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## REDESIGNING LAST-MILE LOGISTICS CONSIDERING CONSUMERS' BEHAVIOUR: A REVIEW OF LITERATURE

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### 1. Introduction

Last-mile logistics faces significant challenges due to ongoing industry developments, including the surge in e-commerce demand, sustainability concerns, and high operational costs (Boysen et al., 2021). The current trend of digital consumption, accelerated by the COVID-19 pandemic, has made e-commerce and online food delivery the primary means of purchasing necessities, resulting in a notable increase in home deliveries. Consequently, the pressure to achieve decarbonization and zero-emission vehicles in the next two decades adds further complexity to these challenges.

Being in direct contact with consumers, last-mile logistics plays a vital role in satisfying customer needs (Li et al., 2021). However, providing a high level of service can also lead to increased costs and environmental impacts, particularly in urban areas with dense e-customer populations (Hagen and Scheel-Kopeinig, 2021). The rise in home deliveries contributes to traffic congestion and fossil fuel consumption, exacerbating negative impacts on social and environmental well-being (Vasiutina et al., 2021). Additionally, logistics service providers (LSPs) must contend with rising operational costs, driven by customers' expectations of fast and affordable deliveries (Taha and Kyamakya, 2022). Balancing high-quality service and adopting greener practices, such as using electric vehicles, further increases operational costs for LSPs.

Many innovations have been introduced to overcome the challenges within last-mile logistics and many studies have tried to explore them. Past studies have explored the use of new modes of transport in last-mile logistics such as electric tricycles (Xu et al., 2022); cargo bikes and electric van Utomo et al. (2021); and drone delivery (Merkert et al., 2022, Shavarani et al., 2018) while other studies explore the use of new storage modes such as automated (Rabe et al., 2021) and movable parcel lockers.

Numerous studies explored consumer responses to innovations in last-mile logistics, such as collection and delivery points (CDP) (Otter et al., 2017), central last-mile micro depots (Hagen and Scheel-Kopeinig, 2021), parcel locker (Iannaccone et al., 2021) or self-service express cabinets (Jiang et al., 2020) usage in last-mile logistics. Later studies also explored consumers responses on the use of drone delivery both for parcel (Merkert et al., 2022) and food delivery (Waris et al., 2022). Another study investigated how autonomous vehicle for parcel delivery would affect the number of customers and their satisfaction (Shbool et al., 2022). Nevertheless, how last-mile logistics providers should design services considering consumer responses remains an underexplored topic.

Previous studies primarily focused on optimizing last-mile logistics operations from the perspective of logistics service providers (LSPs), with limited consideration of consumer reactions. They addressed topics like revenue maximization (Lin et al., 2022a) or the sustainability and cost impact (Li et al., 2020). Some studies investigated the optimisation of locations and service areas for new service such as smart parcel lockers (Che et al., 2022). Another study explored vehicle routing problems in last-mile logistics by considering self-driving robot (Chen et al., 2021) or considering customer's time satisfaction (Zhang et al., 2020).

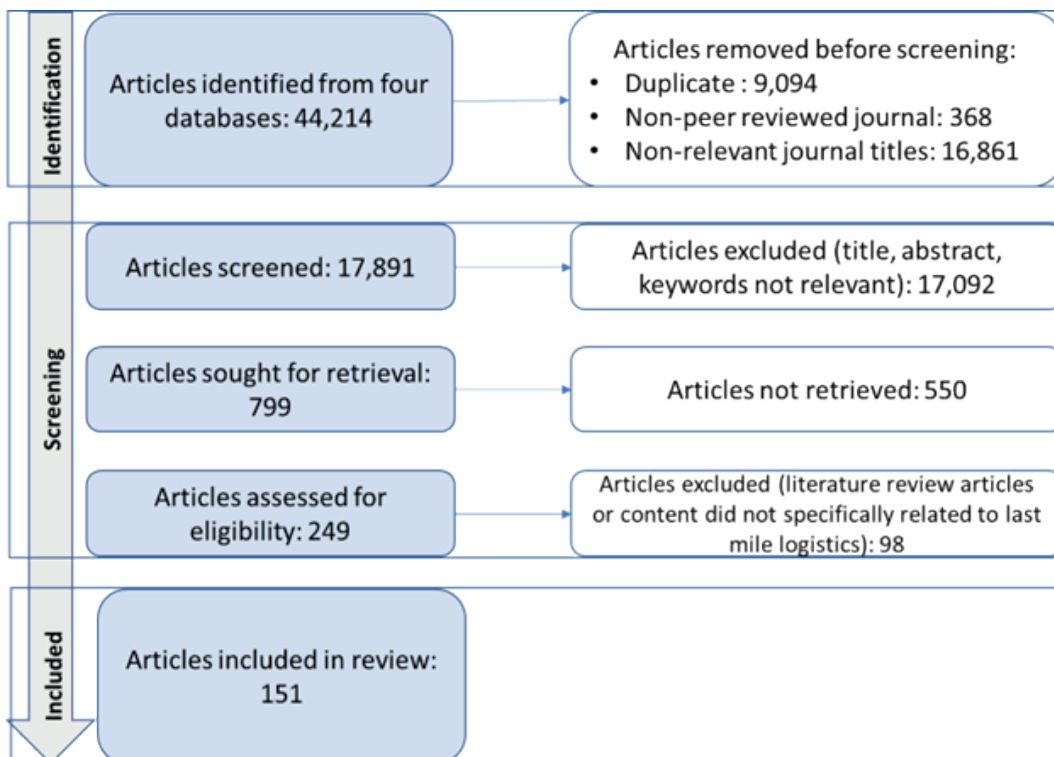
Despite these contributions, there is a lack of research directly accounting for consumers' acceptance of new innovations when redesigning a last-mile delivery system. Considering that these innovations aim to meet consumer demand and achieve decarbonization, consumer responses should be considered when planning their operational implementation, influencing the operators' decarbonization pathway. Matching customers' needs with suitable delivery modes remains an essential area for future research, as highlighted by Boysen et al. (2021).

