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Towards Sustainable Packaging in E-Commerce:
Implementation Opportunities and Challenges

Laura Nimtsch

Work project carried out under the supervision of:

Luís Veiga Martins

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Abstract

By exploring sustainable packaging within e-commerce, this work highlights the importance of addressing packaging waste issues exacerbated by the pandemic, while noting that its adoption remains limited at scale. The main objective is to identify key opportunities and challenges faced by digital businesses in implementing sustainable packaging solutions. This research adopts a qualitative approach, drawing its data primarily from scientific literature, industry reports, and ten in-depth expert interviews. Results reveal major opportunities, yet challenges like supply chain constraints or economic viability persist. These findings suggest that strategic collaborations are essential for overcoming obstacles, thereby facilitating sustainable packaging adoption.

Keywords

E-Commerce, Sustainable Packaging, Opportunities, Challenges, Sustainable Supply Chain, Circular Economy, Reusable Packaging, Recycling

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The List of Abbreviations is presented in Table 1.

1 Introduction

1.1 Motivation and Problem Definition

In recent years, the rapid growth of e-commerce profoundly redefined the commercial landscape (White 2022, 4), gaining traction globally, especially among European consumers (Beyrouthy 2024; Chueamuangphan, Kashyap, and Visvanathan 2020, 29). Particularly driven by the COVID-19 pandemic, the transition to online shopping has rapidly intensified (Kim 2020, 214), a trend anticipated to persist going further (Escursell, Llorach-Massana, and Blanca Roncero 2021, 2). Although e-commerce yields several benefits, e.g., due to its convenience, tailored customer experiences, low costs, and high efficiency - facilitating economic growth, enhanced profitability, and high customer retention (Oláh et al. 2019, 7) - there are major concerns that must be addressed.

In fact, a strong correlation between the growth of e-commerce and the amplified packaging consumption exists (Lai et al. 2022, 351-352), leading to adverse environmental consequences (Arora et al. 2023, 1270; Afif, Rebolledo, and Roy 2022, 930) and human health risks (Xie et al. 2021, 1). Single-use and overpackaging result in substantial packaging waste (Jestratičević, Maystorovich, and Vrabič-Brodnjak, 2022, 332; Lai et al. 2022, 352; Fidlerová et al. 2021, 423), greenhouse gas (GHG) emissions (Meherishi, Narayana, and Ranjani 2019, 10), as well as plastic pollution - deteriorating air, soil, and water quality (Boz, Korhonen, and Koelsch Sand 2020, 1; Chamas et al. 2020). Consequently, consumer demand for sustainable packaging (SP) grew (Herbes, Beuthner, and Ramme 2018, 204) and the European Union (EU) introduced regulatory frameworks aimed at promoting SP adoption (European Commission 2024a) - impacting business strategies. Despite recent efforts, there are barriers discouraging firms from implementing SP (Afif, Rebolledo, and Roy 2022, 916) whereas opportunities for its adoption exist simultaneously (Boz, Korhonen, and Koelsch Sand, 2020, 1; Chueamuangphan, Kashyap, and Visvanathan 2020, 31).

1.2 Research Question and Objective

This study focuses on the identification of strategic priorities of e-commerce companies concerning their shift to SP adoption. Therefore, the following central research question (RQ) arises:

What are the main opportunities and challenges for implementing sustainable packaging in the context of business-to-consumer (B2C) e-commerce within Europe?

Consequently, the thesis' primary aim is to investigate which aspects firms need to pay particular attention to when introducing SP solutions. Moreover, this study seeks to uncover pivotal opportunities while identifying key challenges that must be overcome to prevent packaging waste.

1.3 Scope and Limitations

This study examines key opportunities and challenges of adopting SP within the B2C e-commerce sector in Europe. The scope encompasses focus areas including logistics, the role of consumers and the European regulatory environment. However, the research scope is subject to several limitations. This study is limited to the B2C segment - hence findings may not extend to business-to-business (B2B) or brick-and-mortar retail contexts where processes differ. In addition, this work focuses on firms with a strong online presence, potentially excluding smaller companies with unique challenges. The study is geographically restricted to the European market, limiting the findings' applicability to other cultural, regulatory, or economic environments. Furthermore, the food and electronics sectors are excluded due to considerable differences in packaging requirements. Ultimately, data collection is primarily based on scientific literature, industry reports, and expert interviews which may reflect biases or neglect other factors affecting SP adoption. Despite these constraints, the study reveals valuable aspects of the practical and strategic considerations for companies seeking to adopt SP solutions in the European B2C e-commerce context.

2 Literature Review

This chapter aims to establish a substantial foundation, needed to follow the subsequent analysis.

2.1 E-Commerce and (Sustainable) Packaging

E-commerce can be defined as a commercial transaction through the internet - including B2B, B2C (OECD 2008a, 166), or consumer-to-consumer (C2C) transactions (Laudon and Traver 2016, 58).

Hence, it is a digital transfer of products or services between consumers and vendors, not involving a physical retail location (Chueamuangphan, Kashyap, and Visvanathan 2020, 28). After an order is placed, delivery is usually conducted through third-party logistics service providers (LSPs) that are vital in e-commerce (Hua and Jing 2015, 269; Delfmann, Albers, and Gehring 2002, 203). In fact, e-commerce offers clients the convenience of shopping online anytime from anywhere (Oláh et al. 2019, 1-2) which is why online shopping is experiencing exponential growth - with European e-commerce revenues projected to steadily rise, reaching \$977.36 billion in 2029 (Figure 1).

In this context, European B2C sales are projected to experience a compound average growth rate of approx. 9.91% until 2027 (Biancolin and Rotaris 2024, 1). However, this trend notably increases packaging waste, resulting in environmental consequences (Chueamuangphan, Kashyap, and Visvanathan 2020, 30-31). To be precise, e-commerce generated more than one billion kg of plastic packaging waste in 2019 with usage projected to rise to 4.5 billion pounds by 2025 (Figure 2). If companies want to remain competitive, they must change considerably (Deloitte 2024), ideally developing strategies aligned with the Sustainable Development Goals (SDGs), e.g., SDG 12 - Responsible Consumption and Production or SDG 13 - Climate Action (United Nations 2024). Thus, this paper focuses on B2C, as B2B packaging solutions are already better understood and adopted at scale, e.g., in terms of reusable packaging (Ellen MacArthur Foundation 2019, 5).

Overall, three packaging types exist. Primary packaging is the first layer that directly surrounds the product, designed to protect and promote it to end users. Secondary packaging accumulates and protects primary packaged goods for efficient storage and logistics purposes, typically using cases or cardboard boxes for consolidation. Tertiary packaging groups multiple units of secondary packaging for efficient transport, using materials like pallets or plastic wrap to secure goods during distribution. (Escursell, Llorach-Massana, and Blanca Roncero 2021, 2; Fidlerová et al. 2021, 425) This work identifies opportunities and challenges relevant to all three types. Notably, packaging is crucial in e-commerce, ensuring products reach consumers in optimal condition while providing containment and protection for a safe, cost-effective, and efficient storage, transport and marketing along supply chains (SC) (EXPRA 2024a, 16; Molina-Besch and Pålsson 2015, 47).

The term “sustainability” originates from the UN Brundtland Report, defining sustainable development as progress that meets the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development 1987, 51). Consequently, the Sustainable Packaging Coalition defines SP as packaging using SMART design, incorporating recycled and sustainably sourced renewable materials, being designed for reusability, recyclability, or compostability with clear end-of-life instructions to serve as a valuable resource for future generations. SMART packaging design is a *systems approach* that prioritizes *material health, accessibility, reduced material use, and life-cycle thinking*. (SPC 2024, 6-9) It is vital to acknowledge that this work refers to the term “sustainable packaging”. However, multiple definitions of SP exist, and any packaging has some degree of environmental impact, leading to a spectrum of sustainability rather than a strict division with no environmental harm (Boz, Korhonen, and Koelsch Sand 2020, 2-4). This work focuses on environmental and economic sustainability, neglecting the social component, e.g., ethical production due to scope limitations.

2.2 EU Regulations concerning (E-Commerce) Packaging

The European Green Deal is the EU's overarching strategy to achieve climate neutrality by 2050, reducing net GHG emissions by at least 55% by 2030 from 1990 levels. Within this framework, the New Circular Economy Action Plan (NCEAP) drives resource efficiency, reduced waste, and enhanced recycling - crucial steps for managing the ecological consequences of packaging within the fast-growing e-commerce industry. The Waste Framework Directive supports the EU Green Deal by establishing key principles for waste reduction, e.g., the Waste Hierarchy (Figure 3), which guides waste strategies by advocating for prevention, reuse, or recycling over disposal. (European Commission 2024b; 2024c; 2024d) The Polluter Pays Principle (PPP) - reinforced by the EU Green Deal - holds producers financially accountable for packaging waste disposal and recycling, requiring firms - particularly those operating internationally - to support national recycling efforts (OECD 2008b). A key tool here is the Extended Producer Responsibility (EPR) Principle which was initially applied to packaging before expanding to other waste streams and holds producers accountable for the entire packaging lifecycle - promoting sustainable design. These requirements can lead to costs due to investments in SP, compliance with EPR regulations, and contributions to national recycling systems, all of which are necessary to support the NCEAP's goals. (Eunomia Research and Consulting 2021, 15-16) Ultimately, the Packaging and Packaging Waste Regulation (PPWR), replacing the Packaging and Packaging Waste Directive (PPWD), emphasizes e-commerce and sets specific targets (Table 2). By 2030, packaging has to be recyclable or reusable, it establishes a 70 % recycling target for waste, and mandates clear labeling and an empty space ratio of max. 50 % - holding online retailers accountable. (European Parliament 2024) In summary, these policies are interconnected, establishing a robust framework for SP in e-commerce by enforcing producer accountability, waste reduction, and the promotion of a circular economy (CE).

2.3 Key Opportunities for Sustainable Packaging Adoption

Within the e-commerce context, SP presents numerous promising chances. This literature review will explore six key opportunities that can play a pivotal role in advancing SP implementation.

