Logistics challenges of e-grocery last-mile delivery: a literature review

Montuori G. [a)], Tumino A. [a)], Seghezzi A. [a)]

a. Dipartimento di Ingegneria Gestionale, Politecnico di Milano, Via Lambruschini, 4B 20156 – Milano - Italy (giulia.montuori@polimi.it, angela.tumino@polimi.it, arianna.seghezzi@polimi.it)

Abstract: In recent years, e-commerce has been growing globally and online markets have undergone a radical transformation during Covid-19 Pandemic. In this context, Food and Grocery sector has expanded exponentially thus leading to a development of last-mile logistics which is the least efficient supply chain activity in terms of economic and environmental impact.
At the moment, B2C e-commerce players face multiple challenges due to logistics complexities and efficiency. On the other side, demand complexities rise from Service Level expectations, and consumers' willingness to pay for logistics services.
Food and Grocery e-commerce has three main configurations: the enogastronomic e-commerce, the on-demand food delivery and the e-grocery. Among these, the third one has reported the highest growth during and after the Pandemic. However, beside complexities of e-commerce logistics, the online purchase of grocery products raises new challenges due to product peculiarities, logistics requirements and complexity of orders.
The aim of this work is therefore to investigate which are the main problems associated with last-mile delivery for e-grocery and which are the appropriate variables to describe them. In order to achieve this objective, a Systematic Literature Review has been performed to identify key issues addressed by scholars and existing typologies of last-mile delivery problems in this sector.
The contribution of this research is threefold: firstly, it analyses the state of the art of last-mile challenges for e-grocery from an academic perspective and proposes a classification. Secondly, the identification of logistics variables associated with identified problems highlights potential threats for E-grocery players. Therefore, this work supports managers to identify challenges in a structured way before planning appropriate countermeasures for the specific context. Thirdly, it identifies opportunities for future research directions.

Keywords: E-grocery; food E-commerce; last-mile; home delivery; Literature review.

I. INTRODUCTION

In 2021, eCommerce B2C represented 21% of worldwide retail market. In the same year, online sales in Europe amounted to 718 billion euros (+21% from the previous year) thus highlighting a permanent shift in consumers' behaviour after Covid-19 Pandemic.(Assolombarda and Politecnico di Milano, 2023). In this context, Food & Grocery increased by 15% in 2022 thus emerging as one of the most dynamic product sectors (Osservatorio eCommerce B2C, 2022).

The growth of B2C e-commerce has led to a development of last-mile delivery (LMD) (Huang, Savelsbergh and Zhao, 2018; Nogueira, de Assis Rangel and Shimoda, 2021) which is one of the most expensive, least efficient, and most polluting stages in the entire supply chain in the urban logistic context (Morganti *et al.*, 2014; Nogueira, de Assis Rangel and Shimoda, 2021) thus requiring improvement to guarantee both economic and environmental sustainability. Previous studies have highlighted logistics challenges faced by B2C eCommerce players including high complexity of logistics activities, the difficulty in estimating intangible online transactions, the challenging Service Level, the dimension of orders and dispersion of destinations (Mangiaracina *et al.*, 2019). Furthermore, new challenges have arisen on demand side, due to diversification of e-consumers' priorities and the higher accessibility of this market (Osservatorio eCommerce B2C, 2021)

From practitioners' perspective, online players view service level targets as necessary constraints to compete on the market. As a result, while effectiveness is set, companies seek efficiency to minimize last-mile costs which may account for half of the total logistic cost (Vanelslander, Deketele and Van Hove, 2013; Mangiaracina *et al.*, 2019).

Food & Grocery eCommerce includes enogastronomic eCommerce, on-demand food delivery, and e-grocery. The logistics problem changes depending on the configuration under analysis (Seghezzi, Mangiaracina and Tumino, 2022). The distribution problem of enogastronomic

eCommerce is similar to that of "generic" parcels in terms of type of products (non-fresh) and orders dimension (Fernie, Sparks and McKinnon, 2010). On-demand food delivery has emerged and grown between 2013 and 2015, therefore it is still a new research field (Seghezzi, Mangiaracina and Tumino, 2022). Finally, e-grocery is the online sale of grocery products. This configuration is associated with a distribution problem which is even more complicated than eCommerce complexities previously mentioned because of product peculiarities (e.g. frozen and fresh products, low shelf-life…), specific requirement for storage and transport conditions, high number of lines per orders (Fernie, Sparks and McKinnon, 2010; Seghezzi, Mangiaracina and Tumino, 2022). As a consequence, transport for e-grocery has become an attractive research field for academics (Hübner, Kuhn and Wollenburg, 2016) and for practitioners aiming at performing efficient last-mile delivery and align effectively with customers' expectations.

