby contributing to excess consumption. Striking the right balance between encouraging individuals to make sustainable choices and preventing overconsumption is needed to promote responsible use of digital technology.

At the same time, to foster more environmentally conscious consumer behaviour and ensure adequate protection against greenwashing, consumers need reliable information on the environmental sustainability of different products. Better

Striking the right balance between encouraging individuals to make sustainable choices and preventing overconsumption is needed to promote responsible use of digital technology

[13] See https://smart-drop.be/en.

access to comprehensive data on the LCA of products available in the marketplace is desirable in this context. LCA data provides critical insights into the environmental impact of a product throughout its life cycle, from raw material extraction and manufacturing to distribution, usage and disposal. This information can empower consumers to compare products not just based on price and quality, but also on their environmental footprint. Moreover, expanding the availability of LCA data for all products would encourage manufacturers to adopt more sustainable practices, as consumer demand for eco-friendly products could significantly influence market trends (UNEP, 2012; UNCTAD, 2023b). Moreover, environmental claims made by e-commerce platforms and retailers should be based on verifiable and reliable information.

6. Legal and regulatory measures

Together with persuasive technologies and digital applications, legislation, regulations and non-binding guidelines that address misleading and deceptive environmental claims can be effective in this context and influence the environmental impact of e-commerce. Exponential growth in the use of green claims in e-commerce as part of advertising strategies by traders presents challenges to consumers and consumer protection authorities (UNCTAD and Superintendence of Industry and Commerce of Colombia, 2022).The use of the term “sustainability” in various corporate communications can also at times be confusing and amount to greenwashing or a misuse of green claims (UNEP, 2022a).

The United Nations guidelines for consumer protection do not explicitly mention greenwashing in the context of e-commerce. However, paragraph 63 on e-commerce recommends that Member States should, where appropriate, “review existing consumer protection policies to accommodate the special features of electronic commerce and ensure that consumers and businesses are informed and aware of their rights and obligations in the digital marketplace” (United Nations, 2016).

To gain a better understanding of the existing legal landscape and regulatory measures related to environmental claims, including in the context of e-commerce, an online questionnaire on green claims was distributed to all members of the e-commerce working group under the Intergovernmental Group of Experts on Consumer Protection Law and Policy (UNCTAD and Superintendence of Industry and Commerce of Colombia, 2022). While the majority of respondents (82 per cent) reported not having specific legislation or regulations in place to address environmental claims made through e-commerce or digital means, 63 per cent confirmed having developed, or that they were in the process of developing, educational material on the subject in order to raise awareness among consumers, businesses and marketers.

Countries that reported having specific legislation and guidelines in place in this area included Peru, Sweden and the United States (UNCTAD and Superintendence of Industry and Commerce of Colombia, 2022):

- Peru enforces certain general provisions contained in the Legislative Decree 1044 – Law on the Repression of Unfair Competition. Although this legislation is not strictly related to e-commerce, article 8 considers acts which have “the effect, actual or potential, of misleading other market players as to the nature, method of manufacture or distribution, characteristics and attributes, fitness for use, quality, quantity, price, conditions of sale or purchase” to constitute acts of deception. This includes advertising with environmental claims that could end up being misleading.
- Sweden assesses environmental claims based on general provisions in the Swedish Marketing Act, which implements the Unfair Commercial Practices Directive from the European Union. Sweden has also produced non-binding guidance on the application of the Directive, which

includes a section on environmental claims. The Swedish courts and the Swedish Consumer Agency refer to the Consolidated Code of Advertising and Marketing Communications Practice from the International Chamber of Commerce (ICC), which has a chapter on environmental claims.

- In the United States, the "Guides for the use of environmental marketing claims" from the Federal Trade Commission help marketers ensure that their claims are truthful and supported by evidence.

On 22 March 2023, the European Commission published its proposal for a European Union Directive on substantiation and communication of explicit environmental claims, the Green Claims Directive (European Commission, 2023b). It proposes new rules on the evidence that companies will have to produce to substantiate their green claims, together with a requirement that such claims be verified and certified to be reliable and trustworthy by a third party. European Union countries are required to designate the most efficient competent authority to carry out the enforcement, including inspections, sanctions and judicial pursuits. If adopted, the proposed Directive would impact all businesses, including e-commerce businesses, selling products in the European Union.

