

RESEARCH ARTICLE

Recycled or reusable

A multi-method assessment of eco-friendly packaging in online retail

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Abstract

The rapid growth of online retail increases the demand for packaging. Although packaging is necessary to fulfill logistic and marketing functions, it fosters the depletion of resources, is often used carelessly, and thus negatively impacts the environment. Eco-friendly packaging variants could provide a solution to this problem. Since many stakeholders must be involved to promote their use, this study develops a conceptual framework that reconciles their different perspectives and combines these with an environmental assessment to facilitate the transition to more sustainable online retail. We apply a multi-method research approach to investigate the different views. We use qualitative interviews and website analyses to capture the perspective of online retailers, conduct an online survey ($n = 1491$) to investigate consumers' perceptions of various product and transport packaging alternatives, and perform a life cycle assessment (LCA) of these options. The findings reveal that online retailers lack knowledge regarding consumer preferences and the environmental impact of packaging. The consumer survey shows a strong preference for packaging made from recycled paper and general avoidance of plastic packaging. The LCA results reveal that recycled and reusable variants are environmentally beneficial. The findings are interpreted in light of the relationships assumed in the conceptual framework. From a theoretical perspective, our results indicate that online retailers are concerned about the signaling role of packaging and that consumers refer to heuristic cues when deciding between packaging variants. We reconcile the different perspectives to propose strategies that contribute to a broader distribution of eco-friendly packaging in online retail.

KEYWORDS

consumer behavior, eco-friendly packaging, industrial ecology, life cycle assessment (LCA), multi-method approach, online retail

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1 | INTRODUCTION

Online retail sales have increased considerably in recent years. The Covid-19 pandemic has accelerated this growth, leading to a higher market share of online retail in 2021 (United Nations Conference on Trade & Development, 2022). To deliver products ordered online to consumers, appropriate packaging is crucial as it fulfills protective, marketing, and logistic functions. Product or primary packaging directly surrounds and protects the product. Transport or secondary packaging can combine several products into one shipping unit, protects the product(s) during shipment, and allows effective shipping logistics (Ampuero & Vila, 2006; García-Arca & Prado, 2008; Wallenburg et al., 2021). Both packaging types are also important from a marketing perspective as they may contribute to brand building (Moreau, 2020; Wallenburg et al., 2021).

Currently, there are many different packaging options available on the market, of which cardboard boxes and plastic bags are most widely used (Reitz, 2021; van Loon et al., 2015). Recently, there has been a lively debate on more efficient use of packaging which has been triggered in particular by the large amount of packaging waste, the depletion of resources, and the careless use of packaging (Chakori et al., 2021; Eurostat, 2021; Schüler, 2019; Wandosell et al., 2021). Eco-friendly packaging may address these issues as it implies, among other matters, the use of renewable and recycled materials and effective recovery in biological or industrial closed-loop cycles (Sustainable Packaging Coalition, 2011). Eco-friendly packaging also contributes to reaching the United Nations sustainable development goal (SDG) number 12, “sustainable consumption and production.” With the adoption of SDG 12, the global community has explicitly committed to reducing waste generation through reduction, prevention, recycling, and reuse (United Nations, 2015). Achieving this objective requires the joint effort of different stakeholders. Following this idea, this study suggests a conceptual framework that describes the actors involved in paving the way toward the wider adoption of eco-friendly packaging in online retail. We apply a multi-method research approach that contrasts empirical evidence from environmental and behavioral sciences to investigate the stakeholders’ perspectives included in the framework. Thereby, we respond to recent calls for research from Niero et al. (2021), Suski et al. (2021), and Wandosell et al. (2021), who demand interdisciplinary and context-specific approaches to investigate sustainable behavior. Niero et al. (2021) and Suski et al. (2021) emphasize the need to combine insights from different research disciplines such as environmental and social science to determine how the specific context influences the effectiveness of certain sustainability measures. Wandosell et al. (2021) suggest studying green packaging in various contexts beyond everyday consumer goods such as food and beverage packaging.

We focus on eco-friendly packaging in online retail in Germany as our context of investigation. The German Trade Association recently pointed out that online retail continues to grow in importance, while consumers are placing increasing value on sustainable options (Handelsverband Deutschland, 2022). German research institutions provide a good overview on the use and acceptance of online retail packaging. Reitz (2021), for example, showed that 895,100 t of transport packaging were generated in German online retail in 2019, 90% of which was cardboard packaging. Moreover, related research projects address consumer or retailer expectations on eco-friendly packaging and make specific suggestions for corporate implementation (Detzel et al., 2020, 2021; Tornow et al., 2021; Zimmermann, 2021; Zimmermann et al., 2020, 2021).

Peer-reviewed scientific studies on eco-friendly packaging in this field are yet scarce (Coelho et al., 2020; Escursell et al., 2021; Regattieri et al., 2014). Few studies in the context of online retail analyze the impact of packaging from an environmental perspective. These studies either focus on the differences between in-store and online shopping (Hischier, 2018; van Loon et al., 2015) or compare reusable and single-use packaging options (Park & Waqar, 2022; Zimmermann & Bliklen, 2020). Further studies investigate consumer motives or preferences regarding the use of eco-friendly packaging in online retail (Koch et al., 2022; Lu et al., 2020).

To our best knowledge, no study has yet compared insights from consumer surveys and life cycle assessments (LCA) to allow a more holistic perspective on the different packaging types used in online retail. However, previous studies in the field of food packaging have taken such an approach and yielded valuable insights by comparing consumer preferences and environmental impacts of different packaging alternatives (Boesen et al., 2019; Greenwood et al., 2021; Otto et al., 2021; Steenis et al., 2017). These studies revealed a contradiction between the consumers’ perception of eco-friendly packaging and LCA results for food or liquid packaging. For example, Otto et al. (2021) and Boesen et al. (2019) point out that consumers overestimate the environmental impact of plastic packaging and underestimate that of glass and biodegradable plastic.

This study aims to advance previous research by simultaneously investigating multiple stakeholder perspectives on eco-friendly packaging use in online retail. We argue that online retail companies, consumers, and scientific assessments of the environmental impact of packaging (e.g., from LCA) build a complex mix of interests that must be reconciled to increase eco-friendly packaging use in online retail. This study stands out from previous research as we conduct an LCA for the exact same packaging options for which consumers’ and online retailers’ preferences are measured. In addition, it accounts for the role of German national packaging targets, international sustainability movements, and voluntary pacts as important external forces impacting eco-friendly packaging use in online retail. On an aggregated level, we refer to them as political authorities and the media when examining how these affect retailers’ and consumers’ packaging choices. Consequently, we raise the following research questions:

RQ1: How can retailer, consumer, and environmental perspectives be reconciled to promote the use of eco-friendly packaging in online retail?

RQ2: What are the roles of political authorities and the media in this transition?