Regulatory pressure: EU regulations represent a key opportunity for SP adoption since research indicates regulatory frameworks can drive substantial changes by creating a compliance imperative that encourages SP implementation. For instance, EPR - a market-based measure based on PPP - provides strong incentives to reduce material input, as it is primarily driven by weight (Deweese and Hare 1998). Firms are likely to reconsider their packaging when they bear high disposal costs, as EPR compels them to internalize previously externalized costs, thereby implementing SP to avoid sanctions or compliance risks (Afif, Rebolledo, and Roy 2022, 923). The PPWR, set to come into effect in 2025, enhances the focus on e-commerce and provides advantages over the prior PPWD by imposing stricter and more harmonized waste reduction and recyclability standards, thereby compelling digital businesses to adopt SP for regulatory compliance (Ecommerce Europe 2023, 1).

Consumer pressure: Buyer pressure constitutes another vital opportunity for SP implementation, as sustainability represents a key consumer priority, with eco-friendly packaging emerging as a major driver of brand loyalty (Arora et al. 2024, 2, 7). According to Oláh et al. (2019, 2) consumers consistently demand green e-commerce shopping. Moreover, research suggests that end users are even open to paying a premium for eco-friendly packaging (Deloitte 2024). Ultimately, research indicates that consumers in high-income countries tend to exhibit a greater environmental concern (Paul, Modi, and Patel 2016, 124). Consequently, e-commerce firms in high-income European markets face a strong opportunity to adopt SP solutions, as they can meet the consumers' high environmental expectations, simultaneously strengthening their market position.

Potential cost reduction: This economic imperative is key in driving SP adoption, as without clear evidence that SP increases sales or reduces costs, firms often find insufficient business justification to invest in SP (Boz, Korhonen, and Koelsch Sand 2020, 2). Smaller firms, in particular, prioritize cost efficiency in SP adoption, though this factor also plays a role for larger corporations (Kassaye 2001, 444, 448). By adopting SP, firms can potentially reduce costs under EPR, as this approach decreases disposal fees relative to conventional packaging and avoids compliance expenses through adherence to regulatory standards (Afif, Rebolledo, and Roy 2022, 923). Notably, eco-modulation is a key element of EPR and encourages eco-design by providing financial incentives, i.e. bonuses or penalties, thereby motivating e-commerce firms to adopt SP (Lifset et al. 2023, 189). Especially reusable packaging models, which become more cost-effective with increased volume, provide a substantial savings potential by minimizing the need for continuous investments (Arora et al. 2023, 1268; Ellen MacArthur Foundation 2019, 5; Yusuf et al. 2017, 4, 19).

Competitive advantage: By adopting SP, firms can create a key organizational asset that enables the achievement of a long-term competitive edge (Yusuf et al. 2017, 629-631). Biancolin and Rotaris (2024, 10) argue that the earlier e-commerce firms implement strategic initiatives like SP in response to consumer pressure, the greater their competitive advantage will be. In addition, the PPWR will profoundly impact the e-commerce packaging sector and the era in which packaging was distinguished solely by its price and logistical effectiveness is over. Thus, firms that adopt SP early can gain a competitive edge - not only avoiding the risk of regulatory non-compliance which might result in penalties but also enhancing their brand differentiation and reputation. (EXPRA 2024b, 1; Jestratišević, Maystorovich, and Vrabič-Brodnjak 2022, 331) As a result, SP goes beyond recycling or reusing and helps firms to distinguish themselves from competitors (Afif, Rebolledo, and Roy 2022, 919) which therefore represents a key opportunity and strong driver for SP adoption.

Reusable packaging: The adoption of reusable packaging represents a strategic opportunity for e-commerce firms due to its economic and environmental advantages (Lai et al. 2022, 357; Silva et al. 2013, 380). Other benefits include enhanced brand loyalty, user experience, customization, as well as information on system performance through the incorporation of digital technologies, e.g., GPS tracking. The approach aligns with CE principles and offers substantial business potential, with the Ellen MacArthur Foundation (2019) estimating that replacing just 20% of single-use packaging with reusable alternatives could unlock at least a \$10 billion opportunity globally. As part of the New Plastics Economy Global Commitment, >350 companies have recognized that, wherever possible, reuse business models should be selected to reduce the need for single-use plastic packaging (Ellen MacArthur Foundation 2019). Moreover, aligning with the EU's Waste Hierarchy - which advocates for prevention and resource reuse over recycling or disposal - reusable packaging systems support environmentally responsible practices (European Commission 2024d).

Collaboration: Ultimately, collaboration is key for effective SP implementation in e-commerce. Integrating internal and external stakeholders can boost SP adoption through collective strategies (Afif, Rebolledo, and Roy 2022, 922). A cooperative SC promotes SP solutions that meet diverse stakeholder requirements (Verghese and Lewis 2007, 4384). Platforms like Ecommerce Europe (2024a; 2024b) enable collaboration among entities, e.g. Amazon and Inditex, facilitating the sharing of best practices or advocacy for supportive regulations. Prominent firms, e.g., Amazon or Otto, joined the New Plastics Economy initiative to commit to circularity and drive change (Ellen MacArthur Foundation 2023; 2016). Hence, they defined SP initiatives, which include increased recyclable and recycled material while avoiding single-use plastic, designing for durability or reuse (Amazon, Inc. 2024; Otto Group 2024) Ultimately, fostering collaborative relationships across the SC ensures a fair distribution of packaging costs and benefits among actors (Niero et al. 2017, 18).

2.4 Key Challenges for Sustainable Packaging Adoption

Nevertheless, there are also challenges in establishing SP. Here, it is focused on six main barriers that must be overcome in order to sustainably transform packaging in the e-commerce landscape.

Complex trade-offs in packaging requirements: Adopting SP is challenging due to the complex trade-offs required to balance packaging integrity with environmental pressures (Robertson 1990, 40). SP must reduce environmental impact without compromising protection, logistics efficiency, or consumer appeal, which often results in overpackaging to ensure product integrity (Afif, Rebolledo, and Roy 2022, 926). Additionally, SP decision-making demands inputs from internal departments and external stakeholders, making it difficult to weigh conflicting requirements on a common scale (García-Arca, Prado-Prado, and Gonzalez-Portela Garrido 2014, 331). In this context, digital businesses lack guidance on managing these multi-dimensional trade-offs between environmental, as well as other packaging requirements (Molina-Besch and Pålsson 2016, 45).

Economic viability: Implementing SP in e-commerce faces significant challenges due to economic viability. SP design and innovation can be costly, with firms often prioritizing economic benefits before adopting SP (Verghese and Lewis 2007, 4381). Key expenses include high labor and material costs, as well as investments in specialized equipment and logistics infrastructure, which are often more expensive than conventional packaging solutions (Afif, Rebolledo, and Roy 2022, 926; White, Wang, and Li 2014, 3). Furthermore, small and medium-sized firms, which tend not to view packaging as a priority, are especially constrained by limited budgets and may lack resources (Yusuf et al. 2016, 629). As a result, SP solutions with unfavorable cost structures or extended time horizons for return on investment (ROI) are ultimately not adopted (Boz, Korhonen, and Koelsch Sand 2020, 2), highlighting the critical role of economic feasibility in advancing SP practices.

Attitude-behavior-gap: An attitude-behavior-gap is a discrepancy between individuals' expressed environmental values and actual purchasing behaviors. This phenomenon presents a key challenge for SP adoption in e-commerce, as consumers may vocalize a preference for eco-friendly packaging yet fail to translate these attitudes into responsible action (Boz, Korhonen, and Koelsch Sand 2020, 10). Factors contributing to this gap include perceived inconvenience, lack of information, price trade-offs, perceived greenwashing, or the inability to distinguish SP from non-sustainable options (Boz, Korhonen, and Koelsch Sand 2020, 9; Jerzyk 2016, 708; Olson 2013, 173). Zalando, together with e-commerce peers like Adidas, published a report on the persistent attitude-behavior-gap. While sustainability is indeed increasingly relevant to consumers, it often ranks below factors like price-value ratio, with 81% of respondents naming it their top priority. (Zalando SE 2021, 18) Consequently, companies may struggle to align their SP initiatives with consumer behavior, making education essential to foster genuine engagement and adoption (Lai et al. 2022, 358-359).

User experience (UX) design: UX design poses another challenge to SP adoption, as a typical e-commerce website journey must intuitively guide consumers without causing a choice overload, a factor known to reduce engagement or satisfaction with provided options (Nagar 2016, 99). A well-designed UX can be essential in addressing consumer misunderstandings regarding SP, as research shows that consumers lack a clear understanding of its principles (Boz, Korhonen, and Koelsch Sand 2020, 7). Strategic choice architecture, i.e., using defaults or arrangements of alternatives, is crucial for guiding clients toward sustainable decisions. However, even minor modifications in choice design can steer individuals toward specific behaviors, thereby impacting their decision-making processes. Research indicates that when choices are not intuitively presented, consumers may ignore them in favor of familiar or default options, potentially undermining SP adoption. (Franzoi and vom Brocke 2022, 2-3; Weinmann, Schneider, and vom Brocke 2016, 433)

Reverse logistics: Bernon, Tjahjono, and Ripanti (2018, 483) advocate for using reverse logistics to enable a CE. However, in e-commerce - where return rates are substantially greater compared to offline retail (Ramanathan 2011, 255) - reverse logistics poses a major challenge, particularly for reusable packaging. Returning reusable packaging from home is suitable for e-commerce, as pick-ups can be combined with new product deliveries. Nevertheless, establishing reverse systems requires complex processes, e.g., collection, transport, storage, inspection, and redistribution - each of which increases logistical complexity and resource demands. (Fidlerová et al. 2021, 423; Ellen MacArthur Foundation 2019, 19) Additionally, reverse logistics are impeded by infrastructure and capacity limitations, unpredictable return volumes, high inventory costs, and the need for efficient tracking and coordination (Lai et al. 2022, 354; Lacy, Long, and Spindler 2020, 35). Firms also encounter challenges in information management and visibility, particularly regarding real-time updates. Despite the availability of advanced information technology, they struggle to control the quantity, quality, and timing of returns, as supportive capabilities remain underdeveloped. (García-Sánchez, Guerrero-Villegas, and Aguilera Caracuel 2019, 2; Sundin, and Dunbäck 2013, 2)

Rebound effect: Finally, circular rebound effects can arise, with unintended consequences undermining sustainability (Bradley and Corsini 2023, 127). In this context, analyses of the German non-food e-commerce market indicate that reusable packaging may exhibit lower sustainability than single-use packaging, mainly due to increased carbon dioxide emissions from transport (Figure 4). Consequently, while SP adoption aims to reduce environmental impacts, e.g., through waste minimization or prolonged lifespans, the rebound effect highlights the complexities, where improved circularity through reuse can lead to increased GHG emissions, potentially negating some of the intended environmental benefits. Hence, e-commerce firms must consider the full lifecycle emissions to minimize rebound effects and thus overcome this ultimate key challenge.

