Consumer acceptance of packaging return mechanisms in e-commerce deliveries: Mechanisms, profiles, and drivers

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SHORT SUMMARY

The growth of e-commerce has increased parcel volumes and packaging waste, creating new challenges for sustainable urban logistics. This study examines stated acceptance of three return mechanisms: central collection, back mailing, and return during next delivery using questionnaire data from 2,012 respondents across four European cities: Dortmund, Paris, Trondheim, and Zurich. Latent class cluster analysis and a multivariate ordered probit model identify consumer acceptance profiles and their attitudinal, behavioural, and contextual determinants. Return during next delivery receives the highest acceptance, followed by central collection; back mailing is substantially less accepted. Three profiles emerge: total acceptors, selective acceptors (the majority, whose acceptance varies by mechanism), and non-acceptors. Environmental concern, social activity engagement, and shopping behaviour consistently explain acceptance across mechanisms, while socio-demographic effects remain limited. These findings suggest that packaging return systems can achieve meaningful recovery rates by targeting frequent delivery users and embedding return within existing delivery interactions.

Keywords: Reverse logistics, circular economy, reusable packaging, urban logistics, consumer behaviour, behavioural heterogeneity, latent class analysis

1. INTRODUCTION

The e-commerce sector has expanded rapidly over the past decade and now represents a substantial share of retail activity in many economies (Riahi Samani et al., 2024). This growth has been accompanied by a sharp rise in parcel volumes, with more than 161 billion parcels shipped worldwide in 2022, approximately 30 % more than in 2019, and forecasts indicate an increase to around 225 billion parcels by 2028 (Pitney Bowes, 2023). Estimates indicate that packaging accounts for more than 30 % of total greenhouse gas emissions associated with e-commerce orders (Statista, 2021), making it one of the single largest sources of environmental impact within the e-commerce supply chain.

Existing research on e-commerce packaging has largely focused on the environmental and economic impacts of packaging production (Clement and Spinler, 2025; Escursell et al., 2021),

packaging design and material choice (Syed Ali et al., 2024), and reuse potential (Yue et al., 2024). From a consumer behaviour perspective, most studies have focused on food items and packaging (Corona et al., 2024), while comparatively little empirical attention has been given to how consumers perceive and accept returning transit packaging material used in Business-to-Customer (B2C) e-commerce.

This paper examines stated consumer acceptance of three alternative packaging return mechanisms - central collection, back mailing, and return during next delivery - in the context of urban e-commerce logistics across four European cities: Dortmund, Paris, Trondheim, and Zurich. This study makes a novel contribution by focusing on consumer acceptance of packaging return in e-commerce, an aspect that has received comparatively little empirical attention despite its centrality to the feasibility of reusable packaging schemes. The primary contribution lies in its behavioural focus. By examining consumers' stated likelihood of participating under different return mechanisms, the study provides direct evidence on the conditions under which packaging return schemes are likely to succeed, complementing existing work on packaging reuse and reverse logistics. Beyond aggregate acceptance, the study advances understanding of behavioural heterogeneity by identifying distinct acceptance segments, shedding light on why uniform return policies may produce uneven participation outcomes and underscoring the importance of mechanism design tailored to different consumer groups. Further, the study integrates segmentation and multivariate modelling approaches to provide complementary insights into consumer behaviour. While the identification of acceptance profiles captures discrete differences in participation patterns across all three mechanisms and examines the determinants of segment membership, the multivariate ordered model allows for an assessment of how socio-demographic characteristics, attitudinal factors, and urban context influence the acceptance of each return mechanism. The combined use of these approaches offers a more comprehensive behavioural characterisation than either approach alone. Finally, by drawing on survey data from four European cities, the study provides a comparative urban perspective that assesses whether acceptance patterns generalise across cities with different delivery environments and mobility conditions — evidence directly relevant to platforms and policymakers seeking to scale packaging return schemes across diverse urban settings.

2. METHODOLOGY

Survey instrument and data collection

This study draws on primary survey data collected in four European cities: Dortmund (Germany), Paris (France), Zurich (Switzerland), and Trondheim (Norway). The four cities represent a range of urban scales, e-commerce contexts, and delivery environments across Europe.

The data were collected as part of a broader research effort to understand shopping behaviour and delivery practices among residents of urban areas and their surroundings. An online questionnaire was administered simultaneously in the four cities, using a common survey instrument designed to capture multiple dimensions of shopping, delivery, and mobility behaviour. The survey was administered through a professional online panel, and recruitment procedures were designed to yield a representative sample of the adult population in each city, including age- and gender-balanced distributions.

