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Review

The Impact of E-Commerce-Related Last-Mile Logistics on Cities: A Systematic Literature Review

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Abstract: E-commerce-related last-mile logistics have a great impact on cities. Recent years have seen sustained growth in e-commerce in most developed countries, a trend that has only been reinforced by the COVID-19 pandemic. The perceived impact of this phenomenon varies depending upon the perspective of the players involved: individual members of the public, companies, or the public administrations. Tackling the issue from these perspectives, the goal of this article is to explore the kinds of impact this phenomenon has and will have. We use as the basis for their classification the so-called triple bottom line (TBL) of sustainability, encompassing people, planet, and profit; we complement this with the impact classification used by the European Science Foundation's impact assessment working group. After performing a systematic review of the literature following PRISMA guidelines, our results show that, albeit to different degrees, the four impact dimensions analyzed (economic, social, environmental, and technological) have only received incipient coverage in the existing literature. Given its ever-growing importance, we believe that greater attention needs to be paid to this phenomenon, especially with regard to those aspects having the greatest impact upon urban systems and the different stakeholders involved. Only in this way can the public policies needed to mitigate these externalities be properly implemented.

Keywords: last mile; urban logistics; e-commerce; impact assessment; systematic review

1. Introduction

Recent years have seen a huge expansion in e-commerce, with high growth rates of up to two digits in most developed countries. Revenue from online food delivery, for instance, and according to Statista's Online Food Delivery Report 2019, is growing at 7.5% in UK, 7.7% in Germany, 10.6% in France, 10.7% in Spain, and 8.4% in Italy. This has led to a consequent increase in last-mile deliveries associated with online sales [1,2]. Added to this gradual increase over time are the knock-on effects of the COVID-19 pandemic. Aside from any short-term impacts of the self-isolation and lockdown periods imposed in many countries, the very structure of the market may be undergoing transformation, very quickly accelerating its transition towards e-commerce [3]. All this will, in turn, magnify the externalities associated with traffic congestion, pollution, and noise in urban areas where pressure is already increasing due to the increase in urban density. Cities are now home to more than half the world's population [4]. This, added to the fact that public policy on this issue is still at an early stage, could lead to tensions in many cities, particularly those with the most congested transport networks. This boom in e-commerce can also provide businesses with an expanded customer base and new opportunities to increase their market due to the resultant economies of scale [5], making the tackling of this issue all the more vital.

Urban freight logistics are made up of the flow of goods circulating throughout a city. In general, an urban transport system can be defined as the set of transportation elements—public as well as private—that involve the mobility of people and goods within the metropolitan area: infrastructure,

management, means of transport, entities, service providers, and users [6]. The goal of urban freight distribution is to supply specific items on time and in the right way, guaranteeing low costs and offering good customer service. The boom in e-commerce in recent years has led to a sizeable increase in home delivery packages, with a huge surge in the number of orders shipped and hence in urban freight traffic. Moreover, in e-commerce, every home becomes a potential delivery point, leading to accelerated growth in delivery numbers and new scenarios that exacerbate the impact of urban freight distribution.

All this means that freight distribution and transportation companies have seen a sharp increase in their activities. However, they have found a serious obstacle along the way: the "last mile", one commonly accepted definition for which is "the last stretch of a business-to-consumer (B2C) parcel delivery service. It takes place from the order penetration point to the final consignee's preferred destination point" [2]. It is in this last stretch of the delivery process that the highest operating costs and the greatest organizational problems occur [7,8].

City logistics (and especially last-mile logistics) lay bare the conflicting interests of the different stakeholders involved [1,9–11]. These stakeholders can be classified into three categories: private enterprise (haulage and shipping companies, small retailers, large retailers, and logistics operators), the public administrations, and members of the general public. Although the interests of private enterprise are obvious, this is less the case for the public administrations (with their often-ring-fenced, political-sphere-specific focuses) and the general public, whose different roles often lead to clashing interests. A number of authors have shown how the implementation of some urban freight transport policies have failed due to different stakeholders' lack of engagement in the process [12–14], but more research is needed to determine the implications of such cases. The phenomenon is also causing problems of mobility and other social, environmental, and economic issues in cities, making analysis of the impact of last-mile logistics a hot topic for research [15,16].