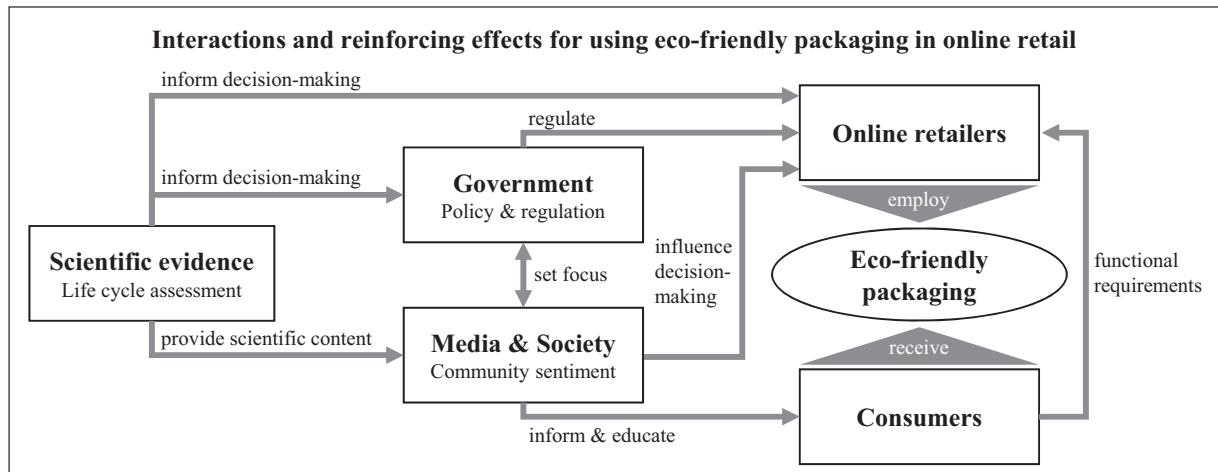


FIGURE 1 Conceptual framework.

2 | CONCEPTUAL FRAMEWORK

To shed light on the use of eco-friendly packaging in online retail, this study suggests a conceptual framework that illustrates the proposed interactions and reinforcing effects of the different actors involved. The framework is depicted in Figure 1 and forms the basis for our empirical analysis.

Online retailers play a crucial role as they are the ones who decide on the packaging. They must select packaging that protects the product(s) during shipment. Retailers also decide whether and which eco-friendly packaging type is used. This is a complex decision since packaging producers offer a wide range of packaging variants (Escursell et al., 2021). At the same time, online retailers must comply with and anticipate policy regulations and acknowledge public opinion shaped through the media. Also, their choice must not diminish their competitive edge. Further, we suggest that online retail companies consider LCA results before switching to new packaging types to avoid environmental burden shifting (Foschi et al., 2020; Sonneveld, 2000).

Online retailers must satisfy consumers' packaging requirements, such as product perception, attractive design, and easy handling (Escursell et al., 2021; García-Arca & Prado, 2008; Nguyen et al., 2020). Thus, packaging fulfills a critical marketing function, making it essential to consider consumers' packaging preferences (Herbes et al., 2018; Jerzyk, 2016; Monnot et al., 2015). If consumers are not satisfied with the packaging of an online purchase, it could discourage them from buying from that retailer in the future. Signaling theory describes mechanisms for reducing information asymmetries between two parties (Spence, 2002) and explains why packaging plays an essential role in online retail (Wallenburg et al., 2021; Wells et al., 2011). As there are high information asymmetries between the seller and the buyer, packaging may serve as an implicit cue that signals quality (Wallenburg et al., 2021).

Although packaging is essential from a marketing perspective, previous studies have shown that when product decisions are perceived as unimportant, heuristic decision-making is likely to occur (Eberhart & Naderer, 2017; Hoyer, 1984). Since the purpose of packaging is only to protect the actual product purchased online, we argue that consumers' preferences might be susceptible to decision heuristics. Heuristic information processing allows quick and easy decision-making based on heuristic cues (Gigerenzer & Brighton, 2009; Gigerenzer & Gaissmaier, 2011). Therefore, research should consider the signaling role of packaging and the potential presence of heuristic cues influencing consumer behavior.

Further, it is crucial to assess the environmental impact of recent packaging alternatives using reliable and transparent evaluation methods such as LCA. LCA is defined by the International Organization for Standardization (ISO, 2006) as the compilation and evaluation of the inputs, outputs, and potential environmental impacts of a product system throughout its life cycle. Due to the growing number of packaging alternatives on the market, this is critical to avoid environmental burden shifting. However, context-specific LCA results for online retail packaging are scarce in the scientific literature. We argue that it is imperative to close this research gap because LCA results are needed to inform both political bodies and online retail companies (Niero et al., 2021).

The framework accounts for governmental regulation and the media as external forces impacting the actors who directly interact with the packaging in online retail. We selected these two stakeholders because we believe they reflect the effect of various external influences, such as national packaging targets, international sustainability movements, and voluntary pacts on an aggregated level.

We attribute an important role to the government since regulatory measures directly affect the packaging choice of online retailers. The companies considered in our study are subject to German and EU legislation and action plans. The EU Directive 94/62/EC on packaging and packaging

waste defines targets to avoid unnecessary packaging and to support circular packaging design. The German packaging law (VerpackG) defines minimum recycling contents and recyclability as well as the development of pool systems for single- and multi-use packaging solutions. As packaging is product specific, the Circular Economy Action Plan, which is part of the European Green Deal, promotes the development of sector-specific solutions including the use of secondary materials and pool systems for reusable packaging (European Commission, 2022a). An exemplary development of a sector-specific solution in Germany is the obligation to offer reusable packaging for take-away food and beverages by 2023 (VerpackG). The content of the recent proposal for an EU regulation on packaging and packaging waste reveals that further sector-specific regulations are to be expected, which will also affect the online retail industry (European Commission, 2022b).

Political decision-makers need scientific evidence on the environmental impact of different packaging types to develop appropriate regulatory measures. For example, an LCA conducted by the German Federal Environment Agency (Detzel et al., 2016; Schonert et al., 2002) in 2002 formed the basis for introducing the return deposit system for disposable beverage packaging in Germany.

We suggest that media play a pivotal role in shaping the public and individual perception of eco-friendly packaging and, thus, impact online retailers' packaging choices. According to the agenda-setting theory, media determine the topics of public debate (McCombs & Shaw, 1972). Media process the information provided by the scientific community and are particularly skilled at focusing public perception on the importance of specific issues (McCombs & Shaw, 1972; McCombs et al., 2014). We suggest that agenda-setting currently takes place in the context of packaging, with a particular focus on plastic packaging. Due to the severe consequences of plastic pollution, packaging is very present in media (Nielsen et al., 2020). For example, Males and van Aelst (2021) show that media put plastic pollution on public and political agendas. In a study by Heidbreder et al. (2020), consumers expressed a high level of awareness of plastic-related problems, which indicates that media attention may impact individual consumer perceptions.

The suggested framework illustrates how the stakeholders involved in eco-friendly packaging adoption in online retail relate to one another. In the following, we provide a detailed analysis of retailer and consumer perceptions regarding selected packaging variants and combine these findings with results from a corresponding LCA to answer RQ1. We then discuss our findings against the background of the relationships proposed in the conceptual framework and specifically account for the role of the government and the media (RQ2).

3 | METHODS AND RESULTS

We chose online apparel retail as the context of our investigation because fashion purchases account for the highest share of global B2C online retailing (Statista, 2021). Additionally, the particularly high return rates cause high packaging use (Asdecker, 2021). In the first step, we analyzed online retailers' packaging choices through in-depth interviews and online shop analyses. Building on these insights, we selected specific packaging options and evaluated them from a consumer and environmental perspective, that is, we conducted an online survey to investigate consumer preferences and calculated the environmental footprint (EF) using LCA methodology. Finally, we considered the three perspectives jointly. Data for all three analyses were collected in Germany. Figure 2 summarizes the three-step data collection process, described in detail in the following paragraphs.

