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End consumers' delivery choice in an omnichannel e-retail context: a multinomial logit model

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Abstract

E-commerce is rapidly changing the behaviour of end consumers for purchasing and receiving e-parcels, leading to a significant increase in home deliveries. This phenomenon results in new challenges for cities such as more frequent, smaller, and failed deliveries and geographical sprawl, increasing traffic impacts, and reduced liveability and sustainability. In the new omnichannel e-retail context, end consumers can choose between several delivery channels, including crowdshipping, delivery to parked cars (into trunk), autonomous delivery robots, autonomous parcel lockers, and staffed pickup points. Each alternative has different implications for end consumers and cities. Although some studies have pointed out how end consumers make choices when faced with new alternatives, several aspects remained unexplored. This paper contributes by investigating end consumers' preferences for multiple delivery channels through a stated preference survey. Several attributes are considered including destination location, delivery time and price, time windows, data protection, tracking and tracing service, potential damage, payment timeframe, flexibility, and level of sustainability. The findings highlight that end consumers have limited knowledge of new delivery channels and limited willingness to receive e-purchases away from home.

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Keywords: delivery channel; omnichannel; end consumer; e-retail; city logistics; e-commerce; logit model; stated preferences; crowdshipping; delivery to parked car; autonomous delivery robot; autonomous parcel locker; staffed pickup point.

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1. Introduction

During the COVID-19 pandemic, the growth of end consumers buying online accelerated, and this upward trend is continuing (Comi and Polimeni, 2024; De Oliveira et al., 2022), leading to a substantial increase in home deliveries. E-commerce offers end consumers various advantages, such as access to a wider range of products, better price comparisons, and the convenience of purchasing anytime and anywhere (Kedia et al., 2017). However, the growth of e-commerce has created complex challenges for city planners and transport operators, as end consumers often purchase from multiple e-retailers and request deliveries to various locations. Subsequently, transportation issues arise due to the complexity of optimising geographically sprawled and small deliveries. This leads to an increase in the number of freight vehicle movements (Yu et al., 2016) contributing to an increase in traffic impacts (e.g., congestion, pollution emissions). In addition, delivery failures remain a persistent issue. Studies have shown that first-attempt delivery failure rates can vary widely, from *2*% up to *40*%, depending on transport operators' policies for dealing with "no-one-at-home" cases (Durand et al., 2013). Van Duin et al. (2016) indicated that *25*% of first-time home deliveries in the Netherlands were failing.

To mitigate issues related to failed and sprawled deliveries, new delivery channels (alternatives) have developed. Self-collection channels, including autonomous parcel lockers and staffed pickup points, allow end consumers to collect their e-purchases at their convenience, reducing the risk of delivery failures by offering flexible time windows and enabling transport operators to consolidate deliveries. However, such alternatives may increase traffic further, as end consumers might undertake additional journeys to collect their e-purchases.

Meanwhile, the growing variety of delivery channels has made end consumers' choices increasingly important. Given the potential of alternatives to address issues, it is crucial to analyse delivery channels in depth, focussing on how their service attributes influence end consumers' decisions. According to literature as discussed below, the identified alternatives now include traditional mail (*TR*), crowdshipping (*CS*), delivery to parked cars (into trunk, *TT*), autonomous delivery robots (*ADRs*), autonomous parcel lockers (*PL*), and staffed pickup points (*PP*). The objective of this study is thus to investigate how the attributes of these delivery channels influence end consumer decisions. A discrete choice model is developed using survey data and this was used to derive new insights on end consumers' preferences for delivery channels.

The remainder of this paper is organised as follows. Section 2 presents a brief review of the literature which positions the contribution of the paper. Section 3 describes the proposed method as well as the results obtained. Finally, Section 4 presents the conclusions and outlines future research directions.