This article delves into the academic contributions made in recent years (2009–2019) around the impact of e-commerce-related last-mile logistics in cities. Based on the perspective of the stakeholders involved (members of the public, businesses, and the public administrations), the goal is to explore the impacts that this phenomenon has and will have, using sustainability theory's "triple bottom line" concept (people, planet, and profit) [17] as the basis and complementing this with the impact assessment classification used by the European Science Foundation's Working Group 2 on Impact Assessment [18].

The remainder of this article is structured as follows: Section 2 gives a background based on the literature. Section 3 details the methods we used to implement our systematic review. Section 4 develops a framework for the impacts of last-mile logistics, classifying the different types of impact found in academic literature. Section 5 contains a discussion. Finally, the main results of this study, their implications, and potential lines of future research are summarized in the conclusions.

2. Background

The growth in e-commerce has revolutionized the physical distribution of goods in our cities [19]. Understanding e-commerce as Internet-based business-to-customer (B2C) transactions [20], we can assert that Internet purchases and customized deliveries are the trends with the greatest impact upon urban freight transport systems. The diversification of delivery channels and the increasing range of services offered by retailers and logistic operators are leading to changes in urban freight flow patterns. More goods must be delivered, more destinations have to be covered, more vehicles are moving, and more complexity is added to the system day after day. These changes are magnified by social and behavioral factors such as demographic trends, the globalization of supply chains and the adoption of new consumer technologies [21]. The recent growth of e-commerce, for instance, has led to a significant increase in direct-to-consumer deliveries, fortifying the role of "last-mile" logistics. Customers can choose not just home-delivery services, but also additional locations for the delivery such as lockers or pick-up points. There is even an upward trend for click-and-collect options, allowing the consumer to

buy online but pick up the product from the retailer in person. Providing such services efficiently is becoming extremely difficult due to its increased complexity, dynamics, and uncertainty [20].

Last-mile logistics must be understood within the framework of city logistics (CL) [22]. CL can be defined as "the process for totally optimizing the logistics and transport activities by private companies with support of advanced information systems in urban areas considering the traffic environment, the traffic congestion, the traffic safety and the energy savings within the framework of a market economy" [23]. It includes aspects such as freight traffic management, freight facilities, and modal adaptation. CL supports urban economies and sustainable development, but it also entails negative externalities that can worsen with the growth of demand. This explains why policymakers and regional planners are taking notice of it. At present, incorporating urban logistics planning into the scope of urban planning is gradually being recognized and valued by practitioners [24]. CL and new domains, such as the Physical Internet, are breeding grounds for initiatives that jointly address the economic, operative, social, and environmental sustainability of transportation and logistics, mitigating the inefficiencies and externalities that characterize the last-mile segment of the supply chain [25]. When applied to urban environments, for instance, the Physical Internet allows for the emergence of the so-called hyperconnected city logistics, a conceptual framework for designing urban logistics and transportation systems that are significantly more efficient and sustainable due to technological innovations [26].

E-commerce is creating a surge in customized deliveries that increases even more the social and environmental externalities of freight distribution systems [27]. The distribution of goods within the city is therefore becoming a crucial issue of CL, which requires further study [22]. It is imperative to implement new methods and techniques to evaluate both the benefits and the externalities of such systems [28]. In this sense, several authors point to modeling urban freight systems and evaluating CL schemes as a rational basis for evaluating CL initiatives [29,30]. They assert that recent developments in information and communication technologies are creating new opportunities to implement more integrated and dynamic solutions [31]. In e-commerce-related logistics, data infrastructure and information management are crucial to optimize routes, speed up deliveries, improve energy efficiency, and increase the operational capacity of distribution and reverse logistics, as well as to make the entire system more environmentally friendly [32]. All of this can be contextualized depending on the type of impact these new systems are causing. According to the European Science Foundation [18], impact can be defined as the "consequences of an action that affects people's lives in areas that matter to them". Impact does not have to be beneficial. There can also be different perspectives as to whether a particular impact is positive or negative. Moreover, impact need not be anticipated or foreseen. For analytical purposes, impact can be divided into different categories: scientific, technological, economic, social, political, environmental, health, cultural, and training. This classification is considerably broader than that of the triple bottom line (TBL) [17], which establishes that impact can be broken down into three categories: economic, social, and environmental [1].