3.1 | Retailer perspective

To investigate online retailers' perspectives on eco-friendly packaging, we conducted semi-structured interviews with $n = 8$ online apparel retailers in 2020. Besides four retailers selling conventional fashion, we specifically included two companies specializing in sustainable clothing and two sportswear retailers. All interview partners were either sustainability or supply chain managers. They described what type of (eco-friendly) packaging their companies use or plan to use in the future and what challenges they face regarding eco-friendly packaging in their business processes (cf. Table S11.1 in Supporting Information S1 for a detailed overview of the interview questions). The results indicate that four retailers use low-density polyethylene (LDPE) polybags for product packaging, three use polybags with certified recycled content, and one employs bags made of recycled paper. For transport packaging, all use cardboard boxes. Additionally, four retailers employ plastic shipping bags and two use recycled plastic shipping bags for small orders. Retailers explained they still have reservations regarding the transition to more eco-friendly materials. Reasons were a lack of knowledge of the availability of packaging alternatives and their corresponding environmental impact, functional disadvantages in the highly automated logistics processes, higher costs, and fear of low consumer acceptance.

Further, we searched the homepages of 67 German online apparel retailers regarding information on packaging materials and quantities used. Among these were the 31 top-selling online shops at the time of data collection in 2020, 21 online shops for outdoor and activewear, and 15 online shops for sustainable clothing. The results revealed that only 14% provide information about packaging in the FAQ or during checkout. Additionally, only 12% indicate they employ eco-friendly packaging options according to the criteria provided by the Sustainable Packaging Coalition (2011), such as polybags with recycled content.

Moreover, we conducted systematic online research to categorize which product and transport packaging options are available to online apparel retailers in general. In sum, we analyzed the product range of 17 packaging providers, who focus on different packaging solutions and materials. As a

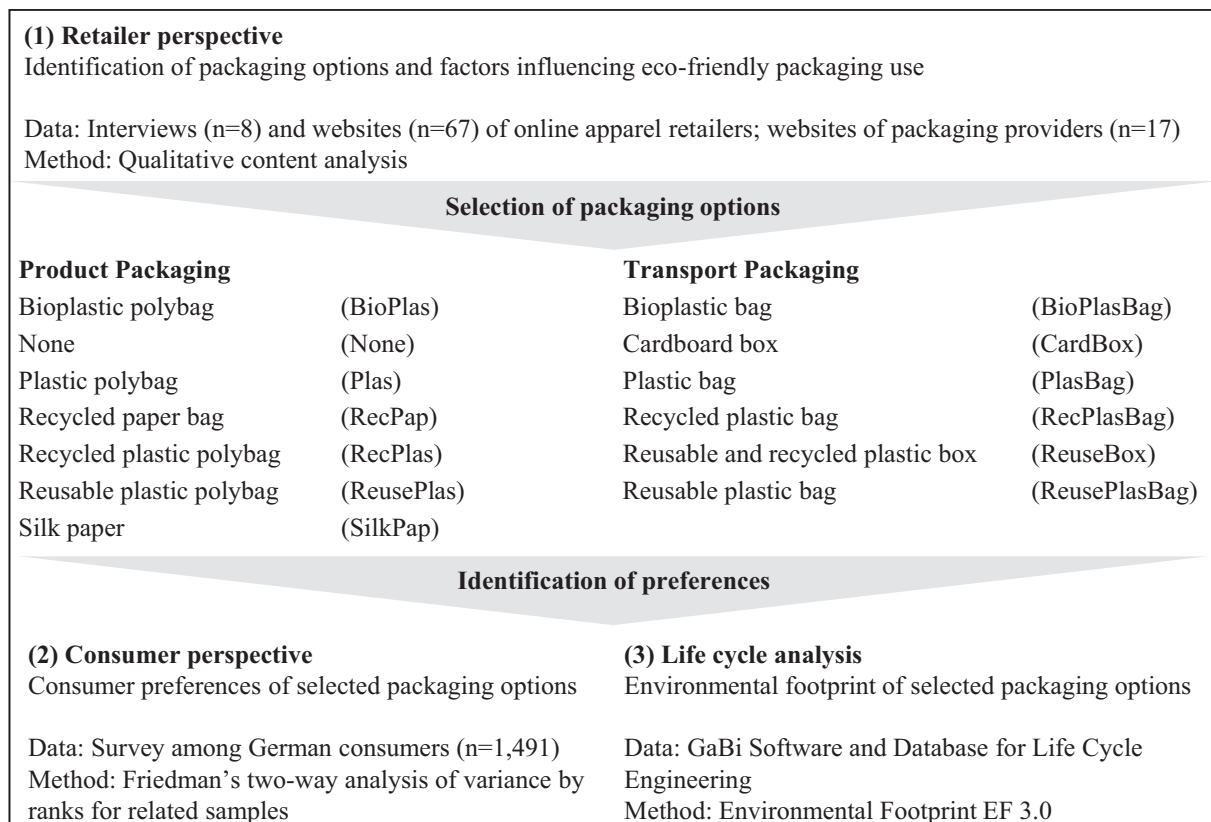


FIGURE 2 Data collection process.

result, we identified recycled, bioplastic, and reusable polybags as alternatives to traditional plastic polybags. Further, silk paper or packaging from recycled paper was available. Concerning transport packaging, retailers can choose from cardboard boxes made from recycled paper and shipping bags made from primary, recycled, or bioplastics. Reusable options included shipping bags and plastic boxes incorporated into a deposit system.

The findings from the retailer analysis formed the basis for selecting the packaging options for further assessment (cf. Figure 2).

3.2 | Consumer preferences

We conducted a representative online survey among the German population to investigate consumers' packaging preferences. The questionnaire was pre-tested prior to final data collection. The data were collected in mid-2020 using the panel provider *respondi*. The sample represents the German population aged 18–65 regarding gender, age, net income, and residential area. Only individuals who purchase clothing online at least once a year were allowed to participate in the survey. In total, we collected data from 1650 respondents. After removing outliers and speeders following the suggestions by Leiner (2019) and Greszki et al. (2015), 1491 participants remained for the analyses. A detailed sample description is provided in Table S1.2 in Supporting Information S1.

At the beginning of the survey, we collected demographic data. Then, respondents were provided with a definition of eco-friendly packaging, describing it as consisting of recycled or renewable materials, using non-hazardous materials throughout the life cycle, and allowing for effective recovery in closed-loop cycles. Thus, the definition focused on the environmental characteristics of sustainable packaging as suggested by the Sustainable Packaging Coalition (2011). Attention checks verified understanding of the definition. Further, data on individual online purchase behavior, the general importance of packaging, and related aspects such as willingness to pay were collected. We also assessed respondents' environmental concerns on a 7-point Likert scale using items from Roberts and Bacon (1997). Finally, we measured respondents' preferences regarding eco-friendly packaging in online clothing retail for both product and transport packaging. For this purpose, we showed participants a list of seven types of product packaging and six types of transport packaging (cf. Figure 2). Participants could view a detailed description of each packaging type if they wished. We selected the packaging options based on our retailer interviews and market research (cf. Section 3.1).

Participants were asked to rank these solutions from lowest to highest value. The highest value indicated the most preferred and 1 the least preferred packaging choice. The survey questions are provided in detail in Table S1.3 in Supporting Information S1. The mean ranks (m) for the product and transport packaging variants are provided in Figure 3. Figure 3 also illustrates the frequency distribution of ranks for each packaging option.