2. Background

Delivery channels and their adoption have received a lot of attention in the literature. For example, McKinnon (2016) highlighted *CS* as a delivery channel with the potential to reduce impacts of urban freight traffic. Subsequently, Ranieri et al. (2018) reviewed innovative alternatives such as *ADRs*, *CS*, *PP*, and *PL*, emphasising their contribution to reducing external costs. Boysen et al. (2021) proposed a broader framework encompassing *TR*, *ADRs*, *CS*, *PP*, *PL*, and *TT*. In addition, some studies have compared *TR* and *PL* taking into account operational costs (Cardenas et al., 2017), while van Loon et al. (2015) explored the environmental implications of *TR* and *PP*. Beyond these comparisons, researchers have investigated the vehicle routing problem for *ADRs* and *TT*, demonstrating their potential to improve delivery efficiency (Chen et al., 2021; Morganti et al., 2014). The growing interest in new delivery channels has also led researchers to investigate the acceptance of alternatives by end consumers. Several studies have focused on single alternatives, such as *PL* (Tsai and Tiwasing, 2021; Yuen et al., 2019), *PP* (Kim et al., 2017; Milioti et al., 2020) and *ADRs* (Hwang et al., 2019; Kapser and Abdelrahman, 2020), while others have examined these channels collectively (Cai et al., 2021). Furthermore, self-collection alternatives, including *PP* and *PL*, have been analysed that highlight the acceptance of the end consumer (Collier et al., 2015; Zhou et al., 2020). Gatta et al. (2018) examined the benefits of *CS*, while Vakulenko et al. (2018) focused on the appeal of *PL*, revealing that these delivery channels can help address critical delivery challenges, such as failed deliveries and geographical sprawl.

However, few studies have focused on end consumers' preferences when the user is faced with a large panel of different delivery channels. Thirumalai and Sinha (2005), for example, analysed satisfaction with *TR* in relation to product type, while Otter et al. (2017) examined Austrian end consumers' preferences for delivery time windows,

comparing *TR*, *PP*, and *PL*. Similarly, Xiao et al. (2018) assessed the varying effects of *TR*, *PP*, and *PL* on e-shopping. Other studies have focused on innovative delivery channels, such as *CS*. Punel et al. (2018) investigated determinants that push end consumers to adopt *CS* in the USA. Gatta et al. (2021) further contributed to this field by analysing the choices of the delivery channel between in-store, *TR*, and *PP*. Meanwhile, Merkert et al. (2022) compared *TR*, *ADRs*, and *PL* characterised in Australia. Furthermore, Wang et al. (2024) analysed the preferences of end consumers for *TR*, *PL* and *PP* in Singapore, considering factors such as physical effort, social interaction with staff, and product value. Similarly, Tsai and Tiwasing (2021) studied Thai end consumers and found that convenience, reliability, privacy, compatibility, and relative advantage are determinants of the use of *PL*. A study in Bangkok examined factors that affect intention to use *PL*, finding that perceived ease of use, trialability, and awareness play key roles. Klink and Schweizer (2025) investigated general end consumers' attitudes toward delivery channels in Europe, identifying trust, price, and environmental impact as major drivers of choice. Samani et al. (2025) assessed the competitiveness of *ADRs*, *CS*, and *PL*, considering end consumers' preferences in the State of Tennessee, USA. Together, these studies underline the importance of understanding end consumers' decisions to optimise delivery processes and enhance end consumer satisfaction. However, scientific research remains limited in the exploration of innovative alternatives, self-collection channels, and traditional mail together, underscoring the need for further research that investigates the service attributes influencing end consumers' choices.

3. Methodology and results

The research employs a stated preference experiment to quantify how service attributes influence delivery channel choices. The following subsections describe the survey design and data collection procedures, the development of the discrete choice model, and the estimation and validation of model parameters.

3.1. Survey design and data collection

The general approach is operationalised, as introduced in Hriekova et al. (2025). Several discrete choice models were considered. Building on the literature (Merkert et al., 2022; Wicaksono et al., 2022), a multinomial logit model was chosen based on the easy-to-apply criteria and the assumption that no correlation is expected to exist among the identified alternatives. Given a generic user, the systematic utility function U_j for each alternative j has been specified as a linear combination of attributes $X_{j,k}$ through the coefficient β_k and the alternative specific constant ASC_j:

$$U_j = \sum_k \beta_k \cdot X_{j,k} + ASC_j \qquad (1)$$

In order to characterise alternatives, based on the results of the literature review briefly described above, ten service attributes with their relative levels have been considered. Destination location (*L*) refers to the point where the end consumer prefers to receive the e-purchase. The most convenient option is to receive e-items directly at home or in the workplace (level *0*), both commonly referred to as points of interest (PoI) in the literature (Morganti et al., 2014; Rai et al., 2020; Risberg, 2023). Alternatively, receivers may opt to collect their e-items from a designated self-collection point. When this location is close and accessible on foot (level *1*), the alternative remains relatively convenient. However, when such a point is not close and requires one to drive or ride public transport (level *2*), the level of convenience and attractiveness decreases significantly. The delivery time (*T*) is defined as the number of days between the place of the order and the delivery of the e-item. Short delivery times of one to two days (level *1*) are typically preferred, particularly for urgent or high-value purchases. Medium time frames of three to five days (level *3*) are still considered acceptable in many contexts. However, when delivery exceeds six days (level *6*), satisfaction tends to decline, especially for sectors where speed is a key priority, such as electronics, pharmaceuticals, groceries and perishable goods (Alkhiyami et al., 2024; Janjevic and Winkenbach, 2020; Merkert et al., 2022). The delivery price (*C*) represents the financial cost incurred by the end consumer solely for the delivery service. A free delivery option (*0* euros, level *0*) is generally more appealing and is often used as a promotional tool. A moderate cost of *5* euros (level *5*) may be accepted when the service quality justifies it. In contrast, a price of *10* euros (level *10*)

significantly reduces attractiveness unless paired with exceptional convenience or speed (Gatta et al., 2021; Nogueira et al., 2021; Oyama et al., 2023).

The time window (*TW*) refers to whether the end consumer is offered the possibility to select a preferred time slot for delivery. When no choice is available (level *0*), the receiver has to remain available throughout the day, which may lead to dissatisfaction. In contrast, when the end consumer can choose a time window (level *1*), such as afternoon or evening, perceived control and service satisfaction increase (Amorim et al., 2024; Kedia et al., 2024; Merkert et al., 2022). The tracking and tracing (*TrT*) service describes the degree of visibility the end consumer has over the status and location of the e-item during the delivery process. In basic systems, only major updates are shown, such as "shipped", "in transit", "out for delivery", etc. (level *0*). More advanced tracking systems allow real-time monitoring (level *1*), offering continuous updates on the location of the e-item, which improves transparency and trust (Souza et al., 2022; Tapia et al., 2024). Potential damage (*D*) reflects the condition of the e-item upon arrival. A lower level of delivery quality (level *0*) could result in damaged packaging while the item remains usable; this still impacts the perception of service. At the higher level (level *1*), the item is delivered in excellent condition with no visible damage to the packaging, as particularly valued for fragile or expensive goods (Dias et al., 2021; Silvestre, 2022).

Flexibility (*F*) refers to the ability of the end consumer to modify the delivery characteristics after the order has been placed. Limited flexibility is offered when only the location can be changed (level *1*), while more advanced services allow changes to location, time, and delivery day (level *2*). Greater flexibility enhances convenience, but often increases operational complexity and cost (Frey et al., 2023; Phillipson and Van Kempen, 2021).

The nature of online purchasing requires end consumers to share personal information via the e-retail platform, raising concerns about privacy and trust. E-commerce continues to face challenges in this regard, particularly from the perspective of buyers. According to Janjevic and Winkenbach (2020), a major issue is the lack of trust in online transactions, especially when it comes to sharing sensitive data, such as credit card information. To address these concerns, two relevant service attributes have been identified, such as payment timeframe (*P*) and data protection (*DP*).

The payment time frame (*P*) refers to the moment when the end consumer completes the payment in relation to the delivery process. This can occur either before delivery (level *0*), where payment is made online during the ordering process, or after delivery (level *1*), where the recipient pays upon receiving the e-item, using either a credit/debit card or cash. Exploring end consumers' preferences on this aspect is important, as the topic remains under-researched in the current literature.

Data protection (*DP*), on the other hand, involves the handling of personal information such as address, phone number, and location, details that may vary depending on the delivery channel chosen. Although e-retailers are expected to ensure the security of this information, cyber-attacks, thieves remain an unpredictable threat. For this reason, data protection is considered a service attribute with varying levels of perceived security: low (level *0*), where there is a risk of data loss or breach, and high (level *1*), where strong protections are in place and risks are minimal.