Green and environmental labels offer transformative opportunities to mitigate environmental impacts, marking a crucial step towards more sustainable practices. For instance, the Nordic Swan Ecolabel for e-commerce logistics endorses reduced climate impact and upholds good labour standards.[14] Additionally, an initiative by the Dutch e-commerce federation is partnering with the e-commerce sector, environmental organizations and other stakeholders to discuss what should be included in an ideal environmental e-commerce label.[15] This initiative would result in a certification based on six pillars: strategy, delivery, packaging, returns, product offering and circular economy.

International organizations are supporting efforts to advance the credibility of environmental claims and prevent misleading practices and greenwashing. In November 2022, UNEP and adelphi, as part of the One Planet Network, published "Guidelines for providing product sustainability information in e-commerce" (box V.7).

Box V.7
Guidelines for product sustainability information in e-commerce

To prevent greenwashing and misuse of green claims, UNEP and adelphi, as part of the One Planet Network, have developed guidelines for providing product sustainability information in e-commerce.

These guidelines are voluntary and contain recommendations and good practice on how to communicate product sustainability information and encourage conscious consumer decisions based on transparent and reliable claims.

The guidelines are based on five fundamental principles (reliability, relevance, clarity, transparency, and accessibility) and five aspirational principles (sustainability dimensions, behaviour change, multichannel communication, collaboration and comparability).

The target audience includes e-commerce platforms, online sellers, policymakers, consumer organizations and other NGOs.

Source: UNCTAD, based on One Planet Network and adelphi (2022).

[14] See https://www.nordic-swan-ecolabel.org/criteria/e-commerce-logistics-111/.

[15] See https://www.thuiswinkel.org/webshops/kennisbank/kennisartikelen/dit-zijn-de-trends-voor-duurzame-e-commerce/.

E. Opportunities for contributing to the circular economy and fostering a sharing economy

Platform business models used for e-commerce can help to promote greater resource efficiency and waste reduction by enabling the reuse, reselling, lending, giving, swapping and renting of products and services directly between individuals. This can facilitate the transition to circular and sharing economies, which helps to reduce pressure on scarce resources such as water, non-renewable energy and raw materials, increasing the efficiency of production (United Nations, 2021b). For instance, consumers trading used electronics, furniture, clothes and other items on third-party platforms can help to lessen the demand for new products and the resources required to produce them. In facilitating trade in second-hand goods, goods for refurbishment and the repair of existing products that might otherwise be discarded or left unused, e-commerce may extend the lifespan of products and encourage a shift towards more responsible consumption and production.

Another opportunity for fostering circularity can be found in peer-to-peer activity whereby goods and services are shared among consumers, often facilitated by a third-party online platform (Collini et al., 2023). Applications that allow users to share vehicles can help to reduce the number of vehicles on the road and vehicle kilometres driven, encouraging more sustainable transportation systems (Transport and Environment, 2017). Such applications have become popular in both developed and developing countries. For instance, Didi, a taxi-hailing application in China enables users to share taxis and bikes; Rapido is the first bike taxi application in India; and the Lyft ride share application enables different passengers traveling along similar routes to share a ride in the same vehicle. "Slow fashion" applications, like Nuw in Ireland and Swopped in the United Kingdom, allow users to swap items from high-street to designer goods, through their mobile phones, and inch closer to circular economy objectives. Nuw includes an impact calculator that lets users track the carbon, waste and water offset created every time they swap (*The Guardian*, 2021).

Another way of improving sustainability is through business models that prioritize environmental and social responsibility solutions and circular economy infrastructure. For example, OLX India, an online classified marketplace, reported a reduction of eight million tons of CO_2 in one year by facilitating product resale and reducing the need to produce new goods.[16] Similarly, Taragram, a social enterprise in India, collects and converts waste material into eco-friendly, high-quality paper which it sells online, while creating sustainable employment and support to communities in rural areas (Taragram, 2020).