It is quite apparent that understanding last-mile logistics consumers' perception is one of the key points, especially for last mile logistics providers, in designing a robust solution strategy to decarbonise last-mile delivery while fulfilling the consumers' demand.

The main aim of this paper would be to comprehensively analyse the existing body of literature concerning the role and impact of consumers in the last mile logistics process. The primary objective of this study is to identify the research gap within the context of last mile logistics, specifically related to the role of consumers in the light of new innovations in last mile logistics utilising quantitative methodological approach.

## 2. Methodology

This section discusses the literature review processes to identify the research gap of consumers in last mile logistics services. The process employs the PRISMA 2020 Statement that becoming more popular in operational research such as the study by Utomo et al. (2018). The process started by identifying previous studies via academic journal databases using keywords relevant to the study as the search queries. The collected records were then managed and processed using EndNote 20 software to acquire relevant articles to the topic of the study. The records were then sought for full text retrieval and the unretrieved titles were excluded from the list. The remaining articles in the records were then screened manually to exclude any irrelevant articles resulted in the final records used for this study. The steps carried out is presented in figure 1.



**Figure 1** Literature review flow diagram

The literature search was conducted in October 2022 using Proquest, Science Direct, Web of Science and Ebsco databases. The keywords used in the literature search were derived from the main topic of the study that was broken down into four main components which are: (1) last-mile logistics; (2) consumer; (3) decision rules; and (4) quantitative analysis. The synonym or other highly relevant common terms were also included in the search query when retrieving the records from all the databases chosen. The final keywords and the Boolean logic used in the literature search process are as follow:

1. (Last-mile logistics OR last-mile delivery OR urban delivery OR city logistics) AND
2. (Consumer OR customer OR user) AND
3. (Preference OR behaviour OR behavior OR satisfaction OR decision making OR decision rule) AND
4. (Quantitative OR operational research OR simulation modelling OR data analytics OR statistics)

The initial literature search yielded 44,214 records. After removing duplicates and articles from non-peer-reviewed journals or beyond the study's scope, 17,891 articles remained for further screening. The screening process involved filtering based on title, abstract, and keywords, resulting in 799 articles. Out of these, 249 full-text articles were obtained. These full-text articles were assessed for eligibility, and finally, 151 articles were included in the review.

### 3. Literature analysis and classification

#### 3.1. Literature classification based on stakeholders

Out of the 151 articles analysed, 93 papers (62%) focused on logistics service providers (88 papers discussed third-party logistics providers (3PL) (e.g., Kahr, 2022) and 5 papers discussed non-third-party logistics providers, such as supermarkets or grocery shops (e.g., Truden et al., 2022), 40 papers (26%) on consumers or customers of last-mile logistics (2.5% of which act as sender, such as online retailers that hire 3PL services to deliver products to customers e.g., Brotcorne et al., 2019. And 97.5% act as receiver, such as households who order food through online delivery platforms e.g., Dsouza and Sharma, 2021). The remaining papers (11%) adopted a broader perspective, considering multiple stakeholders like public authorities, local governments, and residents (e.g., Szmelter-Jarosz and Rześny-Cieplińska, 2020). Research on last mile logistics in the sample showed a rising trend in the past five years. Both consumer-focused and logistics service provider-focused papers exhibited a similar increasing pattern.