The e-commerce sector is thus faced with multiple challenges. The problem of responding to the growing number of orders constantly arriving from different locations is one of them. These can range from a few meters to a few kilometers away, and they are normally characterized by having very tight time-windows [33]. The chief obstacles to the successful implementation of these systems in the industry are: delivery size (small) and frequency (high), the organization of the network (a large number of recipients spread throughout the city), and the complexity of the logistics activities themselves (performed by wholesalers, suppliers, and retailers) [34]. All this calls for a process of constant innovation involving last-mile delivery solutions that make it possible to reduce last-mile delivery costs [35].

Last-mile innovations can be broken down into three types: organizational, technology-enabled, and data-technique-enabled [36]. The first category, organizational innovations, can include the implementation of new last-mile organization models or methods. Examples of this include urban consolidation centers [37–39], synchronization and horizontal collaboration [5], and crowdsourcing [40–42].

With regard to technological innovations, automated lockers, drones, and autonomous vehicles are the most noticeable examples [43–45]. Data-technique-enabled innovations refer to applications of said techniques (data mining, data analytics, big data, etc.) to last-mile logistics to improve effectiveness and efficiency. An example would be mapping consumer behavior: by analyzing electricity consumption during the day and throughout the week, a probability distribution of the customer's presence at home can be derived. However, academic research on logistics has concentrated heavily on the exploitation of historical traffic data sets to optimize time-dependent routes [46,47], leaving other viewpoints as of yet practically unstudied. In [48], it was concluded that the innovations with the potential to reduce the impacts and externalities generated by last-mile delivery activities can be classified into five main categories: new vehicles, proximity stations or points, collaborative and cooperative urban logistics, optimization of transport management, and routing. Combining them would create a smart logistics system that could mitigate the negative externalities.

It is therefore obvious that minimizing the negative impact of urban freight transport and optimizing load flow efficiencies are some of the main goals of CL. However, there are others. It is crucial to analyze all the potential solutions for the different interest groups involved, and this represents the first step towards successfully designing an urban logistics strategy [49]. Despite this, stakeholder performance in areas of crowdsourcing, urban development, CL, urban mobility, and crowd logistics still needs to be improved [50]. Implementation of logistics policies and the associated traffic measures cannot be successful without an understanding of the interests of the different stakeholders involved: otherwise, this implementation may be disincentivized. Collaboration and information exchange between local authorities and logistics service providers can undoubtedly facilitate the adoption of CL measures, but a harmonized and long-term vision on policymaking for urban freight transport across cities and regions could be a game-changer [51]. Local governments and logistics companies face various challenges in the foreseeable future due to various socioeconomic, operational, and environmental trends and factors [52]. In this regard, the literature points to the current lack of measurement and assessment methodologies to help decision makers understand the operations and performance of urban distribution systems. This would allow them to formulate integrated policies that improve the efficiency thereof and reduce their negative externalities [49]. Some authors even suggest that public authorities should adopt the role of intermediary between the interested parties, acting as mediators rather than overseeing authority [34].

3. Methodology

This article proposes a systematic review of academic articles on the impact of e-commerce-related last-mile processes on cities. The goal is to determine what impact this phenomenon has and will have, from a number of standpoints. Our approach takes into account the different kinds of stakeholders involved: users (members of the general public), companies, and the public administrations. Impacts are considered in a broad sense, and they include those on traffic and parking (mobility), on companies' operations, on the environment, on shifting company profitability, on the transformation of retail structures (traditional "bricks and mortar" vs. online retailers), on the transformation of logistics processes, on new urban dynamics (such as the use of the cargo bikes), or on the sharing economy [53], to name but a few examples.