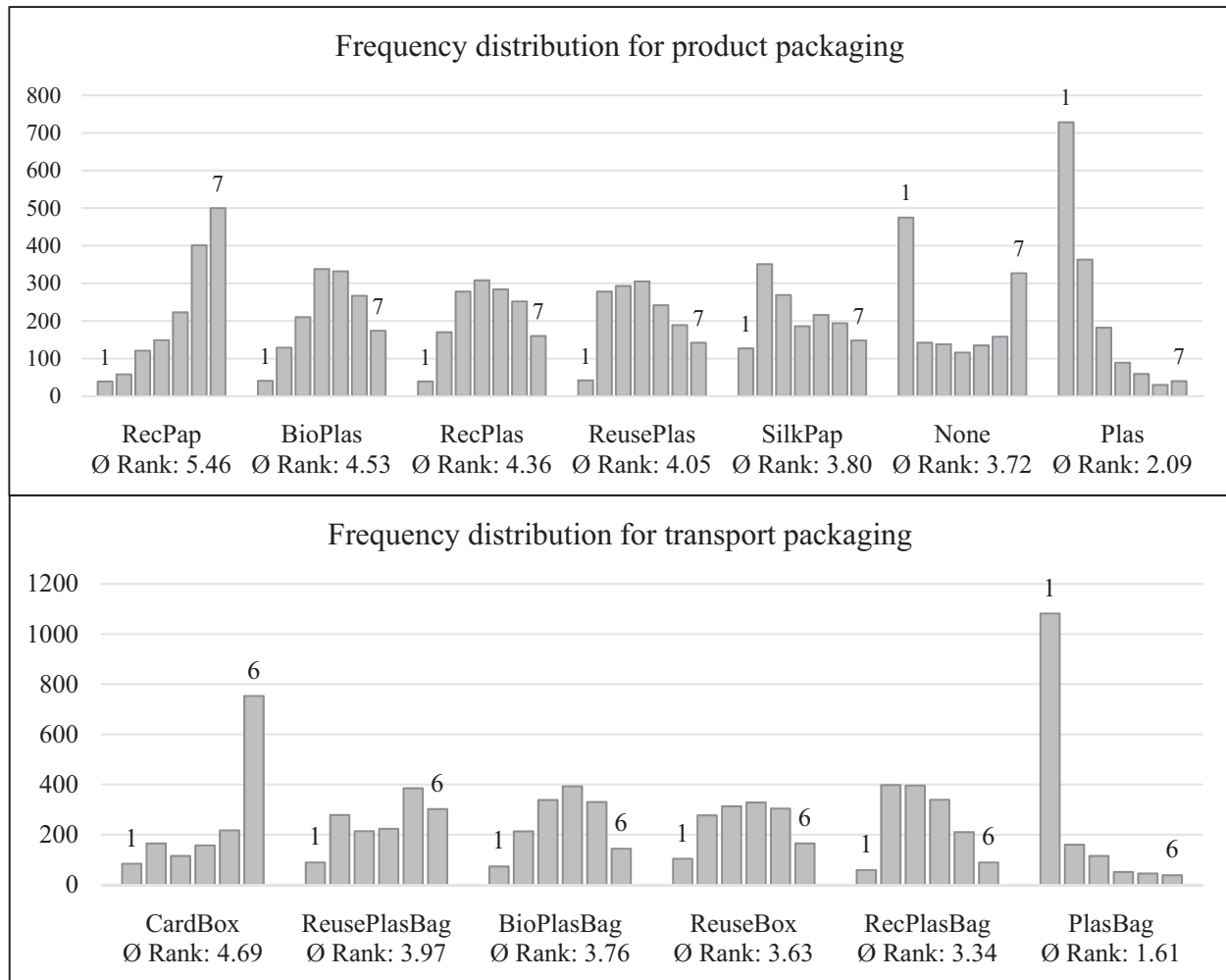


FIGURE 3 Mean ranks and frequency distributions for product and transport packaging. Note: 1 = least preferred option; 6/7 = most preferred option. BioPlas, bioplastic polybag; BioPlasBag, bioplastic bag; CardBox, cardboard box; Plas, plastic polybag; PlasBag, plastic bag; RecPap, recycled paper bag; RecPlas, recycled plastic polybag; ReuseBox, reusable and recycled plastic box; ReusePlas, reusable plastic polybag; ReusePlasBag, reusable plastic bag; SilkPap, silk paper. The underlying data for this figure can be found in Supporting Information S2.

Our findings indicate that consumers strongly prefer packaging made from recycled paper for both product and transport packaging ($m = 5.46$ for recycled paper bag and $m = 4.69$ for cardboard box). In contrast, plastic packaging is the least preferred ($m = 2.09$ for plastic polybag and $m = 1.61$ for plastic bag).

Friedman's two-way analysis of variance by ranks for related samples revealed that there was a statistically significant difference in consumers' preferences for both product packaging ($\chi^2(6) = 2018.08, p = 0.000, N = 1491$) and transport packaging ($\chi^2(5) = 2258.61, p = 0.000, N = 1491$) (Friedman, 1937). Pairwise comparisons of multiple related samples using Dunn–Bonferroni tests with Bonferroni correction further supported these results (Castañeda et al., 1993). Kendall's concordance coefficient W indicates that the overall consumer rankings of the packaging variants are rather discordant ($W = 0.226$ for product packaging and $W = 0.303$ for transport packaging), suggesting that consumers do not have similar preferences except for paper and plastic packaging (Kendall & Gibbons, 1990). We conducted subgroup analyses to further validate our findings (cf. Table S11.4). Preference for packaging made from recycled paper and rejection of plastic packaging for both product and transport packaging is evident in all groups, underlining the robustness of our findings.

3.3 | Life cycle assessment

We conducted an LCA of the seven product and six transport packaging options given in the consumer survey to assess their environmental impact. LCA is a tool that supports environmental decision-making and is designed to identify potential trade-offs between product alternatives (Woods et al., 2021). With LCA, a product's environmental impact along the whole value chain, from extensive use of resources in the production process

to waste at the end-of-life, is considered. For the environmental impact assessment of the various packaging options in this study, we used the environmental footprint EF 3.0 methodology developed and recommended by the European Commission as part of the Product Environmental Footprint (PEF) guidelines. The PEF is a multi-criteria measure of the environmental performance of a good or service throughout its life cycle. It addresses 16 impact categories such as acidification, climate change, and resource depletion (fossil and water). These impact categories cover all relevant environmental issues related to the product supply chain. In addition, as part of the impact assessment, weighting and normalization were performed as recommended for the single score EF. The EF is calculated with the GaBi Software and Database for Life Cycle Engineering v10.5 CUP 301 2021.2 (1992–2021). Furthermore, we used the Circular Footprint Formula (CFF) developed by the European Commission (2018) to allocate the burdens and credits of producing or using recycled materials and to avoid double counting. This formula deals with complex systems at the end-of-life phase, for example, when reuse, recycling, and incineration are involved. According to the PEF methodology, in such cases, the CFF shall be applied (European Commission, 2019; Finkbeiner et al., 2019).