3 Methodology

3.1 Research Design

Overall, this work employs a qualitative methodological approach, chosen for its ability to offer nuanced findings for complex, multi-stakeholder issues like SP in e-commerce. The primary objective is to identify key opportunities and barriers to SP adoption across various stakeholder groups in the e-commerce packaging SC. Consequently, a qualitative approach was selected to allow for rich, detailed responses that capture the topic's complexities, providing a holistic view of the factors impacting SP adoption. Here, interviews were selected as the principal approach for gathering data because of their effectiveness in capturing the diverse stakeholders' perspectives.

3.2 Stakeholder Groups

This research examines three stakeholder groups, each critical in the e-commerce packaging SC, and selected based on precise criteria. Interviewee details are outlined in Table 3. Each participant is cited using a group identifier (A, B, C) and a chronological number reflecting the response order.

E-Commerce Companies: Firms that sell directly to consumers online, being responsible for the packaging decisions directly impacting sustainability [group A]. Participants were selected based on the firms' strong online presence and demonstrated interest or active engagement in SP practices.

LSPs: Organizations responsible for the transport, delivery, and reverse logistics of e-commerce parcels, where packaging affects efficiency and environmental impact [group B] - chosen based on collaborations with major e-commerce companies, thus in direct contact with packaging processes.

End-of-Life Packaging Management Entities: Firms involved in the processing of e-commerce packaging waste, focusing on disposal, recycling, and waste reduction efforts [group C] - selected based on their European presence and expertise in downstream impacts of packaging sustainability.

3.3 Data Collection

The study's data was primarily gathered through interviews. The interview sample included business representatives from the three stakeholder groups, each playing a critical role within the e-commerce landscape and offering unique perspectives on the opportunities and challenges in SP adoption. Accordingly, the insights are from industry experts, reflecting personal opinions and not speaking on behalf of their firms. The interview process was conducted through a questionnaire sent via email and involved a total of ten participants, with five representatives from group A, three from group B, and two from group C. Participants were provided with open-ended questions, enabling them to offer detailed responses at their convenience. A total of 15 similar questions were asked, with two specific questions tailored to each stakeholder group to address their unique roles along the SC. The format allowed for in-depth insights with a response period of several weeks to ensure comprehensive input. Key themes explored in the interview are presented in Table 4.

3.4 Data Analysis

The interview data was evaluated through a thematic analysis which is a qualitative method suitable for identifying key patterns and variations. This approach involved systematically grouping similar insights and identifying recurring themes related to SP. This analysis facilitated a thorough comprehension of the opportunities and barriers shared by each stakeholder group. However, the scope was restricted by the limited sample size, potentially failing to comprehensively reflect the full spectrum of the e-commerce packaging SC. Moreover, potential biases, e.g., differing question interpretations, might influence the research findings. While the insights gathered are valuable, the generalizability of the results is constrained by the specific focus on a limited set of stakeholders.

4 Results and Discussion: Key Opportunities and Challenges

This section outlines key interview insights on SP adoption, focusing on practical considerations.

4.1 E-Commerce Companies

Notably, all e-commerce experts (A1-A5) validated the 12 literature's key chances and barriers, but some were deemed more significant due to various factors. Thus, the focus is placed accordingly.

To be precise, European regulatory pressure, e.g., in terms of the EPR and PPWR, was identified as a major chance for SP adoption (A1, A2, A3, A5). However, interviewees also noted that there is a tension between overregulation and the continued freedom to make unsustainable choices. The legislative process is perceived as slow and fragmented, involving multiple non-harmonized laws that create uncertainty and hence cause firms to withhold investments. (A1, A2) For instance, local political initiatives, like the French Triman symbol with its specific, national labeling obligations, exemplify these inconsistencies (A2). The forthcoming PPWR is anticipated to improve this (A1) and drive SP adoption (A2), as “the acceleration happens through regulatory nudging” (A5). This underscores the complexities, as regulations represent both a key opportunity and a main challenge.

Consumer pressure is another confirmed key opportunity (A1, A3) as SP improves experiences by meeting rising demand (A2, A3, A5), though experts simultaneously emphasized the attitude-behavior-gap as a key challenge (A2, A3). According to them, “consumers tend to say they prefer SP but in reality, it has no effect when the price fits customers' expectations” (A2). Purchasing decisions are primarily driven by factors such as speed, cost, or convenient returns, and packaging often receives little attention as it is quickly discarded (A2, A3). Hence, experts either viewed consumers as an enabler (A1) or barrier (A2), highlighting that further education is needed (A3).

Moreover, each interviewee indicated potential cost reductions as a key opportunity (A1-A5) since economic viability always represents a challenge within e-commerce. According to A1, there is a 300% cost difference between shipping in paper- versus plastic mailers from a packaging supply perspective. However, “higher prices are in competitive times a No-Go” and “ROI must be reached after a short period - no longer than 2-5 years” but “savings due to packaging changes are often low” (A2). Other experts confirm this by noting that “to scale a solution [...] it must be price-compatible with conventional packaging or at least have only a small surcharge” (A3). As “companies [...] tend to make cost-based decisions” (A1), it is critical that potential cost reductions are achieved when implementing innovative SP solutions, so costs are not jeopardized (A5).

Although every interview partner highlighted the strong potential of reusable packaging (A1-A5), e.g., due to enhanced sustainability or potential cost benefits (A5), the associated barriers currently outweigh this opportunity. In fact, “reusable e-commerce packaging sounds like the holy grail but there is no proven solution yet solving the return flows” (A1). An interviewee underlines this issue, as they face challenges because “major adjustments to [...] logistics processes are [...] necessary” (A3) - serving as a reason why they are not yet able to implement it. Therefore, supply must be ensured at all times “because an operation will come to a stop if there is no packaging available to prepare shipments” (A1). The rebound effect was also stressed, as reusable packaging “always [...] means more trucks on the roads” (A5), resulting in higher GHG emissions. Additionally, there are “non-harmonized [...] approaches” (A2) from different start-ups (A1, A2) - each with its own Electronic Data Interchange (EDI), so complexity increases. Ultimately, the initial investment for individual firms is not cost-effective, but a shared infrastructure for returns and cleaning would make reusable packaging viable (A1, A2). Overall, firms should constantly reassess this issue and try to identify opportunities for implementing reusable packaging in the near term (A3).

Most interviewees viewed complex trade-offs in packaging requirements as the biggest challenge (A2, A3, A4). Besides the packaging's environmental function, it has to fulfill other crucial needs like protection, costs, and consumer-, legal-, and logistical requirements. Hence, SP must meet many demands, with numerous aspects proving to be contradictory in practice. (A4) For instance, “reusable packaging often results in significant empty space or SP made entirely from 100% recycled materials is often significantly heavier than packaging made from primary materials to maintain equivalent performance characteristics” (A4). According to another interviewee “it is always a trade-off between overpacking and damage rate. In the end, the loss of the articles weighs more than any kind of packaging.” (A2). As a result, trade-offs are inevitable, yet a minimum standard for each requirement must be met - which represents a major challenge (A2, A4).

Packaging on-demand machines were pointed out as an additional key opportunity to avoid empty space or waste - being particularly relevant in the context of corrugated box packaging and online retailers that handle a wide variety of product shapes (A2). However, currently “they need an incredible lot of space and are expensive” (A2), thus not affordable for (smaller) companies.

Finally, two additional key barriers were identified. First, buyers tend to use large quantities of PVC adhesive tapes to secure returned items, often applying excessive tape to ensure that products are not lost during the return. The underlying client concern is the potential financial loss associated with shipment discrepancies. However, this practice diminishes the recyclability of plastic mailers and corrugated boxes by increasing **contamination**, thus education is needed. (A2) Second, Nike's next steps involve progressively optimizing packaging sizes. Key challenges in this process include limited awareness and understanding of the current situation, mainly resulting from deficiencies in the **right data availability** or **master data accuracy**. (A1) This likely extends to other companies.

4.2 Logistics Service Providers

The LSPs (B1-B3) confirmed the 12 key chances and barriers, yet the focus was placed differently. Increasing consumer pressure was pointed out as a key driver (B1-B3). If firms adopt SP to meet client expectations, they will achieve “higher retention rates, positive word-of-mouth, brand loyalty and differentiation” (B2). In this context, LSPs confirmed competitive advantages as a key chance (B1-B3) through unique selling propositions or new segment attraction although no respondent from group A pointed this out. Here, regulatory pressure was also validated by stating that “once the CSRD is effective [...], the public will be able to better understand and compare sustainability practices and will make better decisions” (B2). The Corporate Sustainability Reporting Directive (CSRD) is an EU regulation mandating firms to disclose ESG information, enhancing transparency and accountability (European Commission 2024e). However, the PPWR initially aimed to set a holistic reuse target for e-commerce packaging, but cardboard boxes were subsequently exempted, thus “it seems as if the opportunity is missed to really enable the transition to SP” (B3).