Although sharing systems may promote sustainable consumption and production, there is the risk of circular economy "rebound" effects, which partially or fully cancel out the benefits. This occurs when circular economy activities, despite having lower per-unit-production impacts, lead to increased consumption and production levels. This can have negative implications for natural resource consumption and the environment (Zink and Geyer, 2017). For example, while promoting sharing of bicycles and taxis on the Didi platforms in

[16] See https://www.thehindubusinessline.com/news/how-olx-india-users-helped-reduce-their-carbon-footprint/article24078672.ece.

China, it may have inadvertently increased China's carbon emissions by enabling a shift from public transport to private taxis.[17]

Mitigating the risk of such rebound effects requires a collective effort from all stakeholders. Governments could provide financial incentives to e-commerce platforms and businesses that promote pro-social sharing models and facilitate sustainable consumption and production patterns, while platforms and businesses could partner with organizations on circular economy initiatives that advocate sharing services or reducing waste. Moreover, consumers can be encouraged to consume in a more sustainable manner, for example by using sharing systems and repairing products instead of buying new ones and by supporting policies that promote circularity.

F. An agenda for action

This chapter has explored the different environmental impacts of e-commerce, as well as actions and measures for more sustainable practices. As e-commerce continues to expand, understanding its various sustainability challenges, especially for goods, is crucial. E-commerce has reshaped consumption patterns and logistics, with multiple environmental effects. Precise impact assessments are hindered by data limitations. But e-commerce presents both opportunities and risks – from warehousing and storage to transportation and logistics, packaging, returns, and consumer behaviour.

Making e-commerce more environmentally sustainable requires collaborative efforts from governments, businesses, platforms, logistics providers and consumers. Initiatives could focus on responsible and sustainable sourcing, energy-efficient logistics and production processes, adopting renewable energy, eco-friendly packaging and delivery solutions as well as sustainable consumption. Policymakers need to create the right mix of legislative and regulatory instruments and tax incentives to reduce CO_2 emissions in transportation and minimize plastic waste generated by e-commerce. Consumers also have a central role to play, including by adapting their behaviour towards more conscious and sustainable consumption and encouraging businesses to prioritize sustainability in e-commerce. Likewise, international organizations can promote an environmentally sustainable e-commerce sector, including through research, capacity-building and training.

Drawing from the discussion in this chapter, including examples of good practice, the following recommendations for different stakeholders are proposed.

1. Promoting better e-commerce practices

Governments and businesses have complementary roles in advancing environmental sustainability. Governments can establish regulatory frameworks, provide incentives and engage in international cooperation. Businesses can drive innovation, adopt sustainable practices and engage with stakeholders to integrate sustainability considerations into their operations and strategies.

Sustainable *warehouse* practices are essential for reducing environmental impact and promoting resource efficiency within e-commerce. Governments can adopt economic incentives, such as tax rebates and reduced VAT, to encourage

[17] Based on written inputs from Ying Tung Chan, Associate Professor, Bay Area International Business School, Beijing Normal University, 23 November 2023.

e-commerce companies to invest in resource-efficient infrastructure and effective waste management in warehouses. Meanwhile, businesses should invest in energy-efficient solutions. This may involve installing energy-efficient lighting and opting for renewable energy sources, such as solar or wind power, to power warehouse operations. Businesses should also implement good practices to effectively manage waste, for example by optimizing inventory management to minimize overstocking or reducing packaging waste. They should also seek to separate different types of waste to facilitate recycling and proper disposal, and regularly monitor waste generation and disposal practices to identify opportunities for improvement. For both governments and businesses, it is essential to address employment, safety, and working conditions for warehouse workers to ensure social sustainability across the supply chain.

In terms of sustainable *transportation and delivery*, Governments can introduce fiscal incentives to encourage e-commerce businesses to adopt eco-friendly delivery practices. This could include subsidies or tax breaks for investments in electric delivery vehicles and bikes, as well as support for low- and zero-emission zones. Exploring opportunities for integrating e-commerce deliveries with existing public transport networks or using public transport hubs as pick-up and drop-off points can help reduce vehicle miles travelled and promote sustainable transportation options. Furthermore, developing credible sustainability labelling (eco-labelling) can help reduce negative environmental impacts and uphold good labour standards in e-commerce logistics.