3.3.1 | Goal and scope

The system boundary includes the packaging material and its production, transport between the warehouse and the customer, and the end-of-life, that is, the disposal. According to the German recycling infrastructure, the disposal is modeled either as incineration with energy recovery or material recycling. We chose the packaging needed for the delivery of a t-shirt for our assessment because it represents the most purchased product in German apparel retail (Statista, 2017). However, the assessment does not include the use phase and the t-shirt itself. The functional unit (FU) is the packaging required to deliver a t-shirt to an online customer in Germany and consists of one product packaging and one transport packaging. The FU expects all analyzed packaging options to fulfill the retailers' definition of product protection and lifetime. The performance of the packaging is not assessed since empirical data such as breakage rates were not collected. However, the study accounts for the quality of packaging by including this aspect in the retailer interviews (cf. Section 3.1). The assessed packaging options represent the preferences expressed by retailers and consumers and, thereby, reflect various packaging attributes—including functionality considerations.

3.3.2 | Life cycle inventory

The data for the LCA were collected from commercially available packaging options. For the product packaging, we used the average size of a standard polybag for reference. Thus, we assume a feasible level of comparability for the different product packaging types. We did not scale the transport packaging options to a uniform size but used small packaging types that a t-shirt could fit into. The assumptions made to ensure comparability of the different packaging options are provided in Supporting Information S1 (Table S1.5). The inventory analysis included the packaging characteristics, the mass of the packaging, and specific properties such as material types, recycled content, color, and reusability. For the transportation from the warehouse to the customer, we used a standard route of 300 km. For the reusable transport packaging options (reusable plastic bag and box), the transport is calculated with 600 km to include the return of the packaging. We used a diesel-driven light-duty vehicle with a maximum of 3.5 t gross weight in the LCA as a conservative means of transportation. The transport emissions are allocated according to mass proportions of packaging and total load. Furthermore, default values are applied, with a utilization rate of 0.7 and a mix of highway, urban, and rural traffic. For the lifespan of the reusable shipping bag, we refer to the manufacturer's specifications, which assume a minimum number of 20 uses (Repack, 2021). We used data from previous studies to determine the lifespan of the reusable shipping box (50 uses) (Albrecht et al., 2013). The reusable transport packaging options (reusable plastic bag and box) are analyzed as part of their existing return and reuse systems. Thus, the environmental burden of the packaging's production is shared equally between the assumed number of shippings. For the reusable product packaging (reusable polybag), no return infrastructure exists in German online retail yet. Hence the environmental burden is fully allocated to one use, equivalent to single-use packaging. The assessed disposal routes reflect the correct disposal behavior of the consumer within the existing disposal infrastructure. For example, PLA does not have any recovery pathway in Germany yet, so neither recycling nor composting, but incineration was considered the correct disposal route in our analysis. Moreover, our analysis did not include disposal averages based on varying consumer behavior. However, we recommend a more detailed scenario analysis on disposal routes as soon as a reliable methodology is available to include (marine) littering as an end-of-life scenario.

The life cycle inventory for the product and transport packaging options is provided in Table 1.

3.3.3 | Life cycle impact assessment

Figure 4 illustrates the EF of the different product and transport packaging options. Regarding product packaging, the bioplastic bag and silk paper have the highest environmental impact due to the use of primary agricultural products in the raw material acquisition. The bioplastic bag made

TABLE 1 Life cycle inventory for product and transport packaging options.

Product packaging	Material	Color	Mass [g]	Reus-ability	Mass per FU [g]*	Disposal route	Recycled content [%]	Recyclability [%]	
RecPap	Paper	Brown	32	No	32	Recycling	100	100	
BioPlas	PLA	Transparent	9	No	9	Incineration	0	0	
RecPlas	rPE	Transparent	9	No	9	Recycling	100	95	
ReusePlas	rPE	Transparent	12	Yes, but no return system	12	Recycling	100	95	
SilkPap	Silk paper	White	36	No	36	Recycling	0	100	
None	-	-	0	-	0	-	-	-	
Plas	LDPE	Transparent	9	No	9	Recycling	0	100	
Transport packaging	Material	Color	Mass [g]	Reus-ability	Mass per FU [g]*	Disposal route	Recycled content [%]	Recyclability [%]	Distance [km]
CardBox	Cardboard	Brown	11	No	11	Recycling	90	100	300
ReuseBag	rPP	Yellow, with black stripe	80	Yes, 20 uses	4	Recycling	100	90	600
BioPlasBag	PLA	White	11	No	11	Incineration	0	0	300
ReuseBox	rPP	Grey	600	Yes, 50 uses	12	Mix	100	50	600
RecPlasBag	rPE	White, with shipping label	12	No	12	Recycling	80	75	300
PlasBag	LDPE	White, with shipping label	13	No	13	Recycling	0	75	300

Abbreviations: BioPlas, bioplastic polybag; BioPlasBag, bioplastic bag; CardBox, cardboard box; FU, functional unit; LDPE, low-density polyethylene; PLA, polylactic acid; Plas, plastic polybag; PlasBag, plastic bag; RecPap, recycled paper bag; RecPlas, recycled plastic polybag; RecPlasBag, recycled plastic bag; ReuseBag, reusable plastic bag; ReuseBox, reusable and recycled plastic box; ReusePlas, reusable plastic polybag; rPE, recycled polyethylene; rPP, recycled polypropylene; SilkPap, silk paper.

*Mass per FU = (Mass / number of uses).

from PLA contains industrially produced starch from sugar cane. The use of agrochemicals (e.g., mineral fertilizers and pesticides) carries a large environmental impact based on its fossil energy demand. Silk paper is assumed to be produced from primary wood-based cellulose. Its production has a high energy and chemical demand resulting in a comparably high environmental footprint. The packaging made from recycled paper has about the same EF as the plastic bag from primary material. However, its EF is clearly higher than that of the recycled and the reusable plastic polybag. This is particularly due to the lower mass of plastic packaging compared to the paper bag. The product packaging from recycled plastic has the second-lowest environmental impact, and the packaging-free solution has an EF of zero. The low EF of the reusable polybag (ReusePlas) is mainly due to the recycling content. However, the results on the environmental impact of a theoretically reusable packaging with a missing return infrastructure shows the importance of a comprehensive approach (see SI1.5).

The LCA results for transport packaging show that the bioplastic shipping bag has the highest environmental impact, followed by the plastic bag. The reusable shipping box, the recycled bag, and the cardboard box have a lower environmental footprint than the transport packaging from primary materials, that is, plastics and bioplastics. The reusable shipping bag has the lowest EF of the transport packaging options considered. The lower environmental impact of the reusable plastic bag compared to the reusable plastic box shows the strong interrelation between the packaging mass and the environmental impact. Although the reusable box has an assumed lifespan of 50 uses compared to “only” 20 uses of the reusable shipping bag, the bag still has a lower EF due to its lower weight. The transport itself does not contribute significantly to the environmental impact for either variant, that is, single route versus return route. Further details on the LCA are provided in Supporting Information S1 (Tables SI1.5 and SI1.6).

3.4 | Combining online retailer, consumer, and LCA perspectives

The multi-method assessment reveals partial discrepancies between retailers' choices, consumers' preferences, and the environmental impact of the different packaging variants. Figure 5 illustrates that the preferred product packaging variants are not the ones with the lowest EF score.