In line with the results of chapter 4.1, economic viability was emphasized as a key barrier, with a respondent noting “based on conversations we had with clients, the main barriers for SP were [...] the additional costs for both parties” (B1). According to another respondent, the main obstacle to reusable packaging is its higher cost, too. Here, reverse logistics can range from €1.80 to €5 per (empty) unit, plus a €1.50 service fee for the packaging provider, compared to just €0.80 - €1 for a single-use cardboard box which e-commerce retailers do not need to manage post-consumer. (B3) However, while the higher costs associated with SP are evident, this perspective must be critically examined in light of potential long-term savings. As firms innovate and scale up, the cost may decrease, and the higher initial investments might eventually be offset by gains in client loyalty or regulatory compliance. Furthermore, as CE models evolve, the infrastructure for reverse logistics

may become more efficient and cost-effective, presenting new chances for cost reduction over time. Besides the economic barrier, the challenge of UX design was stressed, too - requiring “additional integration work to be able to allow consumers to select a packaging option at shops” (B1). However, with appropriate resource allocation, this barrier can be addressed effectively, potentially facilitating smoother integration and a seamless UX, ultimately fostering wider SP adoption.

Aligned with e-commerce respondents (A2, A3, A4), LSPs also indicate the complex trade-offs in packaging requirements as the biggest challenge (B1, B2) since “often sustainability and business requirements are opposite” (B2). This tension is particularly evident considering the packaging's durability as using paper-based materials can increase the risk of damage, leading to higher costs eventually (B1). Thus, the key is to find better ways to balance trade-offs. Moreover, the previously identified challenge of data availability is further reinforced, as this is a key obstacle in evaluating SP benefits. The complexity of these multi-factor calculations is exacerbated by the lack of relevant data or requires in-depth Life Cycle Assessment (LCA) analysis. This lack of clarity hinders the creation of comparative metrics needed to persuade decision-makers to adopt SP solutions. (B3)

In contrast to e-commerce firms, the majority of LSPs do not perceive reverse logistics as a barrier to implementing reusable packaging (B1, B2), stressing that “logistics operators can adapt to this” (B2). However, they highlight the rebound effect by emphasizing that “it is important to align all the players: if a parcel is larger or heavier, more emissions will arise from transportation. Hence, it is crucial to evaluate the decrease in emissions with packaging considering if it will increase transportation and other emissions” (B2). The sole additional challenge identified by LSPs is linked to **major changes in standard operation procedures**, e.g., staff training, machine adaptation, or the sourcing of sufficient fleet capacity to enable effective reusable packaging collection (B1).

4.3 End-of-Life Packaging Management Entities

Beyond validating the 12 opportunities and challenges identified in the literature review, group C interviewees provided further valuable insights. For instance, they align with e-commerce firms, agreeing that barriers outweigh the potential of reusable packaging. Although “implementing reusable packaging will become a requirement” (C1) due to the PPWR, being “an investment that pays off in the long run” (C1), “the implementation of reuse is the real challenge in e-commerce” (C2). This challenge arises as reuse is not universally applicable, requiring a contextual understanding of its environmental and economic feasibility. Key factors include material, weight, transport distances, return rates, reconditioning, and the number of rotations. Thus, LCAs are needed to determine when reuse outweighs single use, e.g., the minimum number of rotations required for economic or environmental benefits. (C2) To scale reuse, firms should partner with LSPs and adopt **pick-up points** (PUPs) for packaging returns, as they represent a major opportunity for SP (C2). Overall, the last mile of e-commerce causes severe environmental harm, underscoring the need to redirect deliveries and returns to PUPs for more efficient transport. However, for PUPs to be beneficial, consumers should avoid extra trips or access them emission-free. Success also relies on adoption and cost-effectiveness, especially in areas with low delivery or return rates.

Finally - as noted by C2 - while many firms prefer cardboard, “the environment could be better off with **plastic packaging**”, as it is lighter and can have 100% recycled content, similar to cardboard. However, although plastic packaging might represent an opportunity for SP adoption because of its lower carbon footprint (C2), its broader environmental impact - including plastic waste or its long-term sustainability - requires careful consideration. The shift to plastic could exacerbate issues like plastic pollution or microplastics, which persist in the environment and pose significant risks to ecosystems unless accompanied by effective waste management and recycling systems.

4.4 Comparative Analysis of Stakeholder Perspectives

The interview insights shed light on the crucial, practical aspects of adopting SP in the e-commerce sector. All interviewees, representing diverse roles across the SC, confirmed the relevance of the 12 key opportunities and challenges identified in the literature. However, their insights revealed subtle differences in how these factors were prioritized, with perspectives varying depending on the business context. These variations are presented in Table 5 and Table 6.

Overall, the analysis revealed a lack of consensus on SP among stakeholders, with definitions varying widely. While some focused on environmental aspects of SP, e.g., a low carbon footprint or material reduction, others emphasized the social dimension - often overlooked - revealing strong disparities in perspectives. This divergence hinders the development of standardized SP strategies in e-commerce, reflecting misaligned priorities and a potential lack of alignment on key objectives. Despite varying definitions, stakeholders unanimously emphasized the importance of adopting SP in e-commerce, especially to address overpackaging and the resulting waste. Alongside regulatory pressure, most stakeholders saw collaboration as a major chance - emphasizing that “collaboration is key” (B2, C2), and that “the transition can only really take place with many parties involved” (B3). One interviewee further noted that “in our experience, there is great [...] willingness and transparency and little competition” (A3), stressing the need for mutual learning when testing SP.

In conclusion, while the interviewees recognized the opportunities for SP adoption, particularly in terms of external pressure and collaboration, they also identified substantial challenges. These challenges encompass complex trade-offs in packaging requirements, reverse logistics linked to reuse, and especially economic viability. Effectively leveraging these chances and overcoming the identified barriers will be crucial to realizing the full potential of SP within the e-commerce sector.

4.5 Implications for Sustainable Packaging Adoption in E-Commerce

The successful adoption of SP in e-commerce requires not only understanding the opportunities and barriers but also critically assessing how firms approach these transition issues. Two key aspects, collaboration as a chance and economic viability as a primary challenge, emerge as central.

Collaboration is frequently highlighted as a key opportunity for advancing SP adoption, yet it remains underexploited. The complexity of SP solutions requires cooperation between suppliers, retailers, LSPs, end-of-life packaging management entities, regulatory bodies, or even competitors.

Despite its recognized importance, e-commerce players hesitate to collaborate due to competitive interests or a reluctance to share knowledge and resources which could accelerate the SP adoption.

This resistance to sharing best practices reflects a focus on immediate competitive gains instead of long-term sustainability goals, thereby hindering progress and limiting systemic change. The frequent citation of economic viability as a key obstacle is especially striking, yet arguably understandable given the higher costs associated with SP. Despite their vast financial resources, sophisticated SCs, and global influence, costs are framed as an obstacle. This raises doubts about whether sustainability is truly prioritized or if economic concerns are merely used to delay the transition. The claim that SP is economically difficult is especially hard to justify for profitable firms able to absorb initial costs, allocate resources accordingly, and leverage economies of scale through innovation. Given the global climate crisis, prioritizing immediate cost concerns over the long-term (economic) benefits of sustainability diminishes the responsibility these firms uphold.

Consequently, a transition from immediate risk aversion to long-term strategic thinking is required.

E-commerce giants must lead the transition more proactively, fostering collaboration, transcending competitive borders, scaling innovation, and viewing sustainability as a driver of long-term growth.

5 Conclusion

The global focus on sustainable e-commerce presents a crucial yet challenging mission for firms. Packaging, as a core element of e-commerce, affects the environment through waste and emissions. Thus, many companies are committed to fighting climate change by defining clear strategic targets, thereby integrating SP alternatives. Yet, the key chances for advancing SP, along with barriers that may impede this progress, remain unclear. Hence, this section summarizes the study's key findings.

To answer the RQ, data is primarily drawn from scientific literature and in-depth expert interviews. The stakeholders are split into three main groups, i.e. e-commerce companies, LSPs, and end-of-life packaging management entities, which allows a granular investigation. The literature review reveals six central opportunities and challenges which are further validated by industry experts. Subsequent qualitative research points to three additional chances, as well as three barriers. A high-level overview is presented in Table 7. Based on the analysis, the RQ is answered, and major chances include the introduction of reusable packaging at scale, consumer-, and regulatory pressure - especially in light of the upcoming PPWR which imposes specific e-commerce targets and penalties, positioning SP as a strategic investment and risk mitigator. On the other hand, the results indicate that barriers primarily involve economic viability, reverse logistics, consumer attitude-behavior-gaps, and complex trade-offs in packaging requirements. The chances each entail implementation challenges or vice versa - e.g., reusable packaging highlights this dual relationship, involving logistics constraints and potential rebound effects. This research clearly illustrates the overarching chances and obstacles to establishing SP in B2C e-commerce in Europe. However, it also raises questions of how to seize the main chances and mitigate obstacles to advance a CE. In this context, every interviewee stressed the importance of collaboration - viewing it not only as a major opportunity to adopt SP but also as an effective strategy to overcome major challenges. In

general, this work emphasizes that tremendous progress still must be made to ensure SP adoption at scale. The overall investigation shows which aspects firms must pay particular attention to when transforming their packaging practices. Thus, this paper outlines strategic priorities concerning their shift to SP. This work further provides evidence that it is indeed complex to adopt SP - possibly more challenging than consumers expect - but opportunities enable progress, should firms explore them. However, while the opportunities and challenges outlined offer an initial analysis, there are limitations and further research implications that will be addressed in the next section.

5.1 Limitations and Implications for Further Research

Beyond the scope limitations outlined in chapter 1.3, this study also faces several other constraints. A significant constraint is the focus on qualitative interview data, which, while providing deep insights, may not adequately encompass the full diversity of the industry's perspectives. To better grasp the findings' implications, future research might adopt a hybrid method approach integrating qualitative and quantitative data in order to acquire an enhanced understanding of SP adoption. Engaging a more extensive or diverse set of interviewees, e.g., including B2B e-commerce, smaller firms, customers, and a broader geographic or industry-specific sample, would ensure that the findings are more representative. Additionally, exploring sector-specific challenges, e.g., those within the food or electronics industries, could provide a more nuanced understanding of the varying circumstances across different e-commerce sectors. In this context, it must be highlighted that a “one-sustainable-package-fits-all” solution does not exist. Thus, rather than proposing a universally applicable framework for the ideal SP adoption, it can be argued that its implementation in the e-commerce domain requires a case-by-case assessment, considering different factors. In addition, further research is essential to determine the implications of these findings, exploring specific measures for leveraging the key opportunities and mitigating the major challenges.