The survey instrument was initially developed in English and subsequently translated into French, Norwegian, and German by native speakers. A double-checking procedure was applied to ensure consistency in wording and meaning across language versions, and feedback from local

collaborators was used to refine question phrasing before full deployment. To improve reliability and minimise response bias, several items were reverse-coded, and attention-check questions were embedded within the questionnaire.

Data collection took place over two months, June and July 2025, and was conducted simultaneously across all four cities. Approximately 500 respondents were targeted per city to ensure adequate coverage across key socio-demographic groups. In total, 2,720 completed responses were obtained. Data quality checks were applied to ensure the reliability of responses. After this cleaning process, 2,012 complete and valid observations were retained for analysis (Table 1).

Table 1: Socio-demographic characteristics of the sample

		Dortmund	Paris	Trondheim	Zurich	Full sample
Gender	Men	232	226	270	276	1004
	Women	242	277	252	228	999
Age	Less than 25 years	51	30	31	57	169
	25 to 34 years	100	82	116	89	387
	35 to 44 years	85	75	91	134	385
	44 to 60 years	137	144	129	142	552
	Above 60 years	95	170	155	82	502
Monthly income	Low	170	108	218	164	660
	Middle	176	201	128	181	686
	High	103	152	98	105	458
Education	No university degree	303	145	169	224	841
	University degree	156	354	327	271	1108
Overall Sample		475	504	526	508	2012

Variables

Outcome variables

The present study draws on a dedicated section on acceptance of a packaging return mechanism, in which respondents were asked to indicate their likelihood of returning packaging material under three alternative return mechanisms: (i) returning packaging material at a central collection point, (ii) returning packaging material via back mailing, and (iii) returning packaging material during the next delivery. Acceptance for each mechanism was measured using a five-point Likert scale ranging from "very unlikely" to "very likely".

Explanatory variables

The analysis incorporates attitudinal constructs expected to influence acceptance of packaging return. These include measures of environmental concern and social activity engagement. Environmental concern was measured using a five-point Likert scale ranging from "strongly disagree" to "strongly agree", while social activity engagement was assessed on a seven-point scale. The items for both constructs were adapted from established studies to ensure conceptual validity (Smith et al., 2023).

Furthermore, shopping behaviour was captured through detailed measures of shopping frequency across major product categories, including takeaway meals, home-delivered meals, groceries and everyday household items, healthcare and personal hygiene products (including pharmacy items),

clothing and footwear, electronic goods, leisure and sports items, and furniture and do-it-yourself (DIY) products. Shopping frequency for all categories was measured using seven-point ordinal scales, with category-specific scales reflecting differences in typical purchasing patterns. For the same set of product categories, excluding takeaway meals and home-delivered meals, respondents also reported the distribution of purchases between online and in-store channels on a five-point scale ranging from "always online" to "always in store". Finally, standard socio-demographic variables, including age, gender, education, monthly income, and employment status, were also collected.

Analyses

Two analytical approaches are used to address the research questions. Latent class cluster analysis is used to identify discrete consumer profiles based on acceptance patterns across the three packaging return mechanisms. A multivariate ordered probit model is estimated to examine how socio-demographic characteristics, attitudinal factors, shopping behaviour, and urban context shape acceptance intensity for different packaging return mechanisms. The two models are estimated independently, and their results are interpreted as complementary

Confirmatory factor analysis

Confirmatory factor analysis was conducted in R using the lavaan package in R to assess the reliability and validity of four latent constructs: environmental concern, social activity engagement, shopping frequency, and virtual shopping engagement.

All reliability values exceeded 0.60 and the average variance extracted surpassed 0.50 for each construct, supporting internal consistency and convergent validity respectively (Ab Hamid et al., 2017). All indicators showed statistically significant loadings ranging from 0.594 to 0.881, above the commonly cited minimum of 0.50. One indicator, grocery and household shopping frequency, showed an insufficient loading of 0.369 and was dropped from further analysis. Model fit was satisfactory across all indices: RMSEA = 0.06, TLI = 0.976, CFI = 0.974, and SRMR = 0.062 (MacCallum et al., 1996).

Latent class cluster analysis

The latent classes are derived from respondents' stated acceptance of three packaging return mechanisms, treated as indicator variables:(1) returning packaging material at a central collection point, (2) via back mailing, or (3) during the next delivery.