Efforts by businesses in this area are also important. These could include investing in electric delivery vehicles, cargo bikes, tricycles and scooters, alongside establishing charging infrastructure to support these eco-friendly alternatives. Businesses can incentivize more environmentally sensitive delivery methods, by encouraging consumers to choose slower and consolidated shipments to reduce emissions, optimize delivery routes, and offer click-and-collect options.

In terms of *packaging*, Governments should introduce legislations to regulate excessive e-commerce packaging, particularly focusing on reducing single-use packaging and cardboard boxes. A shift to more reusable, recyclable or biodegradable packaging can help to minimize waste and environmental harm. Initiatives promoting reusable containers, envelopes and capsules for product delivery are also recommended. E-commerce platforms and businesses have a key role in this context. They should seek to eliminate the use of single-use plastics and instead use, for example, carton boxes and recycled shredded paper instead of plastic fillers, thereby reducing the reliance on non-biodegradable materials. Additionally, unnecessary packaging should be avoided by removing extra boxes when the original product packaging adequately protects the item.

Mitigating excessive rates of *returns* is also needed to improve the sustainability of e-commerce. Prohibiting the use of free returns can help discourage unnecessary returns and reduce associated environmental costs. Governments should consider banning the destruction of returned, unsold and overproduced products, promoting reuse, repair and refurbishment. There should also be mandatory reporting requirements for e-commerce platforms and businesses to disclose sustainability-related information, including details on the quantity, types, location and volumes of products being destroyed, facilitating transparency and greater accountability of the industry.

E-commerce platforms and businesses can adopt various strategies to reduce the environmental impact of returns. First, they can charge a nominal fee for all returns and introduce fair use policies with limits on returns within specific time periods. Second, they can provide comprehensive product information and invest in technology such as augmented reality virtual try-on and product

visualization applications to prevent early stage returns by enabling customers to make more informed purchasing decisions. Third, businesses should establish environmental sustainability frameworks for product returns and collaborating with organizations on circular economy initiatives to refurbish returned products for reuse.

2. Encouraging more environmentally conscious consumer behaviour

More sustainable consumer behaviour online can help to enable the demand for sustainable and ethically sourced products, minimize waste, conserve resources and enable a more sustainable lifestyle.

To this end, Governments can consider using legislation, regulations and guidelines that align with international standards to prevent false or misleading claims and greenwashing in online transactions. They can also mandate the adoption by e-commerce platforms and businesses of environmental or labels certified by reputable institutions, ensuring the credibility and reliability of sustainability information provided to online consumers.

Collaborating with e-commerce platforms, businesses and international organizations, governments can raise consumer awareness about the environmental impacts of consumption patterns and purchasing behaviour. Additionally, they should require e-commerce sellers to transparently disclose the environmental cost of their products, promoting greater accountability and informed decision-making among consumers.

Businesses should encourage environmentally conscious consumer behaviour in their buying decisions through targeted awareness campaigns to address negative omnichannel behaviours and highlight sustainable options. Discounts for sustainable packaging or slower shipping options could further encourage eco-friendly choices. For, transparency, businesses should present their sustainability attributes clearly and verifiably, potentially through recognized eco-labels.

3. Improving the evidence base for informed policymaking

Evidence is crucial for Governments. To make informed policy decisions, set realistic targets, and monitor progress, they require reliable evidence. Research-oriented initiatives should focus on innovative solutions along the entire e-commerce value chain. Policymakers could also establish mechanisms to collect relevant data on the environmental impact of e-commerce. This may be achieved by requiring companies to disclose information on their sustainability performance. Such data collection efforts would help to identify areas requiring improvement and track progress over time.

International organizations can also play an important role in this context. They can advance the understanding of the environmental impact of e-commerce and craft a comprehensive research agenda, tailored to countries at various stages of development. Collaboration among international organizations, academia, and industry stakeholders is also important for sharing data, research findings and successful strategies for integrating sustainability into e-commerce practices. Furthermore, partnerships with financial technology, e-commerce and digital companies should be fostered to drive investment in digital innovations that prioritize environmental and social sustainability, thereby advancing a more responsible and sustainable e-commerce ecosystem.