Furthermore, the social component of SP has been disregarded. Consequently, analyzing the social impacts per type of SP can yield relevant insights into their effects on the surrounding environment, informing implementation strategies. Therefore, future research should explore opportunities and barriers linked to the triple bottom line's social pillar for a more comprehensive understanding. The analysis could be narrowed down even further, not only focusing on the main opportunities or challenges but also on minor ones, based on specific criteria, to create an overall portrait. Europe should also be examined more deeply by analyzing each country, as it was not possible to approach the countries individually due to the limited scope. This breakdown would result in a more precise identification of chances and hurdles, leading to measures based on a deeper understanding, e.g., in terms of local infrastructure or supply chain considerations. Another avenue for exploration lies in the identification of opportunities and challenges associated with each type of packaging, i.e. primary, secondary, and tertiary packaging. This pathway could facilitate a deeper understanding of the distinct requirements associated with each packaging category, thereby helping companies to effectively implement SP while considering the operational impacts of each packaging type. To gain further practical insights, it is also recommended to conduct this analysis more granularly for each SP alternative, e.g., reusable, recyclable, or biodegradable options. A detailed exploration like this would provide firms with actionable recommendations for selecting and implementing the most effective SP solutions based on specific needs and contexts.

As a closing remark, this study reinforces the significance of SP implementation in advancing the shift towards a CE in e-commerce. Achieving this shift requires not only addressing opportunities and challenges but, more importantly, a fundamental change in consumption patterns and business practices. By strongly embracing CE principles and fostering collaborations, e-commerce can drive sustainability through reduced environmental harm, resource efficiency, and closed-loop systems.

6 List of References

- Afif, Karima, Claudia Rebolledo, and Jacques Roy. 2021. “Drivers, barriers and performance outcomes of sustainable packaging: a systematic literature review.” *British Food Journal* 124 (3): 915-935. <https://doi.org/10.1108/BFJ-02-2021-0150>.
- Amazon.com, Inc. 2024. *2023 Amazon Sustainability Report*. <https://sustainability.aboutamazon.com/2023-amazon-sustainability-report.pdf>
- Arora, Arun, Tjark Freundt, Brian Gregg, Neira Hajro, Caroline Meder, and Katharina Schumacher. 2024. “How playing offense on sustainability can power e-commerce performance.” McKinsey & Company. March 26, 2024. <https://www.mckinsey.com/capabilities/growth-marketing-and-sales/our-insights/how-playing-offense-on-sustainability-can-power-e-commerce-performance#/>.
- Arora, Tanya, Sarvani Reddy Chirla, Nimisha Singla, and Lovleen Gupta. 2023. “Product Packaging by E-commerce Platforms: Impact of COVID-19 and Proposal for Circular Model to Reduce the Demand of Virgin Packaging.” *Circular Economy and Sustainability* 3: 1255–1273. <https://doi.org/10.1007/s43615-022-00231-4>.
- Bernon, Michael, Benny Tjahjono, and Eva Faja Ripanti. 2018. “Aligning Retail Reverse Logistics Practice with Circular Economy Values: An Exploratory Framework.” *Production Planning & Control* 29 (6): 483–97. <https://doi.org/10.1080/09537287.2018.1449266>.
- Beyrouthy, Lynn. 2024. “E-commerce in the European Union – statistics & facts.” Statista. Accessed October 26, 2024. <https://www.statista.com/topics/3792/e-commerce-in-europe/#topicOverview>.
- Biancolin, Marta, and Lucia Rotaris. 2024. “Environmental impact of business-to-consumer e-commerce: Does it matter to consumers?” *Research in Transportation Business & Management* 52: 101087. <https://doi.org/10.1016/j.rtbm.2023.101087>.
- Boz, Ziyne, Virpi Korhonen, and Claire Koelsch Sand. 2020. “Consumer Considerations for the Implementation of Sustainable Packaging: A Review.” *Sustainability* 12 (6): 2192. <https://doi.org/10.3390/su12062192>.
- Bradley, Charles G., and Lucia Corsini. 2023. “A literature review and analytical framework of the sustainability of reusable packaging.” *Sustainable Production and Consumption* 37: 126-141. <https://doi.org/10.1016/j.spc.2023.02.009>.

- Chamas, Ali, Hyunjin Moon, Jiajia Zheng, Yang Qiu, Tarnuma Tabassum, Jun Hee Jang, Mahdi Abu-Omar, Susannah L.Scott, and Sangwon Suh. 2020. "Degradation Rates of Plastics in the Environment." *ACS Sustainable Chemistry & Engineering* 8 (9): 3494-3511. <https://doi.org/10.1021/acssuschemeng.9b06635>.
- Chueamuangphan, K., P. Kashyap and C. Visvanathan. 2020. "Packaging Waste from E-Commerce: Consumers' Awareness and Concern." In *Sustainable Waste Management: Policies and Case Studies*, edited by Sadhan Kumar Ghosh, 27-41. Singapore: Springer.
- Circpack by Veolia. 2024. *Packaging and Packaging Waste Regulation (PPWR): 2024 Update*. Veolia Environnement SA. https://www.circpack.veolia.com/sites/g/files/dvc4656/files/document/2024/07/PPWR%20infographic%20%28EN%29_0.pdf
- Delfmann, Werner, Sascha Albers, and Martin Gehring. 2002. "The impact of electronic commerce on logistics service providers." *International Journal of Physical Distribution & Logistics Management* 32 (3): 203-222. <https://doi.org/10.1108/09600030210426539>.
- Deloitte. 2024. "Why and how to reduce packaging waste in e-commerce fulfilment centres." What we do. Accessed October 27, 2024. <https://www.deloitte.com/nl/en/Industries/consumer/perspectives/why-and-how-to-reduce-packaging-waste-in-e-commerce-fulfilment-centres.html>.
- Deweese, Donald N., and Michael J. Hare. 1998. "Economic Analysis of Packaging Waste Reduction." *Canadian Public Policy / Analyse de Politiques* 24 (4): 453-470. <https://doi.org/10.2307/3552019>.
- Ecommerce Europe. 2023. *Position paper on the Packaging and Packaging Waste Regulation*. Brussels: Ecommerce Europe. <https://ecommerce-europe.eu/wp-content/uploads/2023/05/ECOM-Position-paper-PPWR-April-2023.pdf>
- Ecommerce Europe. 2024a. "Current Company Members." Company Members. Accessed November 1, 2024. <https://ecommerce-europe.eu/members-of-ecommerce-europe/company-members/>.
- Ecommerce Europe. 2024b. "About Ecommerce Europe." Accessed November 1, 2024. <https://ecommerce-europe.eu/>.

- Ellen MacArthur Foundation. 2016. *The New Plastics Economy: Rethinking the future of plastics*.
https://emf.thirdlight.com/file/24/_A-BkCs_skP18I_Am1g_JWxFrX/The%20New%20Plastics%20Economy%3A%20Rethinking%20the%20future%20of%20plastics.pdf
- Ellen MacArthur Foundation. 2019. *Reuse - Rethinking Packaging*. https://emf.thirdlight.com/file/24/_A-BkCs_aXeX02_Am1z_J7vzLt/Reuse%20%E2%80%93%20rethinking%20packaging.pdf
- Ellen MacArthur Foundation. 2023. “Amazon.” Network. Accessed November 1, 2024.
<https://www.ellenmacarthurfoundation.org/amazon>.
- Escursell, Sílvia, Pere Llorach-Massana, and M. Blanca Roncero. 2021. “Sustainability in e-commerce packaging: A review.” *Journal of Cleaner Production* 280 (1): 124314.
<https://doi.org/10.1016/j.jclepro.2020.124314>.
- Eunomia Research and Consulting. 2021. *Extended Producer Responsibility for Packaging: Elements and Outcomes*. New York: Eunomia.
- European Commission. 2024a. “Packaging waste.” Energy, Climate change, Environment. Accessed October 26, 2024. https://environment.ec.europa.eu/topics/waste-and-recycling/packaging-waste_en.
- European Commission. 2024b. “The European Green Deal.” Accessed October 31, 2024.
https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en.
- European Commission. 2024c. “Circular economy action plan.” Energy, Climate change, Environment. Accessed October 31, 2024. https://environment.ec.europa.eu/strategy/circular-economy-action-plan_en.
- European Commission. 2024d. “Waste Framework Directive.” Energy, Climate change, Environment. Accessed October 31, 2024. https://environment.ec.europa.eu/topics/waste-and-recycling/waste-framework-directive_en.
- European Commission. 2024e. “New rules on corporate sustainability reporting: The Corporate Sustainability Reporting Directive.” Corporate sustainability reporting. Accessed November 17, 2024. https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en.

European Parliament. 2024. *European Parliament legislative resolution of 24 April 2024 on the proposal for a regulation of the European Parliament and of the Council on packaging and packaging waste, amending Regulation (EU) 2019/1020 and Directive (EU) 2019/904, and repealing Directive 94/62/EC (COM(2022)0677 – C9-0400/2022 – 2022/0396(COD))*.

https://www.europarl.europa.eu/doceo/document/TA-9-2024-0318_EN.pdf

EXPRA. 2024a. *30 YEARS OF OPTIMUM EPR: HOW TO MAKE THE BEST OUT OF IT*. Brussels:

EXPRA. <https://expira.eu/wp-content/uploads/2024/10/30-YEARS-OF-OPTIMUM-EPR-HOW-TO-MAKE-THE-BEST-OUT-OF-IT-4.pdf>

EXPRA. 2024b. “European Parliament Takes First Step: Adoption of the Packaging and Packaging Waste Regulation (PPWR) on April 24, 2024.” Newsletter Spring 2024. June 18, 2024.