Furthermore, Patella et al. (2020) identify economic and environmental sustainability (*S*) in urban logistics as closely related to the reduction of greenhouse gas emissions and other air pollutants. Common strategies aimed at improving the sustainability of logistics systems include the use of smaller and electric vehicles, the establishment of urban consolidation centres, and other measures. However, from the point of view of the end consumer, the technical details of these strategies are generally not relevant. Instead, the sustainability of the delivery process can be assessed in terms of its overall environmental impact. Therefore, this attribute is considered at two levels: low (level *0*), when the delivery process generates a higher environmental impact, and high (level *1*), when it reflects a greener and more sustainable approach.

A stated preference (SP) survey was designed using Ngene 1.4© software to generate 36 scenarios grouped into four blocks. Ngene employs algorithms that optimise the design matrix based on the specified service attributes and levels. It generates the choice sets based on the *d*-efficiency criterion, which ensures that the resulting survey design is both statistically efficient and manageable from the respondent point of view. Thus, each respondent was faced with *9* scenarios in the online questionnaire. The SP survey consisted of three sections: (1) socioeconomic and demographic information, (2) habits related to e-purchasing and e-delivering processes, (3) the SP experiment with visualisation and explanation of all six delivery channels, and ten service attributes with their levels. Given the research focus on end consumers' delivery channel choices, it is essential to gather responses from respondents who are familiar with e-purchasing environments. The SP questionnaire was distributed online using Google forms. As several of the

delivery channels identified (*PL*, *ADR*, *CS*, and *TT*) involve advanced technologies or platform-based steps, a detailed presentation of the alternatives was included to ensure that users have clear understanding of the delivery channels. A random sampling approach was used within the online distribution to reduce selection bias and increase generalisability within the target group of end consumers.

3.2. Results

A total of *359* responses (*3231* observations) were collected. The sample reflects a demographic of technology-savvy: more than half of the respondents (*58*%) belong to the *18-24* age segment, and a considerable number of them are students (*36*%) or full-time employees (*40*%), most of whom hold a bachelor degree. Respondents are *35* years old, and above account for nearly *26*% of the sample, contributing to broader age representation. In terms of e-purchasing behaviour, nearly half of the respondents reported shopping online at least once a month but less than once a week, indicating a consistent engagement with e-commerce. Furthermore, the sample demonstrates sufficient e-purchasing power to regularly participate in e-retail activity. As a discussion point, it is noted that, although the sample size was sufficient for model estimation, representativeness may be affected by the online distribution method and potential self-selection bias. In particular, older age groups are under-represented, limiting the extent to which findings can be generalised throughout the population. However, it should be noted that younger, digitally proficient end consumers constitute a significant share of e-buyers and are typically more confident in navigating digital platforms and services. In this context, the composition of the sample may reasonably reflect the active segment of e-commerce users.

As expected, the *TR* alternative was chosen more frequently by *37*% of respondents, *21*% opted for *PP*, and *20*% of the sample preferred *PL*. Meanwhile, innovative alternatives remain hypothetical and are not yet widely adopted globally. *ADRs*, *CS* and *TT* were chosen by *9*%, *8*% and *5*%, respectively. This finding suggests that users have limited knowledge of the innovative alternatives and tend to prefer known delivery channels.

The model developed, as presented below in Table 1, is the result of a trial-and-error process. The Nlogit 5 © software was used to estimate the model parameters, indicating that the flexibility attribute (*F*) was non-significant (p-value > *0.05*) at a *95* % confidence level; thus, it was excluded from the final model.

Table 1. Estimation parameter results.