#### 3.2. Research aims and theoretical lens

The aims of the retained research articles can be classified into several categories (please note that a study can be classified into more than one category) namely:

- 1) Optimisation of last mile logistics service (53 papers e.g., Lin et al., 2022), such as facility location planning and vehicle routing. 50 papers adopted LSP perspective, 2 papers adopted consumers' perspective and one paper combined public administrators and service providers.
- 2) Comparing and evaluating different last mile delivery system (40 papers e.g., Arnold et al., 2018).
- 3) Proposing framework or conceptual design for innovative last mile logistics, such as urban freight consolidation centre (26 papers e.g., Kocsis et al., 2022).
- 4) Consumers preferences and perceptions toward innovative last mile logistics services, such as drone (35 papers e.g., Merkert et al., 2022).

Next, the retained papers are classified based on their theoretical lenses. One finding that could be highlighted is that studies that use LSP perspective mainly employed optimisation theories with very few references to behavioural or social theories e.g., Schnieder et al. (2021). There are 36 papers specifically mention their contribution to theory development (such as theory of planned behaviour, UTAUT and game theory) e.g., Kapser et al. (2021), of which 32 papers took the consumers' perspective and four papers studied the perspective from multiple stakeholders e.g., Kapser et al. (2021)

#### 3.3. Research methodology and type of analysis used in the previous studies

The database search primarily yielded literature employing quantitative methodologies, with only nine research papers deviating from this trend (six used qualitative methodologies, and three adopted mixed methodologies).

There are different analysis techniques used in previous quantitative studies. As much as 49 studies used mathematical modelling such as linear programming e.g., Kahr (2022). The second most common method is statistical modelling with 42 articles in total e.g., Lin et al. (2022b). 10 papers used simulation modelling such as agent-based modelling and simulation (6 papers) e.g., Shbool et al. (2022), system dynamic (2 papers) e.g., Rabe et al. (2021), dynamic traffic simulation (1 paper) e.g., Simoni et al. (2020), and discrete event simulation (1 paper) e.g., Greasley and Assi (2012). The rest used other analysis methods such as multi criteria decision making techniques and game theory e.g., Simić et al. (2021). From the studies that used qualitative methodology, different analysis techniques were used such as critical analysis (1 paper) e.g., Sułkowski et al.

(2022), thematic analysis (2 papers) e.g., Alharbi et al. (2022), and case study (2 papers) e.g., Rosenberg et al. (2021). The studies employing mixed methodologies include studies using SWOT analysis, sustainability balance scorecard, and AHP to identify the sustainable best practice for last mile delivery companies e.g., de Assis et al. (2022).

### 3.4. The type of freight being transported

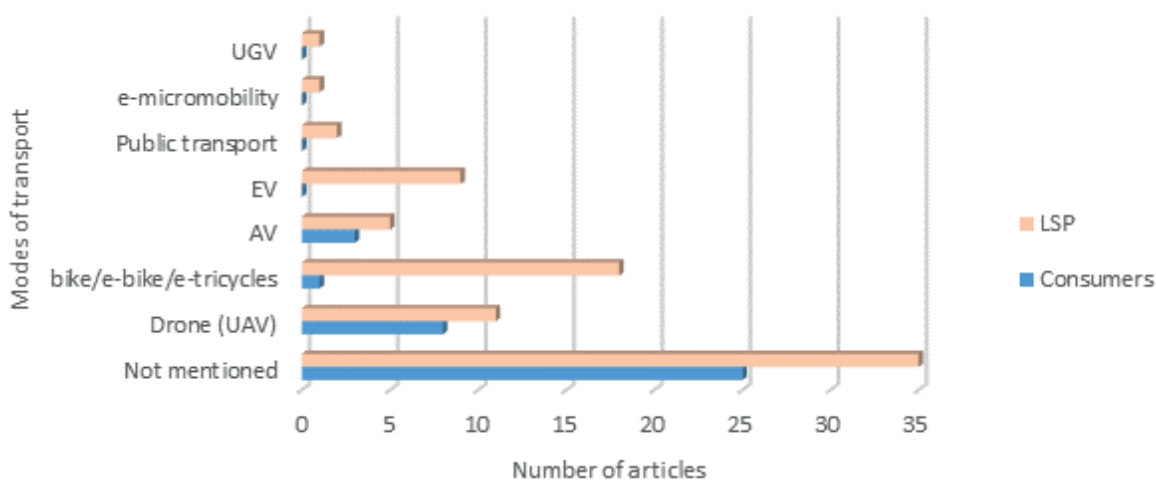
Last mile logistics deals with different types of freight. From the literature retained, 122 articles discussed parcel delivery with 77 articles adopted LSP's perspective e.g., Sárdi and Bóna (2021), and 30 articles were focused on consumers' perspective e.g., Merkert et al. (2022). 12 papers discussed food delivery e.g., Dsouza and Sharma (2021) and eight papers discussed grocery delivery e.g., Gatta et al. (2021). From those discussing food delivery, seven focused on consumers intention and acceptance towards food delivery service, while the remaining five papers focused on the LSP's perspective in optimising their food delivery services with one of them also accounted consumer satisfaction in the optimisation e.g., Zhang et al. (2020). From the eight papers that studied grocery delivery service, only three papers focused on the consumers perspective e.g., Gatta et al. (2021) while the other five focused on the LSP e.g., Truden et al. (2022). There is one paper that used both parcel and grocery in the discussion (Serrano-Hernandez et al., 2021) and one paper discussed about postal service (Rostasova et al., 2020) while nine papers did not clearly mention the freight type in their research.