<https://expira.eu/2024/06/18/european-parliament-takes-first-step-adoption-of-the-packaging-and-packaging-waste-regulation-ppwr-on-april-24-2024/>.

Fidlerová, Helena, Helena Makyšová, Lucia Sklenářová, and Paula Bajdor. 2021. “STREAMLINING PACKAGING AS PART OF SUSTAINABLE REVERSE LOGISTICS PROCESSES.” *Acta logistica* 8 (4):423-433. <https://doi.org/10.22306/al.v8i4.249>.

Franzoi, Sandro, and Jan vom Brocke. 2022. “Sustainability by Default? Nudging Carbon Offsetting Behavior in E-Commerce.” In *30th European Conference on Information Systems: New Horizons in Digitally United Societies*. Timișoara, Romania.

García-Arca, Jesús, J. Carlos Prado-Prado, and A. Trinidad Gonzalez-Portela Garrido. 2014. “Packaging logistics: promoting sustainable efficiency in supply chains.” *International Journal of Physical Distribution & Logistics Management* 44 (4): 325-346. <https://doi.org/10.1108/IJPDLM-05-2013-0112>.

García-Sánchez, Encarnación, Jaime Guerrero-Villegas, and Javier Aguilera-Caracuel. 2019. “How Do Technological Skills Improve Reverse Logistics? The Moderating Role of Top Management Support in Information Technology Use and Innovativeness.” *Sustainability* 11 (1): 58. <https://doi.org/10.3390/su11010058>.

Herbes, Carsten, Christoph Beuthner, and Iris Ramme. 2018. “Consumer attitudes towards biobased packaging – A cross-cultural comparative study.” *Journal of Cleaner Production* 194: 203-218. <https://doi.org/10.1016/j.jclepro.2018.05.106>.

- Hua, Wei, and Zhou Jing. 2015. "An Empirical Study on E-commerce Logistics Service Quality and Customer Satisfaction." *WHICEB 2015 Proceedings* 62: 268-275.
- Jerzyk, Ewa. 2016. "Design and Communication of Ecological Content on Sustainable Packaging in Young Consumers' Opinions." *Journal of Food Products Marketing* 22 (6): 707-716.
<http://doi.org/10.1080/10454446.2015.1121435>.
- Jestratijevic, Iva, Irina Maystorovich, and Urška Vrabič-Brodnjak. 2022. "The 7 Rs sustainable packaging framework: Systematic review of sustainable packaging solutions in the apparel and footwear industry." *Sustainable Production and Consumption* 30: 331-340.
<https://doi.org/10.1016/j.spc.2021.12.013>.
- Kassaye, W. Wossen. 2001. "Green dilemma." *Marketing Intelligence & Planning* 19 (6): 444-455.
<https://doi.org/10.1108/EUM0000000006112>.
- Kim, Rae Yule. 2020. "The Impact of COVID-19 on Consumers: Preparing for Digital Sales." *EEE Engineering Management Review* 48 (3): 212-218. <https://doi.org/10.1109/EMR.2020.2990115>.
- Lacy, Peter, Jessica Long, and Wesley Spindler. 2020. *The Circular Economy Handbook: Realizing the Circular Advantage*. Berlin, Germany: Springer Nature Limited. <https://doi.org/10.1057/978-1-349-95968-6>.
- Lai, Nai Yeen Gavin, Adrian T. H. Kuah, Chang H. Kim, and Kok Hoong Wong. 2022. "Toward sustainable express deliveries for online shopping: Reusing packaging materials through reverse logistics." *Thunderbird International Business Review* 64 (4): 351–362.
<https://doi.org/10.1002/tie.22259>.
- Laudon, Kenneth C., and Carol Guercio Traver. 2016. *E-commerce 2016: business. technology. society*. 12th edition. London: Pearson.
- Lifset, Reid, Harri Kalimo, Antti Jukka, Petrus Kautto, and Mirella Miettinen. 2023. "Restoring the incentives for eco-design in extended producer responsibility: The challenges for eco-modulation." *Waste Management* 168: 189-201. <https://doi.org/10.1016/j.wasman.2023.05.033>.

- McKinsey & Company. 2023. "Estimated emissions of single use vs. reusable e-commerce packaging in Germany in 2022, by type (in grams of CO2 per item per cycle)." Statista. Accessed November 3, 2024. <https://www.statista.com/statistics/1405171/single-use-reusable-packaging-emissions-germany/>.
- Meherishi, Lavanya, Sushmita A. Narayana, and K.S. Ranjani. 2019. "Sustainable packaging for supply chain management in the circular economy: A review." *Journal of Cleaner Production* 237: 117582. <https://doi.org/10.1016/j.jclepro.2019.07.057>.
- Molina-Besch, Katrin, and Henrik Pålsson. 2015. "A Supply Chain Perspective on Green Packaging Development - Theory Versus Practice." *Packaging Technology and Science* 29: 45-63. <https://doi.org/10.1002/pts.2186>.
- Nagar, Komal. 2016. "Drivers of E-store Patronage Intentions: Choice Overload, Internet Shopping Anxiety, and Impulse Purchase Tendency." *Journal of Internet Commerce* 15 (2): 97–124. <https://doi.org/10.1080/15332861.2016.1148971>.
- Niero, Monia, Michael Hauschild, Simon Hoffmeyer, and Stig Olsen. 2017. "Combining Eco-Efficiency and Eco-Effectiveness for Continuous Loop Beverage Packaging Systems: Lessons from the Carlsberg Circular Community." *Journal of Industrial Ecology* 21 (3): 742-753. <https://doi.org/10.1111/jiec.12554>.
- Oceana. 2020. "Estimated annual e-commerce plastic packaging use in 2019 with projections to 2025." Statista. Accessed October 27, 2024. <https://www.statista.com/statistics/1271093/annual-e-commerce-plastic-packaging-use-globally/>.
- OECD. 2008a. *OECD Glossary of Statistical Terms*. Paris: OECD Publishing.
- OECD. 2008b. *The Polluter Pays Principle: Definition, Analysis, Implementation*. Paris: OECD Publishing. <https://doi.org/10.1787/9789264044845-en>.
- Oláh, Judit, Nicodemus Kitukutha, Hossam Haddad, Miklós Pakurár, Domicián Máté, and József Popp. 2019. "Achieving Sustainable E-Commerce in Environmental, Social and Economic Dimensions by Taking Possible Trade-Offs." *Sustainability* 11 (1): 89. <https://doi.org/10.3390/su11010089>.

- Olson, Eric L. 2013. "It's Not Easy Being Green: The Effects of Attribute Tradeoffs on Green Product Preference and Choice." *Journal of the Academy of Marketing Science* 41 (2): 171-184. <https://doi.org/10.1007/s11747-012-0305-6>.
- Otto Group. 2024. *Sustainability 2023/24*. https://www.ottogroup.com/medien/dynamic/docs/en/bpk/2024/otto_group_ar_2023_24_sustainability.pdf
- Paul, Justin, Ashwin Modi, and Jayesh Patel. 2016. "Predicting green product consumption using theory of planned behavior and reasoned action." *Journal of Retailing and Consumer Services* 29: 123-134. <https://doi.org/10.1016/j.jretconser.2015.11.006>.
- Ramanathan, Ramakrishnan. 2011. "An empirical analysis on the influence of risk on relationships between handling of product returns and customer loyalty in E-commerce." *International Journal of Production Economics* 130 (2): 255-261. <https://doi.org/10.1016/j.ijpe.2011.01.005>.
- Robertson, Gordon L. 1990. "Good and Bad Packaging: Who Decides?" *International Journal of Physical Distribution & Logistics Management* 20 (8): 37-40. <https://doi.org/10.1108/09600039010005575>.
- Silva, Diogo Aparecido Lopes, Gece Wallace Santos Renó, Gustavo Sevegnani, Tacila Berkenbrock Sevegnani, and Oswaldo Mário Serra Truzzi. 2013. "Comparison of disposable and returnable packaging: a case study of reverse logistics in Brazil." *Journal of Cleaner Production* 47: 377-387. <https://doi.org/10.1016/j.jclepro.2012.07.057>.
- SPC. 2024. *Definition of Sustainable Packaging*. Baltimore: Sustainable Packaging Coalition.
- Statista. 2024. "Revenue of the e-commerce market in Europe from 2020 to 2029." E-Commerce. Accessed October 27, 2024. <https://www.statista.com/forecasts/715663/e-commerce-revenue-forecast-in-europe>.
- Sundin, Erik, and Otto Dunbäck. 2013. "Reverse logistics challenges in remanufacturing of automotive mechatronic devices." *Journal of Remanufacturing* 3 (2): 1-8. <https://doi.org/10.1186/2210-4690-3-2>.
- United Nations. 2024. "THE 17 GOALS." United Nations - Department of Economic and Social Affairs. Accessed November 11, 2024. <https://sdgs.un.org/goals#>.