	β_L	β_T	β_C	β_{TW}	β_{DP}	β_{TrT}	β_D	β_P	β_S	ASC_{CS}	ASC_{TT}	ASC_{ADR}	ASC_{PP}	ASC_{PL}
value	-0.090	-0.108	-0.110	0.241	0.235	0.151	0.280	0.093	0.186	-2.150	-2.548	-1.897	-0.872	-0.880
t-st value	*-2.50*	*-8.54*	*-13.43*	*+2.86*	*+4.98*	*+1.62*	*+5.83*	*+1.58*	*+3.53*	*-20.49*	*-22.51*	*-18.26*	*-11.53*	*-11.40*

Subsequently, the developed model was assessed using chi-square tests, the likelihood ratio test, and the rho-square statistic. In this phase, the reasonableness and significance of the estimated parameters were verified using tests on expected signs and *t-st values*. The developed model has a high chi-square value of 386.086 with 14 degrees of freedom. Moreover, the likelihood ratio test compares the goodness of fit between the zero-coefficient model and the developed MNL model. The rho-square statistics is *0.146*. The tests indicate that the model fit is satisfactory according to the similar models present in literature (Washington et al., 2011; Comi, 2020).

As mentioned above, initial coefficient tests are based on expected signs of the estimated parameters. Those associated with destination location (*L*), delivery time (*T*) and delivery price (*C*) have negative signs, which are consistent with the expectation that higher levels of these attributes would reduce the satisfaction of end consumers. Another noteworthy finding is that the remaining parameters have positive signs, which is intuitive: having a more customised delivery, such as personalising the delivery (*TW*, *D*), protecting user data (*DP*), and enhancing sustainability (*S*), increases delivery satisfaction. In more detail, the possibility of choosing and adjusting the time window (*TW*) to receive the e-purchase within a preferable timeframe is particularly significant. Additionally, the high level of data protection (*DP*) represents the strong concerns of this related to e-purchasing. Remarkably, analysis of the tracking and tracking attribute (*TrT*) reveals that end consumers prefer real-time tracking to receiving notifications about the main stages of the delivery process. As expected, the level of potential damage (*D*) of the e-item during the delivery process is also a significant attribute. The possibility to make a payment (*P*) after receiving the e-purchase

appears less influential. A high level of sustainability (*S*) influences attractiveness as end consumers are becoming increasingly environmentally conscious.

Furthermore, alternative specific constants (*ASCs*) represent respondents' residual preference for each alternative compared to the reference delivery channel (*TR*). As indicated in Table 1, *PP* is the most attractive alternative among the others (ASC_{PP} = *-0.872*). Then, *PL* has almost the same level of attractiveness, with an ASC_{PL} of *-0.880*. Meanwhile, the *ADR* is less appealing, with an ASC_{ADR} value of *-1.897*, while *CS* has an ASC_{CS} value of *-2.150*. Lastly, *TT* appears less attractive compared to *TR* (ASC_{TT} = *-2.548*).

Finally, *t*-values were examined. The *t-st* values allowed assessment of the significance of the estimated parameters. The calculated *t-st* values were then compared with the critical *t-st* value at a *95*% confidence level. The analysis confirmed that the calculated *t-st* values were above or close to the critical value of *1.96*, indicating statistical significance for all estimated parameters.

4. Conclusions

The importance of service attributes, which influence the decisions of end consumer about the choice of delivery channel for e-commerce purchases, has been investigated. Six alternatives were considered, each characterised by ten service attributes including destination location, delivery time, delivery price, time windows, data protection, tracking and tracing service, potential damage, payment timeframe, flexibility and sustainability. A stated preference survey was carried out, yielding a dataset of *3231* observations. The sample enabled the development of a multinomial logit (MNL) model to assess preferences in an omnichannel e-retail context.

The estimation results indicate a general preference among consumers for traditional mail and familiar self-collection alternatives, such as staffed pickup points and autonomous parcel lockers. In contrast, lower preference rates were observed for innovative delivery solutions, including crowdshipping, delivery to parked cars (into trunk), and autonomous delivery robots. The findings suggest limited end-consumer awareness and trust in less familiar technologies, as well as a general reluctance to receive e-purchases away from home. These results provide actionable insights for logistics providers and e-retailers in planning, developing, and optimising last-mile delivery systems aligned with end consumer expectations.

Future research could employ larger and more demographically diverse samples, including older segments and varied end consumers' groups. The incorporation of revealed preference data, where available, would enhance behavioural realism. Behavioural studies can also help track evolving attitudes as end consumers become more familiar with innovative delivery channels. In addition, advanced modelling techniques, such as nested or mixed logit models, could improve the handling of preference heterogeneity and potential correlation among similar alternatives, especially in contexts involving rapidly developing technologies.

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