### 3.5. Logistics service innovation discussed in previous studies: transport modes and storage modes

Innovations introduced in last mile logistics services mainly come in two forms: transport modes used for moving the freight and storing modes after the delivery process finished. For simplicity, this study classifies them as transport modes and storage modes.

Sixty-six of the retained articles discuss innovative transportation modes with drone being the most popular (21 papers) e.g., Li et al. (2020). 20 articles included the use of bicycle, e-bike or e-tricycle e.g., Hagen and Scheel-Kopeinig (2021). Electric vehicles (EV) and autonomous vehicles (AV) with both have ten articles that included them as the transport modes in the studies e.g., Kocsis et al. (2022). There were also several studies that combine and compare new innovations with the traditional modes of transport in last mile delivery system such as vans and cargo bike e.g., Arnold et al. (2018).

There were only small numbers of other transportation modes innovation discussed in the rest of retained papers. Three papers included the use of public transport in last mile logistics while each Unmanned Ground Vehicle (UGV) (Wu et al., 2021) and e-micromobility (Castiglione et al., 2022) only discussed in one paper. There were 66 articles that did not clearly mentioned the modes of transport being studied. Summary of the different transportation modes innovation in the previous studies is provided in figure 3.



**Figure 3** Innovation in modes of transport discussed in the articles

There are four innovative storage modes discussed in the previous paper. First, 22 papers discussed the use of lockers with relevant improvements e.g., Rabe et al. (2021). 18 previous papers discuss the use of micro depot e.g., Rosenberg et al. (2021). Mobile depot is an innovative storage mode which is included in seven research papers e.g., Krstić et al. (2021). Lastly, three articles considered the use of collect and delivery point (CDP) in the last mile logistics studies e.g., Kedia et al. (2019). The remaining 68 papers did not clearly mention the storage mode included in their studies. Figure 4 shows the comparison of the different innovation in storage modes between articles that focused on consumers and LSP.



**Figure 4** Innovation in storage modes discussed in the articles

#### 4. Research gaps identified from the literature review

The literature review reveals that the consumers' perspective in last mile logistics remains underexplored. Previous research rarely considers consumers' responses or acceptance towards new innovations when redesigning the last mile delivery system. This limitation indicates that consumers' voices are not adequately heard in the process, leading to potential mismatches between design and consumers' demographical and geographical contexts. However, this presents an opportunity to explore the design of last mile delivery systems that consider consumers' responses and acceptance, aligning with previous studies' calls for investigating new concepts in last mile delivery for appropriate customer segmentation and understanding how delivery attributes may affect different consumers' demographics.

Regarding research methodology and analysis techniques, simulation modelling like agent-based modelling is rarely utilised in last mile logistics research. However, agent-based modelling suits analysing last mile logistics consumers due to its emphasis on decision-makers' behaviour and communication within the system, considering how the system reacts to parameter changes resulting from interactions between decision-makers. Supplementing simulation modelling with statistical analysis can provide a more robust representation of consumers' behaviour. Moreover, exploring other freight types, like groceries and food, alongside parcels, is necessary due to the increasing popularity of online food and grocery delivery services offered by various supermarkets. Additionally, understanding consumers' perceptions of implemented innovations, such as electric vehicles, compared to or combined with more conceptual innovations like drones or community refrigeration in last mile delivery system design, is crucial. For this purpose, studies such as Utomo et al. (2021) can be used as a foundation.

#### 5. Conclusion

In conclusion, the literature review indicates that the perspective of last mile logistics consumers is an underexplored area, with limited attention given to their responses and acceptance of new innovations in the delivery system. The current lack of consideration for consumers' voices in redesigning last mile logistics poses risks of misalignment with their needs and contexts. However, this gap also presents an opportunity for future research to explore how consumer responses can influence the design of sustainable last mile logistics services, especially concerning emerging innovations. Integrating simulation modelling and statistical analysis could offer deeper insights into consumer behaviour and interactions within the system. Moreover, the research should not solely focus on parcel delivery but also explore other freight types, like groceries and food, while examining consumer perceptions of existing innovations like electric vehicles alongside conceptual innovations like drones. By addressing these aspects, researchers can contribute to more consumer-centric and efficient last mile logistics systems that meet evolving needs and promote sustainability.

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