- Verghese, K., and H. Lewis. 2007. "Environmental innovation in industrial packaging: a supply chain approach." *International Journal of Production Research* 45 (18-19): 4381-4401.
<https://doi.org/10.1080/00207540701450211>.
- Weinmann, Markus, Christoph Schneider, and Jan vom Brocke. 2016. "Digital Nudging." *Business & Information Systems Engineering* 58: 433-436. <https://doi.org/10.1007/s12599-016-0453-1>.
- White, Gareth, Xiaojun Wang, and Dong Li. 2014. "Inter-organisational green packaging design: A case study of influencing factors and constraints in the automotive supply chain." *International Journal of Production Research* 53: 1-16. <https://doi.org/10.1080/00207543.2014.975854>.
- White, Mary. 2022. "E-Commerce and the Evolution of Consumer Behavior." *International Multidisciplinary Journal Of Science, Technology & Business* 1 (02): 4-7.
- World Commission on Environment and Development. 1987. *Our Common Future*. New York: United Nations. https://digitallibrary.un.org/record/139811/files/A_42_427-EN.pdf?ln=en
- Xie, Guojie, Lijuan Huang, Chrysostomos Apostolidis, Zuqing Huang, Weiwei Cai, and Guokai Li. 2021. "Assessing Consumer Preference for Overpackaging Solutions in E-Commerce." *International Journal of Environmental Research and Public Health* 18 (15): 7951.
<https://doi.org/10.3390/ijerph18157951>.
- Yusuf, Yahaya Y., Adebola E. Olaberinjo, Thanos Papadopoulos, Angappa Gunasekaran, Nachiappan Subramanian, and Hossein Sharifi. 2017. "Returnable transport packaging in developing countries: drivers, barriers and business performance." *Production Planning and Control* 28 (6-8): 629-658.
<https://doi.org/10.1080/09537287.2017.1294271>.
- Zalando SE. 2021. *It Takes Two: How the Industry and Consumers Can Close the Sustainability Attitude-Behavior Gap in Fashion*. Berlin: Zalando SE.
https://corporate.zalando.com/sites/default/files/media-download/Zalando_SE_2021_Attitude-Behavior_Gap_Report_EN.pdf

7 Appendices

7.1 Appendix 1

Abbreviation	Meaning
B2B	Business-to-Business
B2C	Business-to-Consumer
C2C	Consumer-to-Consumer
CE	Circular Economy
CSRD	Corporate Sustainability Reporting Directive
EDI	Electronic Data Interchange
EPR	Extended Producer Responsibility
EU	European Union
GHG	Greenhouse Gas
LCA	Life Cycle Assessment
LSP	Logistics Service Provider
NCEAP	New Circular Economy Action Plan
PPP	Polluter Pays Principle
PPWD	Packaging and Packaging Waste Directive
PPWR	Packaging and Packaging Waste Regulation
PUP	Pick-up Point
PVC	Polyvinyl Chloride
ROI	Return on Investment
RQ	Research Question
SC	Supply Chain
SDG	Sustainable Development Goal
SP	Sustainable Packaging
UX	User Experience

Table 1: List of Abbreviations

7.2 Appendix 2

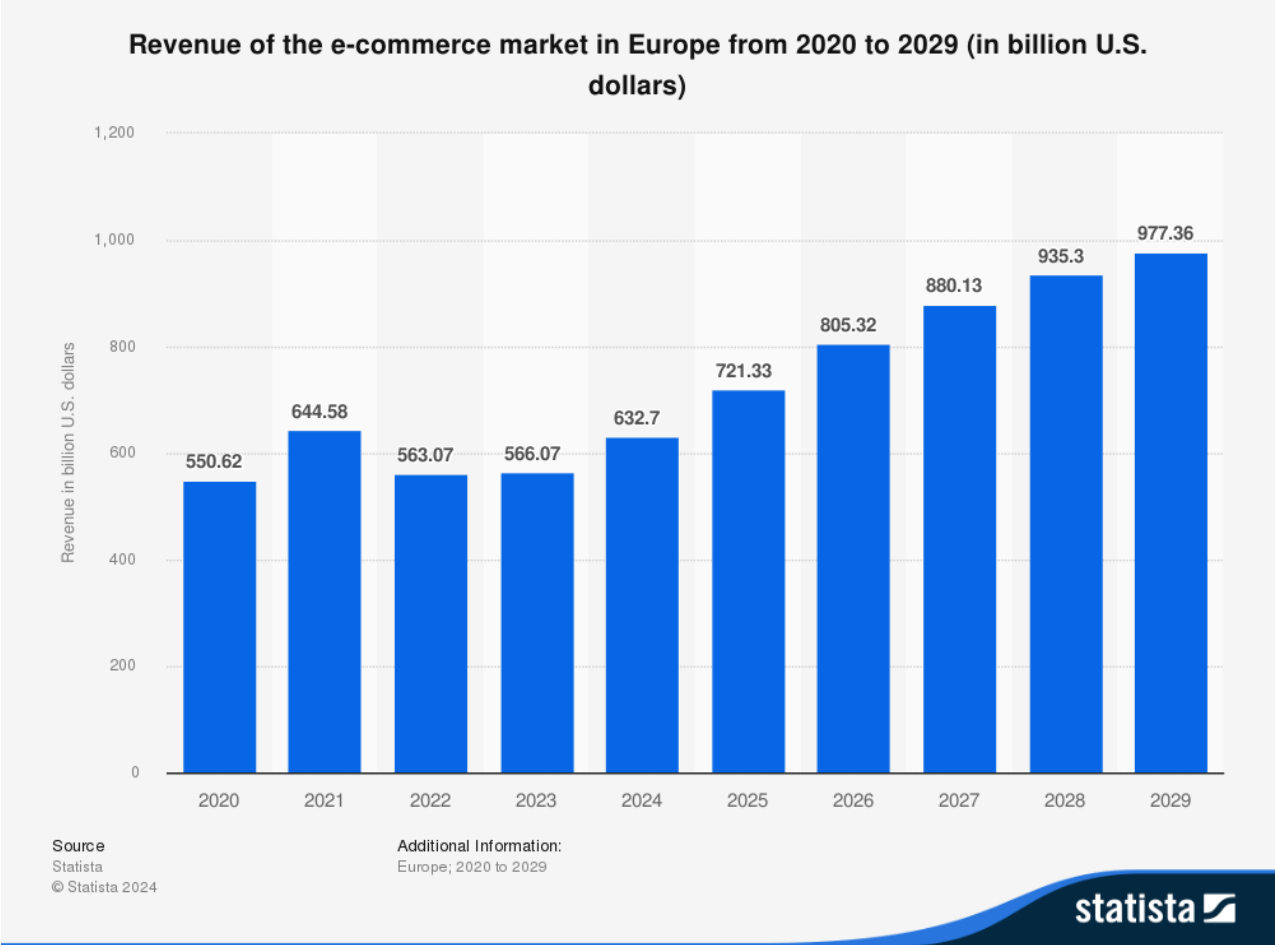


Figure 1: E-Commerce Trend: Revenue in Europe
(Statista 2024)

7.3 Appendix 3

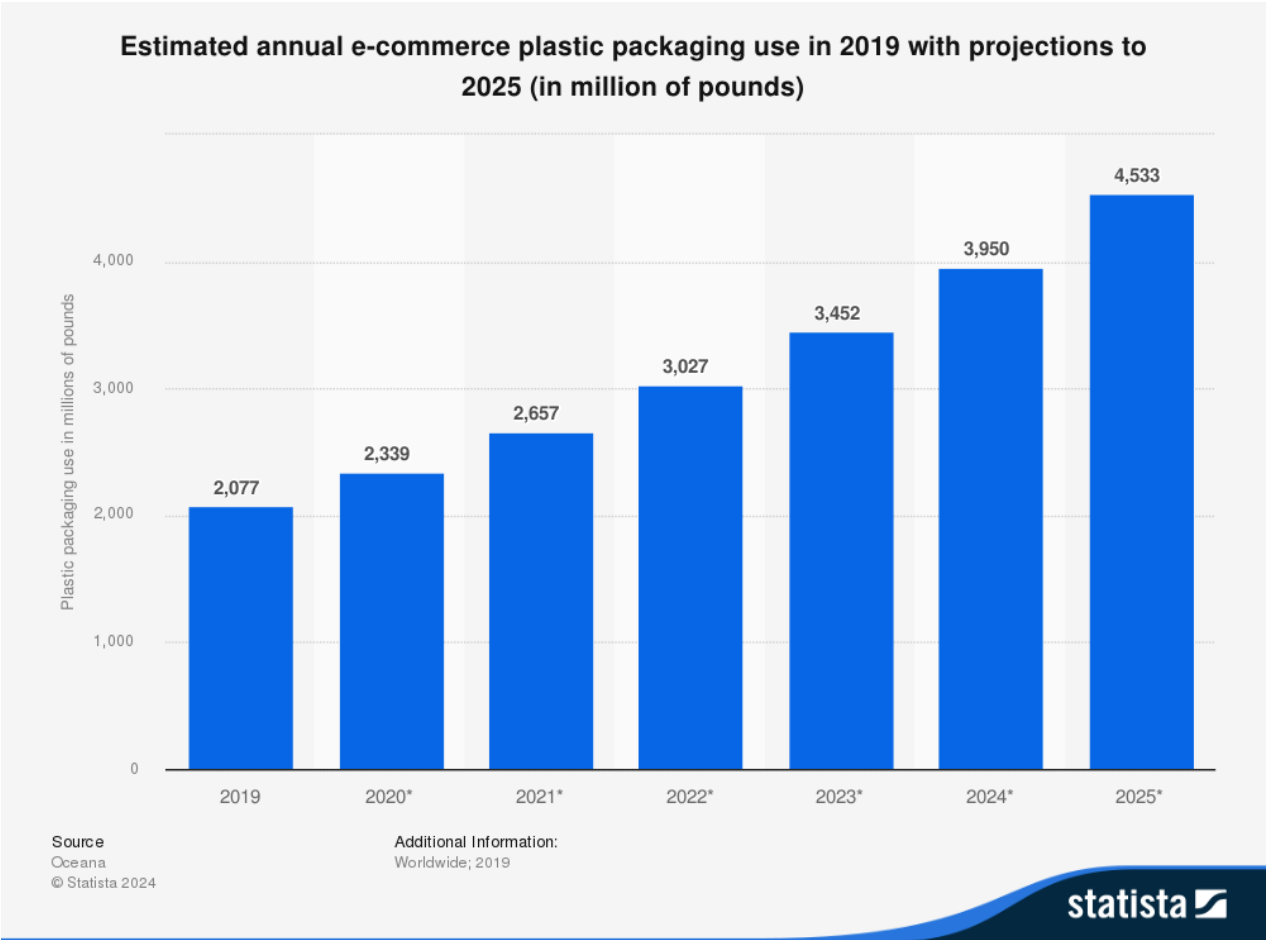


Figure 2: E-Commerce Trend: Global Plastic Packaging Usage
(Oceana 2020)

7.4 Appendix 4



Figure 3: Waste Hierarchy, established in the EU Waste Framework Directive

(European Commission 2024d)

7.5 Appendix 5

Reusable Packaging	Recyclable Packaging and Recycled Content	Labeling	Excessive Packaging
<ul style="list-style-type: none"> Transport and e-commerce packaging to be reusable*: -2030: 40% -2040: 70% Packaging shall always be reusable for transport to affiliates and partners or between own facilities (2030) 	<ul style="list-style-type: none"> All packaging in the EU shall be recyclable (2030) Minimum recycled content in plastic packaging: - 2030: 35% - 2040: 65% 	<ul style="list-style-type: none"> Packaging shall be marked with a label containing information on material composition and reusability (QR Code + Pictogram) 	<ul style="list-style-type: none"> The empty space ratio needs to be max. 50%** (2030)

*In the form of pallets, foldable plastic, and other boxes, trays, plastic crates, intermediate bulk containers, pails, drums, and canisters of all sizes and materials - including straps for product protection and/or stabilization on pallets during transport. Exceptions are in place for packaging used for dangerous goods, direct food contact, cardboard boxes, and other specific cases. **Space occupied by filling materials, such as air cushions, foam, or paper shall be considered empty space.