Multivariate ordered probit model

Consumer acceptance of alternative mechanisms: returning it at a central collection point, via back mailing, or during the next delivery is modelled jointly using a multivariate ordered probit (MVOP) framework estimated simultaneously using the mvord package in R. This joint estimation is preferred over three separate ordered probit models, which would ignore the correlations across the three modes and would yield incomplete insights into shared behavioural drivers.

3. RESULTS AND DISCUSSION

Latent class clustering analysis

The latent class analysis identified 3 classes (due to space constraints, we cannot present the detailed results and only present the most important findings).

The first class, *total acceptors*, accounts for approximately 21 % of the sample. This class exhibits uniformly high acceptance of all three packaging return mechanisms. Total acceptors exhibit the highest levels of environmental concern, shopping frequency, and virtual shopping engagement among all classes, indicating strong engagement with both sustainability-related issues and consumption activities. These characteristics suggest that frequent interaction with e-commerce deliveries and heightened environmental awareness contribute to a stronger willingness to engage in packaging return across different mechanisms. Together, these patterns describe a segment that is highly receptive to packaging return and well aligned with return schemes across different mechanisms.

The second and the largest class, *selective acceptors*, represents approximately 69 % of the sample. This class shows moderate to high acceptance of packaging return mechanisms, though there is clear variation across mechanisms. Attitudinal measures place this class between total acceptors and non-acceptors and close to the sample mean across most latent variables, suggesting neither particularly strong nor particularly weak engagement. These characteristics imply that acceptance among selective acceptors is not driven by strong underlying attitudes, but rather by practical considerations related to convenience and integration with existing delivery routines. As a result, this class appears open to packaging return, but only under conditions that limit additional effort.

The third class, *non-acceptors*, comprises approximately 10 % of the sample and is characterised by consistently low acceptance of packaging return mechanisms. Attitudinal characteristics further distinguish this class. Non-acceptors exhibit the lowest levels of environmental concern, social activity engagement, shopping frequency, and virtual shopping engagement. These patterns suggest a segment that is both less environmentally oriented and less engaged with shopping and delivery-related activities, which aligns with their strong resistance to packaging return.

Multivariate ordered probit model

The acceptance of a particular packaging return mechanism is driven primarily by latent attitudinal and behavioural factors, while socio-demographic and city effects play a more selective role (Table 2). While the class membership model examines what predicts belonging to each acceptance class, the multivariate ordered probit model addresses a distinct question: how individual characteristics shape the intensity of acceptance for each return mechanism.

. **Table 2:** Results from the multivariate ordered probit model (Coefficients reported)

	Central package material collection	**Back-mailing packaging material**	**Returning packaging material on next delivery**
Intercept	$\mathbf{1.433}^{***}$	$\mathbf{1.478}^{***}$	$\mathbf{1.577}^{***}$
Age (Base: Less than 25)			
25 to 34 years	$0.019^{n.s.}$	$-0.122^{n.s.}$	$-0.035^{n.s.}$
35 to 44 years	$0.075^{n.s.}$	$-0.103^{n.s.}$	$-0.012^{n.s.}$
45 to 60 years	$0.065^{n.s.}$	$\mathbf{-0.267}^{**}$	$-0.093^{n.s.}$

Above 60 years	$\mathbf{0.211}^{\dagger}$	$\mathbf{-0.270}^{*}$	$-0.106^{n.s.}$
Gender (Base: Female)			
Male	$0.019^{n.s.}$	$\mathbf{-0.093}^{\dagger}$	$\mathbf{-0.153}^{\dagger}$
Education (Base: No university degree)			
University degree	$\mathbf{0.125}^{*}$	$0.070^{n.s.}$	$0.052^{n.s.}$
Monthly Income (Base: Low Income)			
Medium Income	$0.033^{n.s.}$	$0.020^{n.s.}$	$-0.051^{n.s.}$
High Income	$-0.040^{n.s.}$	$-0.003^{n.s.}$	$-0.018^{n.s.}$
Latent Variables			
Environmental concerns	$\mathbf{0.142}^{***}$	$\mathbf{0.087}^{***}$	$\mathbf{0.128}^{***}$
Social activity engagement	$\mathbf{0.073}^{***}$	$\mathbf{0.052}^{***}$	$\mathbf{0.054}^{***}$
Shopping frequency	$\mathbf{0.046}^{**}$	$\mathbf{0.075}^{***}$	$\mathbf{0.056}^{***}$
Virtual shopping engagement	$\mathbf{0.001}^{\boldsymbol{n.s.}}$	$\mathbf{0.026}^{\dagger}$	$\mathbf{0.036}^{*}$
City (Base: Dortmund)			
Paris	$0.073^{n.s.}$	$\mathbf{-0.321}^{***}$	$0.039^{n.s.}$
Trondheim	$\mathbf{-0.209}^{**}$	$\mathbf{-0.167}^{*}$	$-0.037^{n.s.}$
Zurich	$-0.010^{n.s.}$	$0.045^{n.s.}$	$0.032^{n.s.}$
Correlations			
Central collection	1	0.539	0.511
Back mailing		1	0.698
Return on next delivery			1

Note: Correlation coefficients capture the correlation between unobserved components across the three return mechanisms *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, $^{n.s.}$ not significant.