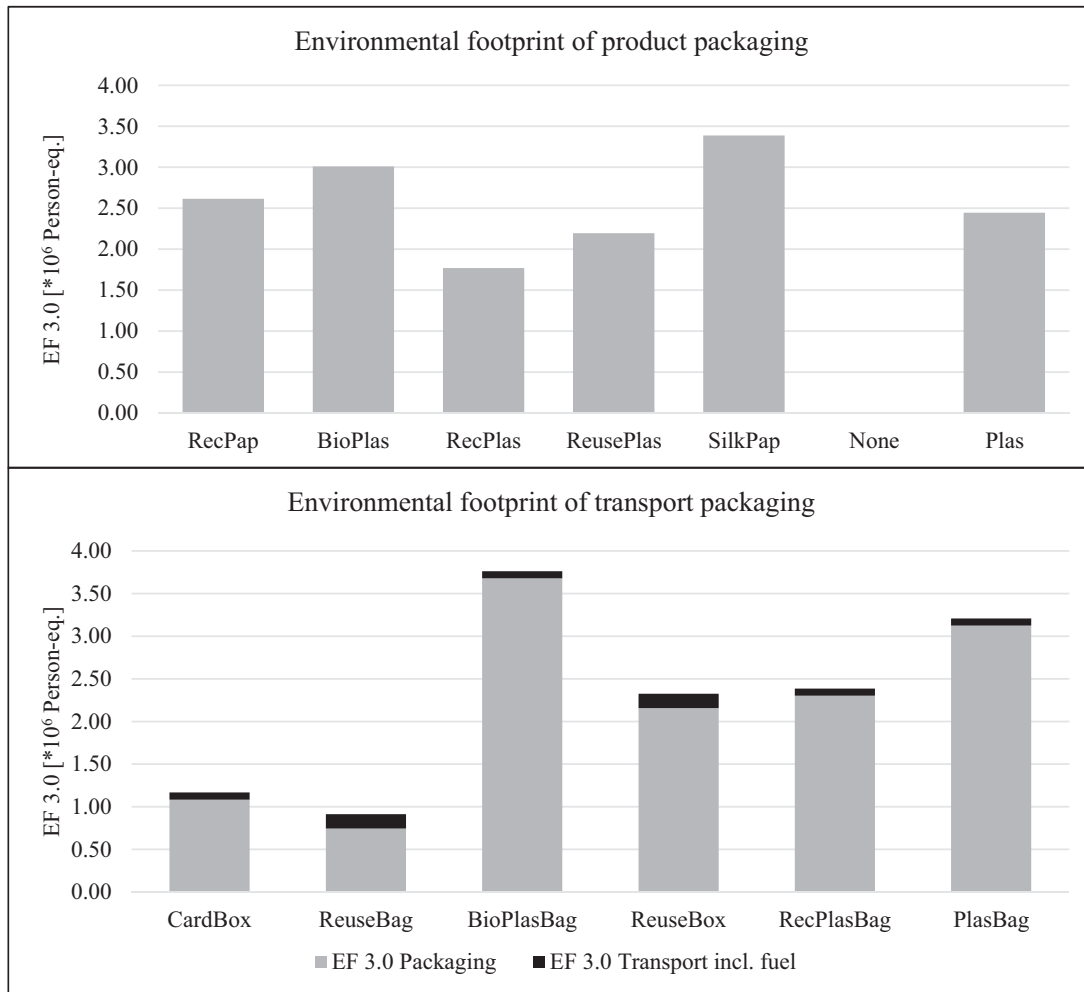


FIGURE 4 Environmental footprint of the product and transport packaging options. BioPlas, bioplastic polybag; BioPlasBag, bioplastic bag; CardBox, cardboard box; EF, environmental footprint; Person-eq., Person-equivalent; Plas, plastic polybag; RecPlasBag, recycled plastic bag; RecPap, recycled paper bag; RecPlas, recycled plastic polybag; RecPlasBag, recycled plastic bag; ReuseBox, reusable and recycled plastic box; ReusePlas, reusable plastic polybag; ReusePlasBag, reusable plastic bag; SilkPap, silk paper. The underlying data for this figure can be found in Supporting Information S2.

Consumers prefer packaging made from recycled paper and bioplastics, which have a rather high EF compared to the alternatives studied. However, consumer preferences and environmental assessments seem better aligned for the transport packaging options cardboard box and reusable plastic bag, depicted in the upper left quadrant of Figure 5. The packaging options mainly employed by retailers, namely recycled plastic polybags and cardboard boxes, align with consumer preferences and EF results (depicted in italics in Figure 5). However, retailers' frequent choice of virgin plastics does not match the other perspectives. Although reusable variants are beneficial from an environmental perspective and accepted by consumers, retailers rarely use them.

4 | DISCUSSION

4.1 | Interpretation of results and theoretical contribution

In the following, the empirical results are discussed in the light of the relationships suggested in the conceptual framework. In line with the framework and with previous studies that underline the marketing role of packaging in online retail (Moreau, 2020; Wallenburg et al., 2021), we find that online retailers are concerned about choosing packaging that satisfies consumer demands. Simultaneously, they strive to minimize the environmental impact of their packaging. This finding underlines that scientific research on the environmental impact of packaging is needed to inform retailers' decision-making. Thus, it supports the existence of a relationship between scientific research and online retailers assumed in the conceptual