Table 2: PPWR - Key Implications for E-Commerce

(Circpack by Veolia 2024)

7.6 Appendix 6

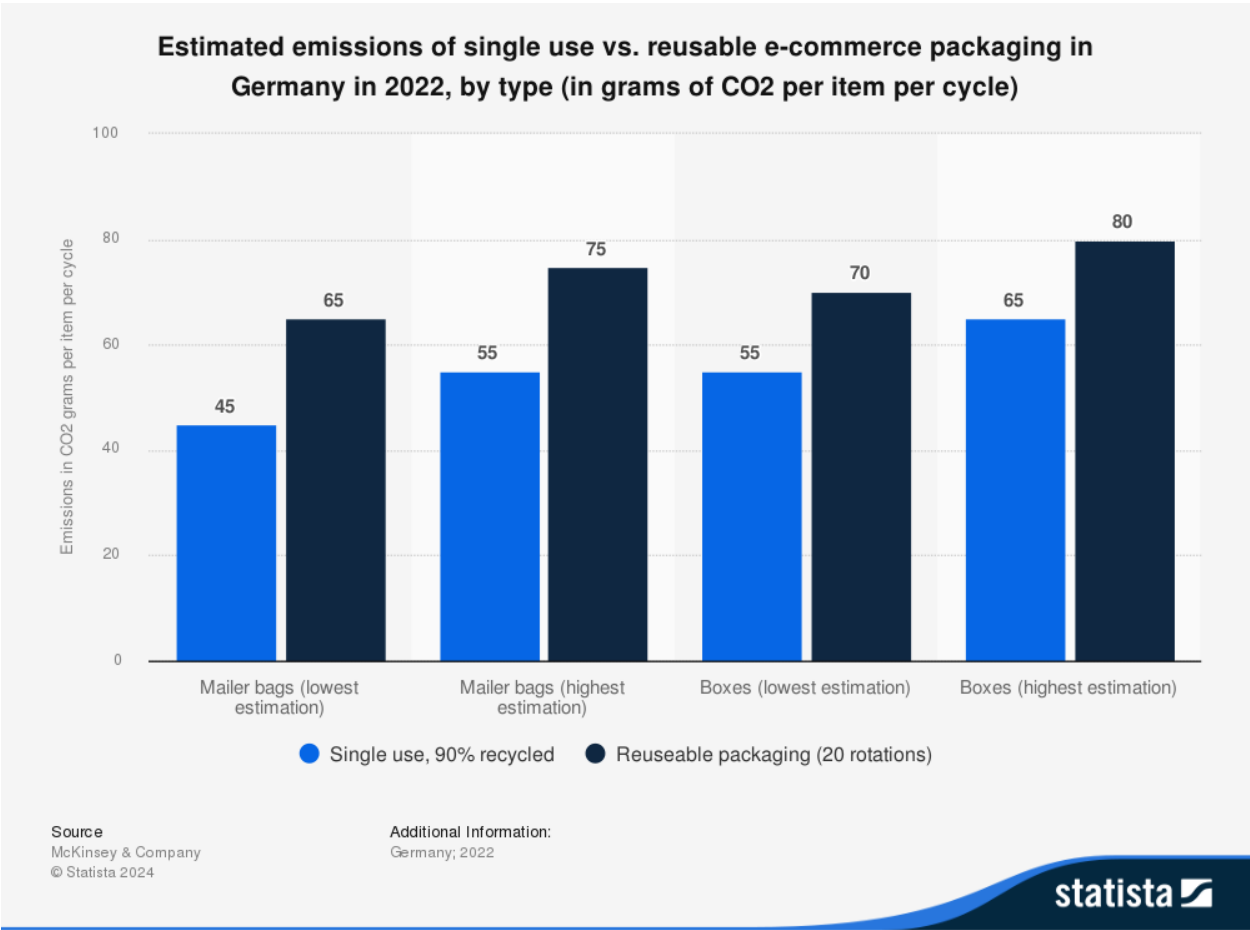


Figure 4: Rebound Effect
(McKinsey & Company 2023)

7.7 Appendix 7

Group	Name	Position	Company	Contact	Date
A1	Erwin Philips	Sustainability Manager - Packaging	Nike, Inc.	erwin.philips@nike.com	29.10.2024
A2	Anselm Schulz	Senior Logistics Manager - Sustainability	About You SE & Co. KG	anselm.schulz@aboutyou.com	07.11.2024
A3	Karla Jabben	Sustainability Manager - Packaging	Otto GmbH & Co KG	karla.jabben@otto.de	08.11.2024
A4	Olaf Dechow	Senior Corporate Responsibility Manager – Materials & Circularity	Otto Group Holding	olaf.dechow@ottogroup.com	12.11.2024
A5	Niklas Kristensen	Supply Chain Manager	Amazon.com, Inc.	nikkris@amazon.co.uk	16.11.2024
B1	Lucie Rowley	Senior Sustainability Manager	Evri Ltd.	sustainability@evri.com	11.11.2024
B2	Allende Irazola	Head of ESG & Sustainability	Paack	allende.irazola@paack.co	15.11.2024
B3	Sarah Maybaum	Senior Expert Clean Operations - Green Packaging	DHL Group	sarah.maybaum@dhl.com	19.11.2024
C1	James Mason	Sustainability and Portfolio Manager	Waste Management Company [confidential]	-	31.10.2024
C2	João Letras	Waste Management Director	Sociedad Ponto Verde	joao.lettras@pontoverde.pt	22.11.2024

Table 3: List of Interview Partners - Qualitative Research

7.8 Appendix 8

Key Themes	Core Investigative Questions
Definitions and Importance of SP	<ul style="list-style-type: none"> ▪ How do you define sustainable packaging? ▪ What role does sustainable packaging play in your current business practices?
Role and Potential of SP Adoption in E-Commerce	<ul style="list-style-type: none"> ▪ Do you consider SP adoption important in the context of e-commerce nowadays? Why? ▪ What potential benefits do you think adopting SP can bring to the broader e-commerce ecosystem?
Implementation Challenges	<ul style="list-style-type: none"> ▪ In your opinion, what are the main challenges for implementing SP practices in e-commerce? (Multiple key challenges can be mentioned here) Why? ▪ In your opinion, what is the biggest challenge for implementing SP in e-commerce? (Only one key challenge should be mentioned here) Why?
Implementation Opportunities and Collaboration Potential	<ul style="list-style-type: none"> ▪ In your opinion, what are the main opportunities for implementing SP in e-commerce? (Multiple key opportunities can be mentioned here) Why? ▪ In your opinion, what is the biggest opportunity for implementing SP in e-commerce? (Only one key opportunity should be mentioned here) Why? ▪ Do you perceive collaborations with other stakeholders as an important opportunity to improve the adoption of SP within the context of e-commerce?
Strategic Approaches for Addressing Opportunities and Challenges	<ul style="list-style-type: none"> ▪ How could the previously mentioned opportunities be exploited, and the challenges be overcome?
External Stakeholder Impact	<ul style="list-style-type: none"> ▪ Do you perceive consumer attitudes and behaviors, as well as the regulatory environment as a barrier or an enabler for adopting SP solutions within e-commerce? Why?

Table 4: Key Themes in the Interview - Qualitative Research

7.9 Appendix 9

	Regulatory Pressure	Consumer Pressure	Potential Cost Reduction	Competitive Advantage	Reusable Packaging	Collaboration
A1	X	X	X			X
A2	X		X			X
A3	X	X				X
A4					X	
A5	X		X		X	X
B1	X	X		X		X
B2	X	X	X	X		X
B3	X	X		X	X	X
C1	X	X	X	X	X	
C2	X				X	X

Table 5: Interview Results - Main Opportunities for SP Adoption in E-Commerce

	Complex Trade-Offs in Packaging Requirements	Economic Viability	Attitude-Behavior-Gap	UX Design	Reverse Logistics	Rebound Effect
A1		X	X		X	
A2	X	X	X		X	
A3	X	X	X		X	X
A4	X	X				
A5		X		X	X	X
B1	X	X		X		
B2	X	X				X
B3	X	X	X		X	X
C1	X	X			X	
C2		X	X		X	

Table 6: Interview Results - Main Challenges for SP Adoption in E-Commerce

7.10 Appendix 10

	Opportunities	Challenges
Literature Review	<ul style="list-style-type: none"> ▪ Regulatory Pressure ▪ Consumer Pressure ▪ Potential Cost Reduction ▪ Competitive Advantage ▪ Reusable Packaging ▪ Collaboration 	<ul style="list-style-type: none"> ▪ Complex Trade-Offs in Packaging Requirements ▪ Economic Viability ▪ Attitude-Behavior-Gap ▪ UX Design ▪ Reverse Logistics ▪ Rebound Effect
Qualitative Research	<ul style="list-style-type: none"> ▪ Packaging On-Demand Machines ▪ Pick-Up-Points ▪ Plastic Packaging 	<ul style="list-style-type: none"> ▪ Contamination ▪ Right Data Availability and Master Data Accuracy ▪ Major Changes in Standard Operation Procedures

Table 7: Overview of Key Results for SP Implementation in E-Commerce