Most studies on last-mile delivery for e-grocery focus on optimization problems presenting algorithms to minimize costs while satisfying customers' orders. Among these, some models include innovative solutions, for example parcel lockers and autonomous vehicles. Other studies focus on technologies to support logistics in multi-stakeholders' environments. Wu et al.(Wu *et al.*, 2023), propose an application of IoE (Internet of Everything) and DT (Digital Twin) technologies in a platform architecture supporting operations, information flows and decision processes in the pharmaceutical sector. Another application has been proposed by Mosca et al., to support information management and performance improvements for healthcare providers (Mosca R. *et al.*, 2022). With reference to e-grocery, technological innovations have been reviewed by Fernàndez (Fernández Vázquez *et al.*, 2021)

A second group of researches target a specific challenge, for example emissions and environmental sustainability, food waste, delivery capacity or time slots management. Mkansi and Nsakanda (Marcia Mkansi and Nsakanda, 2021) discuss a framework to classify logistics problems and variables associated with e-grocery logistics. Their work, however, is not specific on last-mile delivery only and the framework doesn't include supply chain actors and their relationships with variables. This dimension is missing also in the framework used by Punakivi e Saranen (Punakivi and Saranen, 2001). However, in the dynamic environment of e-grocery, collaboration is essential to enable innovation, competitive edge, quality services and value creation (Han et al., 2020). The first goal of this research is the fulfilment of this gap by integrating the identification of the main logistics problems and variables with a categorization which takes into consideration the main supply chain actors involved. The proposed framework should support the study of e-grocery supply chain distribution problem. From practitioners' perspective, this work provides a useful tool for assessing threats and opportunities in last-mile delivery for e-grocery. Future studies may develop further this research by identifying appropriate methodologies to prioritize the classified challenges of last-mile delivery.

This paper is structured as follows: the second section describes the objectives and the methodology of the research; the third section is dedicated to the systematic literature search and material classification; the fourth section describes main findings of the review process and suggests direction for future research; the fifth section is dedicated to final conclusions.

II. Objectives and methodology

To investigate which are the main challenges of last-mile delivery for e-grocery and how they can be classified from an ecosystem perspective, we performed a systematic literature review to answer the following research question:
RQ: *Which are the main logistics problems associated with last-mile delivery for E- grocery? Which drivers can be used to describe them?*

The literature review has followed the steps discussed by Durach and Weiland (Durach, Kembro and Wieland, 2017). In line with other literature review in supply chain management (Mohammad *et al.*, 2023), the process has been the following:

1) Identification of keywords and formulation of the research question
2) Definition of inclusion and exclusion criteria
3) Use of databases and literature search
4) Identification of relevant papers
5) Descriptive analysis and results discussion

III. Systematic Literature Review

A. Keywords selection

The objective of work is the analysis of logistics challenges and associated variables for the last-mile

delivery for e-grocery. Therefore, we selected a number of keywords to examine the state of the art in this field. The following keywords have been used: 'e-grocery', 'food/grocery b2c', 'food/grocery e-commerce', 'food/grocery online shopping', 'last-mile', 'home delivery', 'last-mile logistics'.

B. Inclusion and exclusion criteria

In order to identify relevant papers, a selection of criteria has been applied. This approach has been used in two sequential phases. Firstly, we analyzed titles and abstracts of the retrieved papers and we applied the criteria to minimize the false negative thus maximizing the sensitivity of the process. Secondly, we used the criteria in order to maximize the specificity (reduce the false positive). We read the full-text of the selected papers in order to assess their eligibility.

Table 1: Inclusion and exclusion criteria

Inclusion Criteria	• Logistics problems of LMD • LMD for E-grocery • Logistics Solutions
Exclusion Criteria	• Focusing on other logistics activities than LMD • On-demand food delivery (i.e., delivery of prepared meals, delivery from restaurants) • LMD for other eCommerce product categories • Focus only on consumers' behaviour • Focusing on e-grocery but not on logistics activities

Table 1 shows inclusion and exclusion criteria. In order to be included in the research, the content of a study should satisfy jointly all inclusion criteria. To discard a paper, it is sufficient that one of the exclusion criteria is true.

C. Literature search

The database used for the Systematic Search is Scopus because it is the most comprehensive database in the field of logistics which guarantees an adequate quality of documents. Previous literature reviews on innovations in logistics already relied on this database because of it's the among the largest databases of peer-reviewed scientific literature (Mohammad *et al.*, 2023).