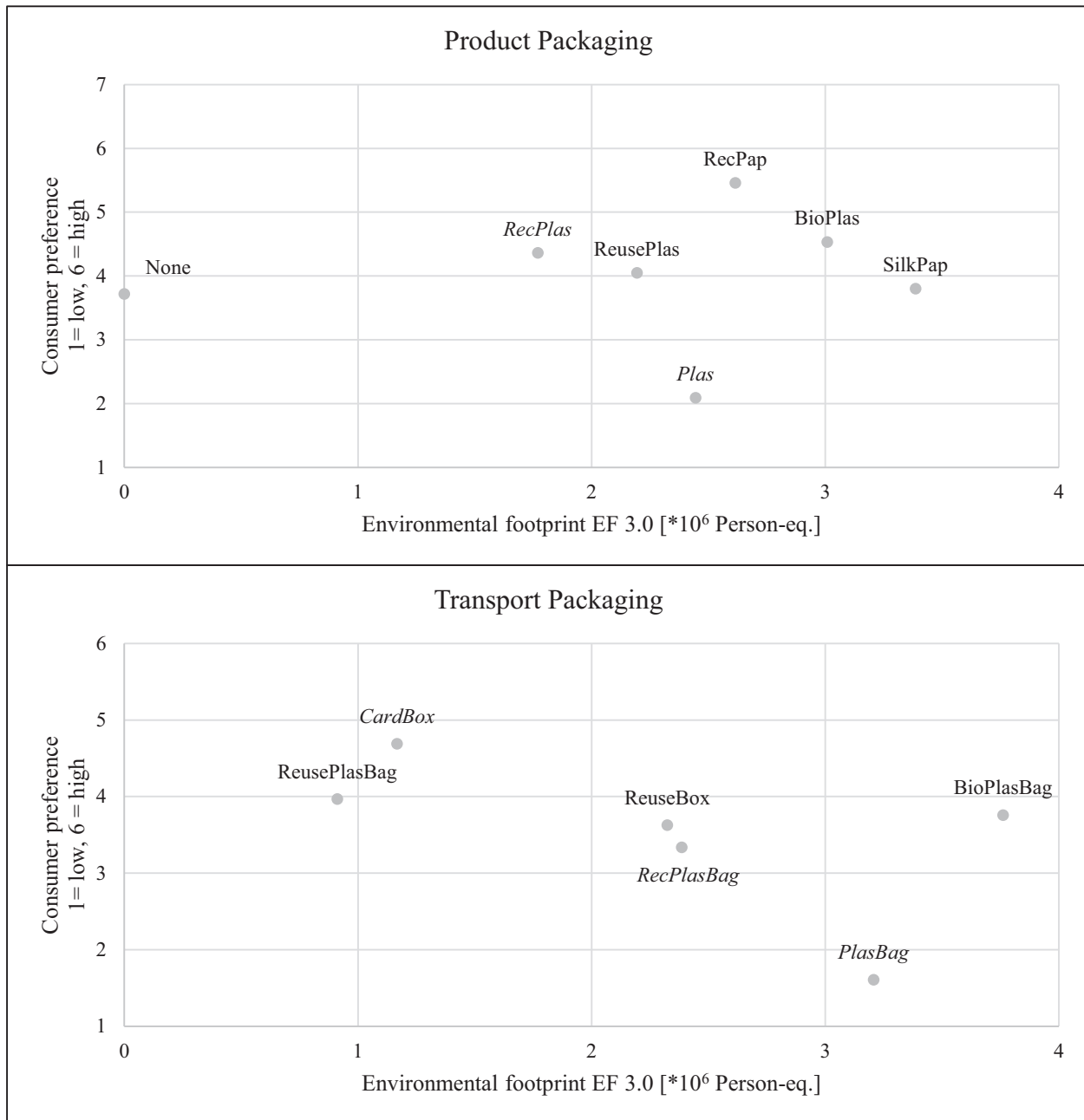


FIGURE 5 Consolidation of results from multi-method assessment. Note: Packaging variants most frequently used by online retailers in italics; BioPlas, bioplastic polybag; BioPlasBag, bioplastic bag; CardBox, cardboard box; Plas, plastic polybag; PlasBag, plastic bag; RecPap, recycled paper bag; RecPlas, recycled plastic polybag; RecPlasBag, recycled plastic bag; ReuseBox, reusable and recycled plastic box; ReusePlas, reusable plastic polybag; ReusePlasBag, reusable plastic bag; SilkPap, silk paper. The underlying data for this figure can be found in Supporting Information S2.

framework. Although retailers acknowledge packaging's strategic relevance, the finding that most have not yet switched to eco-friendly variants might reflect their fear of making an ill-advised packaging choice. The concerns regarding eco-friendly packaging expressed by retailers in the interviews indicate that the signaling role of packaging in online retail found in previous research (Wallenburg et al., 2021) is also relevant for eco-friendly packaging. Our findings reveal that retailers perceive packaging choices to be complicated since they must take account of multiple stakeholder demands. As illustrated in the conceptual framework (cf. Figure 1), their packaging choice must comply with regulatory requirements, meet consumer preferences and functionality demands, and consider recent community sentiment as conveyed through the media, while still achieving a low environmental impact. However, the results from our multi-method assessment reveal that these different perspectives are at least partially contradictory, making it difficult for retailers to follow the ideal-typical selection process for packaging suggested in the conceptual framework. In the following, we will discuss potential reasons for these contradictions and provide measures that can be taken to resolve them.

The online survey reveals that consumers prefer packaging made from recycled paper and avoid plastic packaging. We suggest that these findings could imply that heuristics may drive consumers' attitudes toward the different packaging types. Humans refer to heuristic information processing as it reduces cognitive effort in everyday life and facilitates decision-making (Chaiken, 1980; Gigerenzer & Brighton, 2009; Gigerenzer & Gaissmaier, 2011). In consumer behavior, heuristics are prevalent when a product decision is less important, that is, when products are purchased regularly or are of lower value (Eberhart & Naderer, 2017; Hoyer, 1984). In online apparel retail, packaging is of lesser importance compared to the apparel itself, so that heuristic decision-making is likely to occur. We conclude that our results point to the existence of three heuristic cues that consumers seem to consider. First, *plastic* seems to be a negative heuristic cue indicating packaging that should be avoided. Second, *paper* and *cardboard* seem to be positive heuristic cues signaling a favorable packaging choice. Third, *bioplastic* also appears to be a positive heuristic cue. However, our LCA results reveal that paper and especially bioplastic packaging in online retail do not generally have a lower environmental impact than plastic. This finding is consistent with previous LCA results on packaging (Otto et al., 2021; Park & Waqar, 2022) and also aligns with previous studies showing that decision heuristics are not always based on rational arguments but are also susceptible to misconceptions (Herbes et al., 2018; Otto et al., 2021; Steenis et al., 2017).

We propose that heuristics associated with eco-friendly packaging choices could also point to the influence of public opinion on individual decision-making. We included the role of the media in our conceptual framework because previous studies found that media set the agenda for public debate (McCombs & Shaw, 1972; McCombs et al., 2014). The results from our consumer survey indicate that plastic packaging seems to have a very negative connotation among consumers, which could be due to the extensive media attention on plastic pollution and marine littering in recent years (Males & van Aelst, 2021). Thus, our findings could reflect an agenda-setting role of the media that might have a normative influence on individual consumer behavior.

The focus of previous political regulation on plastic packaging (EU Directive, 2019/904) strengthens the mutual relationship between media and government suggested in the conceptual framework. However, more comprehensive regulatory measures are being developed and could shift media and public attention to other packaging variants. For example, in 2022, the European Commission published a proposal for a new regulation on packaging and packaging waste, which covers among other aspects quotas for using reusable packaging in online retail (European Commission, 2022b). The recent debate on plastic packaging supports the reciprocal relationships between scientific evidence, political regulation, and the media proposed in our conceptual framework. The new regulatory measures on the use of plastic packaging show that policy regulation can translate scientific evidence on the impacts of different packaging types into appropriate legislation. At the same time, the public debate on plastic also highlights the importance of the media in fully presenting scientific evidence and explaining the complexities involved in assessing the environmental impact of different materials.

The subgroup analyses show that individuals who consider themselves highly environmentally concerned are more likely to choose packaging from bioplastics, that is, to make a less eco-friendly decision than all other groups. Previous studies also found that consumers perceive bioplastics positively (Herbes et al., 2018; Orset et al., 2017). The term "bioplastic" implies that the material, that is, PLA, is both biobased and biodegradable. Biobased materials avoid fossil fuel depletion and related impacts, while biodegradable materials break down into organic matter. However, there are various certification schemes for biodegradability, and the term often refers to degradation only under industrial composting conditions (Horvat & Kržan, 2012). The main reason for the high environmental footprint of commercial PLA and many other biobased plastics is the raw material acquisition from industrial farming and extensive use of agrochemicals (GaBi Software and Database for Life Cycle Engineering v10.5 CUP 301 2021.2, 1992–2021). To reduce the overall environmental impact of packaging, shifts in burden must be avoided. The growing awareness of eco-friendly packaging solutions reinforces the need for a joint approach by the various stakeholders involved.

4.2 | Practical implications

Based on the findings of this study, we propose stakeholder-specific strategies for dealing with the different packaging types. The measures differ depending on the level of consumer preference and the packaging's environmental footprint (cf. Figure 6).

We consider type 1 packaging variants the first choice in online retail since these are characterized by high consumer acceptance and favorable environmental performance. The high consumer acceptance should strongly incentivize online retailers to use these packaging types to benefit from a positive signaling effect.