Attitudinal and behavioural drivers

Environmental concern shows a positive, statistically significant association with acceptance across all three mechanisms. The magnitude of the coefficient is comparable across all three return mechanisms, indicating that pro-environmental orientation systematically increases stated willingness to return packaging material regardless of the specific return channel. Social activity engagement also shows positive and significant effects across all mechanisms, suggesting that socially active individuals tend to express higher acceptance of return practices in general.

Shopping frequency further contributes to acceptance. The effect is significant for all mechanisms, with back mailing being the strongest, followed by return during the next delivery and central collection. This pattern indicates that individuals who shop more frequently are more willing to participate in packaging returns, possibly reflecting greater familiarity with parcel-handling and delivery-related routines. In contrast, virtual shopping engagement plays a weaker role. It is not significant for central collection, but exhibits small positive effects for back-mailing and return during the next delivery. The magnitude of these coefficients is comparatively small, suggesting that reliance on online purchasing alone does not strongly determine acceptance once other behavioural factors are accounted for.

Socio-demographic effects

Socio-demographic effects are limited and mechanism-specific. Age is significant only for back mailing, where respondents aged 45 and above show lower acceptance than younger individuals. Gender effects are weak and appear only for back mailing and return during the next delivery, where males report slightly lower acceptance. Education increases acceptance only for central collection, whereas income does not show a statistically significant effect for any mechanism.

Urban context effects

City effects are also mechanism-specific. Relative to Dortmund, respondents in Paris show significantly lower acceptance of back mailing, which is consistent with the descriptive evidence and post hoc comparisons where Paris exhibited particularly low acceptance of this mechanism. The model results indicate that this difference persists even after controlling for sociodemographic and attitudinal covariates, suggesting that contextual or institutional factors related to local logistics practices, norms, or perceived feasibility may play an independent role. Trondheim shows a weakly significant negative association for central collection relative to Dortmund, suggesting somewhat lower willingness to return packaging via central collection in Trondheim after accounting for other variables. No statistically significant effects are observed for Zurich, indicating that covariates may largely explain observed differences in descriptives, or that Zurich is not systematically different from Dortmund once other factors are controlled.

Correlations across acceptance outcomes

The estimated correlations across the latent error components are all positive and relatively strong, confirming that unobserved factors jointly influence acceptance of multiple return mechanisms. The strongest correlation is observed between back mailing and return during the next delivery, followed by correlations between central collection and the other two mechanisms. This pattern is consistent with the Spearman correlations reported earlier and supports the joint modelling strategy. Substantively, these correlations suggest that there are shared underlying orientations, such as a general willingness to participate in packaging returns or preferences for sustainability-related practices, that affect acceptance across multiple mechanisms beyond those captured by the observed covariates

4. CONCLUSIONS

The rapid expansion of e-commerce has made packaging waste one of the most visible environmental challenges in urban logistics. Yet, the behavioural conditions under which consumers are willing to participate in packaging returns remain poorly understood. This study examined consumer acceptance of three packaging return mechanisms in e-commerce deliveries across four European cities, combining latent class analysis and multivariate ordered probit modelling to capture both aggregate patterns and behavioural heterogeneity. The results show that return during the next delivery and at a central collection are broadly preferred, while back mailing faces systematic resistance, and that acceptance is primarily driven by attitudinal and behavioural factors rather than socio-demographic characteristics. These results point to a broader opportunity for sustainable urban logistics. As cities pursue broader sustainability transitions, reducing e-commerce packaging waste is part of a larger shift toward circular material flows. The findings suggest that this shift is achievable, not by transforming consumer values, but by designing return

mechanisms that work with existing behaviours and routines. This mirrors a broader lesson from sustainable transitions: behavioural uptake tends to follow convenience. The move toward more sustainable e-commerce packaging is therefore less a question of consumer willingness than of whether return mechanisms make participation the straightforward and natural choice

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