Initially 171 documents in English were found. Then, filters have been applied in order to include only documents from scientific journals and conferences. Considering the novelty of the field, it has been decided to also maintain Conference works at this stage of the research in order to take into consideration recent studies and solutions which may not be present in articles, yet due to the length of the Publication Process.

At the end of this phase, we assessed 163 titles and abstracts by applying the criteria in Table 1. When the analysis of titles and abstract was not sufficient to assess the eligibility of the paper, the full-text has been read. As a result, 78 papers have been included in the review.

D. Descriptive analysis

The distribution over time of the 78 publications under analysis is shown in Figure 1. The increasing trend of the recent years confirms the growing interest in the last-mile delivery for e-grocery which is aligned with the growth of online sales during the last five years (Osservatorio eCommerce B2C, 2022).

The number of publications of 2023 should be evaluated and compared at the end of the current year.

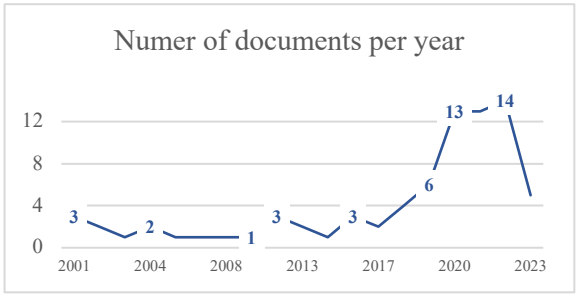

Figure 1: Distribution of documents per year. Source: own elaboration.

Considering the origins of the papers, 4% are literature reviews, 69% are articles published on scientific journals, while a minority (27%) are conference papers. Among the scientific journals containing most of the articles, there are: *Transportation Science, Computers and Industrial Engineering, Research in Transportation Economics, Transportation Research Part E: Logistics and Transportation Review, European Journal of Operational Research, International Journal of Physical Distribution and Logistics Management.*

It is relevant to notice the heterogeneity of journals addressing topics in logistics and transportation but also operational research, computer science, and ecology. This aspect highlights the complexity of the last-mile delivery for e-grocery and the size of the impact on multiple supply chain actors with different roles.

E. Keywords co-occurrence

A bibliometric analysis on key-words occurrence has been performed with two main objectives. Firstly, we wanted to have a picture of the state of the art in terms of clusters of keywords and topics addressed by researchers. Secondly, we aimed at identifying trends and evolution over time.

In order to achieve the second objective of this bibliometric analysis, we investigated the occurrence of these keywords and clusters over time. Figure 2 shows the overlay visualization. Based on the colors adopted it emerges that logistics, home delivery and e-grocery are the topics which have been researched for most time. After that there are last-mile, e-commerce and vehicle routing. It is noteworthy that city and urban logistics and sustainability represent the lightest nodes thus representing the most recent research directions. The chronological perspective on keywords has high relevance in describing the evolution of academic interest and highlighting current critical issues. For this reason, this result will be further discussed in the following sections.