Strategies related to type 2 packaging, that is, packaging that is eco-friendly but less preferred by consumers, address several stakeholders. Previous studies have found that active involvement of consumers is crucial for eco-friendly packaging options to achieve their positive environmental impact. For example, a recent analysis of the environmental impact of reusable packaging in Germany showed that a return rate of at least 80% is required to achieve a favorable environmental footprint. However, in the corresponding field test, the return rate was only between 36% and 74%, which underlines the need for improving communication and participation incentives (Packaging Journal, 2021). Measures to increase consumer acceptance of eco-friendly packaging types should also aim at preventing the spread of mistaken decision heuristics. Building on previous research findings highlighting the importance of transparent sustainability information (Lemke & Luzio, 2014; O'Rourke & Ringer, 2016), online retailers could provide information on eco-friendly packaging on their homepages or during checkout. To mitigate the risk of deterring consumers

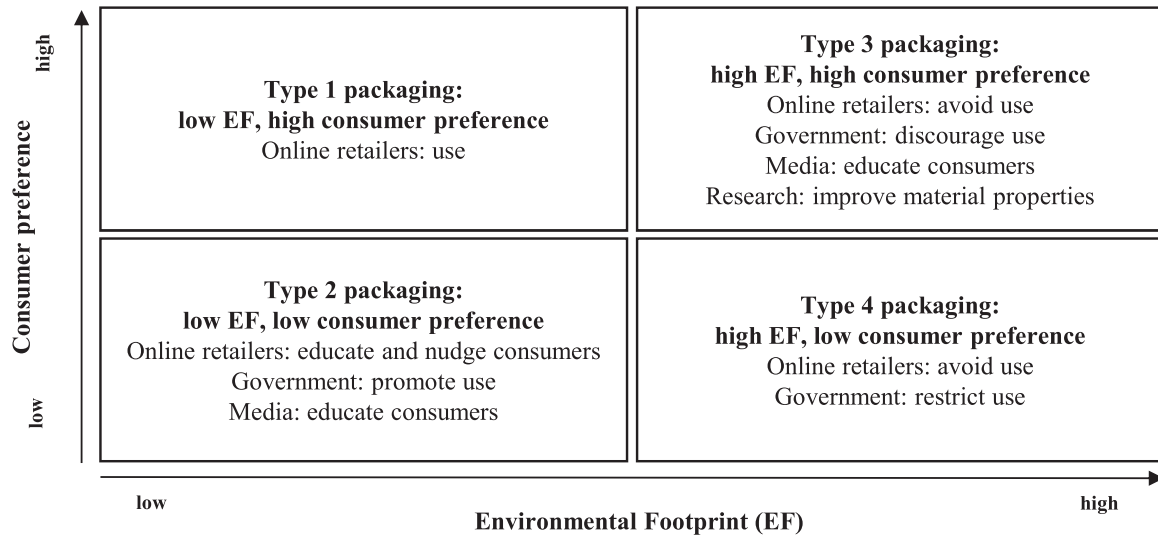


FIGURE 6 Stakeholder-specific strategies for different packaging types.

with unfamiliar types of packaging, online retailers could use nudging strategies, as these were found to be effective in encouraging sustainable consumer behavior (Demarque et al., 2015; Lehner et al., 2016). Hansen and Jespersen (2013) provide a comprehensive overview of responsible nudging strategies that could be used to promote environmental consumer behavior. For example, retailers could make the consequences of packaging waste salient to consumers by providing information about packaging-related environmental pollution, thus inducing higher consumer acceptance of eco-friendly alternatives. The media should also contribute to more favorable consumer perceptions of type 2 eco-friendly packaging variants by communicating their environmental impacts transparently and thus influencing the public debate. For example, this could be achieved through a better scientific representation of research findings in stories. Political authorities could further promote the use of type 2 packaging variants in online retail through legislation. The obligation to offer reusable packaging for food and beverages, as included in the German packaging law (VerpackG), can serve as a model here as it increases visibility of these packaging variants and might influence consumers' perception over time.

For packaging that is well accepted by consumers but that is disadvantageous from an ecological point of view (type 3), we recommend online retailers refrain from using it. Smaller packaging sizes, thinner packaging material, or the complete elimination of product packaging could also improve the environmental performance of the packaging types currently used in online retail (Reitz, 2021). Political authorities could also intervene by banning packaging options that are unambiguously harmful to the environment. The EU directive on single-use plastic products, adopted in 2019, can serve as an example of such regulatory influence (EU Directive, 2019/904). Further, the media should point out the potential problems of these packaging types and identify specific applications where they might be suitable. Scientific research should focus on improving the material properties of innovative packaging types that are promising but, to date, have a rather poor environmental performance, such as bioplastics. Bioplastics which use renewable rather than fossil resources could help mitigate certain environmental risks associated with plastic waste (Di Bartolo et al., 2021). Alternative production methods and better degradation properties could enable a more positive environmental assessment in the future (Coppola et al., 2021; Yin & Yang, 2020).

Packaging variants that are characterized by both low consumer preference and poor environmental performance (type 4) should be avoided by online retailers, and regulatory measures are needed to restrict their use.

4.3 | Limitations and further research

Research on sustainable behavior is particularly susceptible to social desirability bias (SDB) (Fernandes & Randall, 1992; Roxas & Lindsay, 2012). Although we have carefully considered SDB during survey construction, we cannot guarantee that respondents did not give answers they perceived to be socially desirable. However, assuming that our data is subject to SDB, individuals would have ranked those packaging variants highest which they perceive to be the most eco-friendly. Since our results show that consumers do not prefer the packaging variants that perform best in the LCA, we argue that our results point even more clearly to the problem that individuals cannot identify the most eco-friendly packaging options. Therefore, it is reasonable that our implications apply equally under the assumption of SDB.

This study's multi-method assessment of eco-friendly packaging focuses on online apparel retail. Since findings might differ for other product categories, we encourage future research to expand our analysis and investigate additional product types that are typically sold online.

Further, we can only suspect that the general tendencies in consumer preferences found in this study regarding paper and plastic packaging result from how these packaging materials are discussed in the media. To empirically validate these findings, we suggest that future research should take a closer look at the role of the media in shaping consumer attitudes toward specific materials and packaging variants.

Our LCA results do not include sensitivity analyses to investigate how changes to our assumptions affect the environmental assessment of the different packaging variants. Regarding the reusable packaging options, we find that packaging mass and expected lifetime are critical for their environmental assessment. Hence, we recommend investigating their respective impact on the results. In general, further research on the most relevant parameters influencing the EF of apparel packaging is recommended.

Moreover, this study does not investigate the impact of consumer behavior on disposal routes because the scenarios required to assess the environmental impact of the fate of packaging are an extensive study of their own. The disposal routes were specified according to the current waste management situation in Germany. Municipal solid waste disposal, which means incineration instead of recycling, could increase the EF significantly. Nevertheless, the environmentally worst consumer effect on the disposal route is careless littering, which is currently not yet included in LCA impact assessment due to a lack of adequate methodology (Scagnetti & Lorenz, 2022; Woods et al., 2021). Current research on method development is ongoing, and we recommend including these advancements in future research in the field of eco-friendly packaging in online retail.

This study investigated different packaging variants that were used by retailers and were available in mid-2020. Due to rapid technological development, new packaging materials are constantly appearing on the market. Thus, we encourage future research to follow our multi-method approach and investigate these new packaging types. These studies could also examine how the strategies for dealing with different packaging types proposed in this study affect the use of eco-friendly packaging in online retailing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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