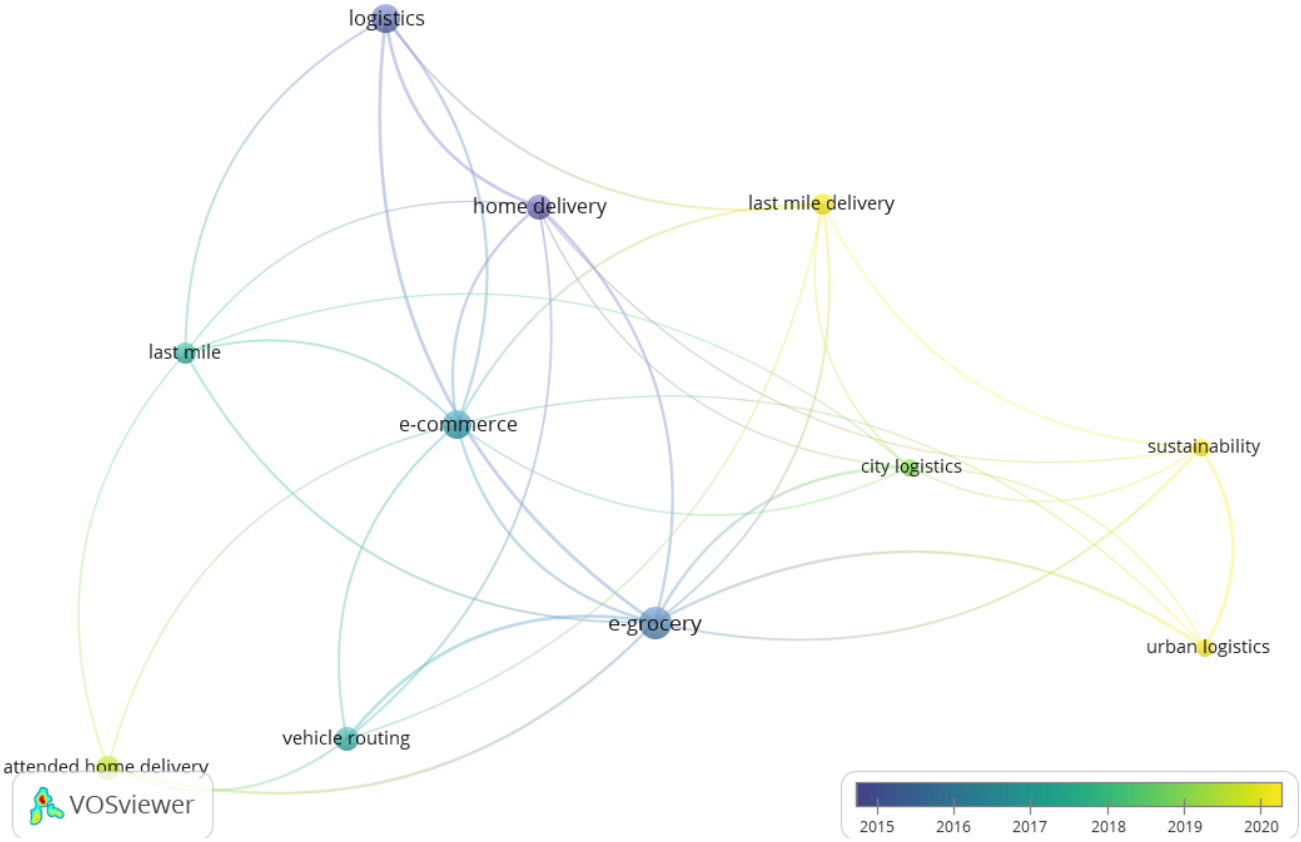

Figure 2: Keywords co-occurrence analysis, overlay visualization. Source: Own elaboration

The co-occurrence analysis focuses on the content of the papers by using their keyword under the hypothesis that if some words frequently occur together, they are thematically related. The output of the analysis is a chart where each node represents a keyword, and the connections highlight co-occurrences. The size of the nodes and the thickness of the links represent frequency of occurrence. In order to answer the two questions beforementioned, the analysis has been performed in two steps.

The first analysis highlighted three main keywords clusters with different colors. The first cluster is associated with e-commerce logistics (*logistics, home delivery, e-commerce, last-mile*). The second cluster refers to *vehicle routing* and *attended home-delivery* for *e-grocery*. The third cluster is about city logistics and sustainability (*last-mile delivery, city logistics, urban logistics, sustainability*).

IV. Content Review and Results Discussion

After the descriptive and co-occurrence analysis the selected papers were analyzed by means of a framework composed by five main sections: search data, preliminary analysis of the paper (methodology, research questions, contributions, limitations, future research), elements of last-mile delivery for e-grocery (definitions, problems

addressed, current situation, proposed or analyzed solutions), theoretical background and overview. Among these sections, the one dedicated to last-mile delivery problems and solutions has been considered the core for the review process.

Among the 78 papers, 42%, including one literature review (Sluijk *et al.*, 2023), present optimization models aiming at improving last-mile delivery performances either with routing algorithms (Beatriz and Fernando, 2011; Cepolina, Cepolina and Ferla, 2021; Chakraborty, Darbhe and Sarmah, 2021; Mehlawat, Gupta and Khaitan, 2021; Hu *et al.*, 2022; Prajapati *et al.*, 2023) or proposing innovative solutions such as parcel lockers and autonomous delivery vehicles (Leyerer *et al.*, 2020; Liu *et al.*, 2020; Dan Liu *et al.*, 2021; D Liu *et al.*, 2021), Refrigerated Ground Vehicle (RGV) and Unmanned Aerial Vehicle (UAV) (Lee, Han and Song, 2022). Dalmijn et al. (Dalmijn *et al.*, 2020) propose a model to optimize battery consumption of electric vehicles.

After that, we identified 33 studies proposing solutions or strategies to improve specific aspects of last-mile delivery for e-grocery. Trott et al. (Trott, Der Landwehr and Von Viebahn, 2021) address environmental issues and emissions control which is also discussed in other eight papers. Another research stream focuses on optimal allocation of time slots for home delivery (Agatz et al., 2008, 2011; Asdemir, Jacob and Krishnan, 2009; García Jiménez and Gómez González, 2011; Yang et al., 2016; Klein et al., 2019; Mackert, Steinhardt and Klein, 2019; Vinsensius et al., 2019; Koch and Klein, 2020; Akkerman, Mes and Lalla-Ruiz, 2022; Truden et al., 2022). The impacts on urban logistics and city planning are discussed by (Murphy, 2007; Saskia, Mareï and Blanquart, 2016; Bjørgen, Bjerkan and Hjelkrem, 2021; Mohammad *et al.*, 2023). Additional studies focus on collaborative approaches, capacity constraints, applications of reception boxes and unattended home delivery. Finally, highly specific solutions for fruit delivery or organic products home delivery are discussed (Murphy, 2003; Mu and Xiangpei, 2013).

Overall, a limited number of studies present a framework to classify the challenges of last-mile delivery.
Punakivi and Saraned (M Punakivi and Saranen, 2001) identify four clusters of input variables for the "Home delivery model" and one cluster of output variables. The input variables are divided into *Demand, Customer Base, Equipment and Service Concept*; the outputs are *Performance Measures.* Mkansi and Nsakanda (M Mkansi and Nsakanda, 2021) classify e-grocery models by means of the following aspects of logistics: *e-fulfillment site, grocery products offered, preferred delivery mode, geographical/penetration reach, customer density, grocery order, returnability convenience for customers and turnover volume requirements.* While presenting several variables of logistics problems, the previously mentioned frameworks focus on three main actors: e-grocery traders, logistics operators and customers.

The dimension of urban logistics is introduced by Bjorgen et al. (Bjørgen, Bjerkan and Hjelkrem, 2021) who analyzed interferences between consumer and travel behavior, urban space and urban logistics. We decided to highlight this perspective because it is representative of the shift towards inclusion of urban logistics in last-mile delivery studies which also emerged from the bibliometric analysis. The incorporation of multiple actors in the framework is the first step towards an ecosystem perspective which enables sustainable value creation. As a result, Figure 4 shows a comprehensive framework shaping the last-mile delivery for e-grocery as a complex problem involving four main actors (blue shapes) which are *consumers, retailers, logistics operators and policy makers*. The players affect four main clusters of variables, here presented as *Customers, Service Concept, Urban Logistics and Performance Measures.* The actors can leverage these variables in order to identify strategies to manage complexities and changes in a dynamic environment.

Future research could address possible approaches to prioritize intervention on the variables depending on the specific context.
We decided to focus on logistics problems and to maintain a high level perspective in order to develop a generalizable framework for e-grocery ecosystems.

A dedicated review of studies on customers' preferences and behavior could provide added value to this work for two main reasons. Firstly, to review existing frameworks for customers' behavior and integrate the most relevant variables in ours; secondly, to support practitioners in managing complexity of diversified expectations. Further studies should also investigate which

success factors enable players to react quickly to changes in e-grocery dynamic environment.

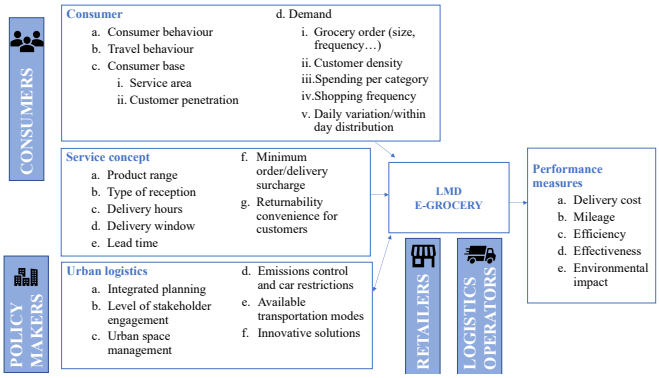

Figure 3: E-grocery last-mile delivery framework. Source: Own elaboration

V. CONCLUSIONS

In the recent years, eCommerce has been growing globally and Food &Grocery sector has been rapidly evolving thus raising logistics challenges to fulfil customers' expectations.

Among the different configurations of Food and grocery e-commerce, E-grocery emerged to be the most relevant in terms of logistics complexity.

In order to assess how it is possible to classify the main challenges associated with last-mile delivery for e-grocery, a systematic literature review has been performed thus highlighting the main actors involved and clusters of variables affecting the complex dynamics of last-mile delivery in this sector. This work has two main limitations. Firstly, although the search has been performed with a systematic approach, some contributions may have been missed. Secondly, we have tried to develop a framework which could be scalable and applicable to different contexts, however the variables may assume different relevance in specific situations due to the heterogeneity of online grocery market. Therefore, future studies should focus on the identification of appropriate prioritization criteria of the variables to enable sustainable value creation for all actors involved.

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