3.1. Systematic Literature Review

To perform this review, we followed the PRISMA guidelines [54], in particular the flow diagram for structuring searches for articles in the most prestigious academic databases. Specifically, the search was performed on the Web of Science, Scopus, and ScienceDirect databases. After completing the search, the articles were screened using content analysis, qualitatively classifying the information and grouping the content by means of summary tables associated with the different impact types to which they refer.

The keywords used in our search were: "city" AND "impact" AND "last-mile" AND "e-commerce".

Screening was performed on articles on topics ranging from business operations to transport management, including urban and regional planning. As we did not limit the search by discipline, we were allowed to keep a broader focus and make a greater number of articles available for a still-nascent field of research.

As can be seen from Figure 1, a total of 375 articles were found. After reviewing the title, the abstract, and the reference list of each paper and applying the inclusion and exclusion criteria, 249 were discounted (Table 1). Of the remaining 104 articles, a further 15 were ruled out after reading the full text. We were thus left with a total of 89 academic articles that would make up the sample used for studying our field of research. Most of the articles analyzed were recently published ones, demonstrating the novelty of the subject (close to 80% of the articles were published in the last three years—2017, 2018, and 2019).

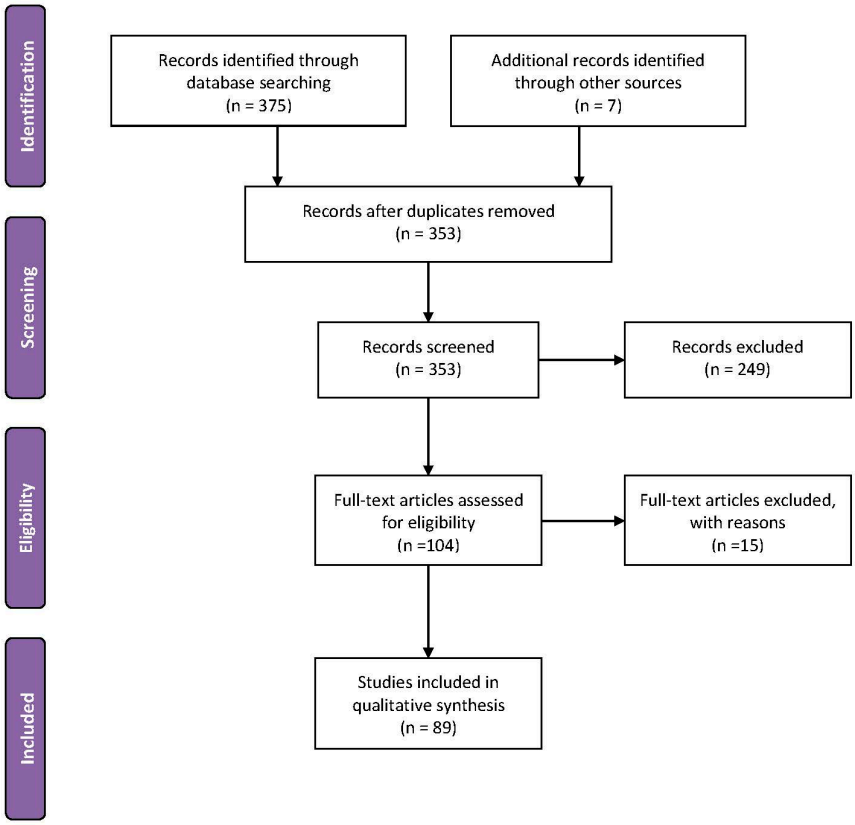

Figure 1. PRISMA flow diagram of literature search and review.

Table 1. Inclusion and exclusion criteria adopted for the literature review.

Inclusion Criteria	Exclusion Criteria
Access to full text	Conference proceedings
English language	Language other than English
Peer-reviewed journals	Non-peer-reviewed journal
Economic, social, environmental, and technological issues	Lack of access to full text
Research analyzing last-mile logistics and their impact on the city	Analysis from the point of view of provisioning rather than distribution
Research that could be extrapolated to other sites	Repeated articles published in different journals but with the same authorship (only the earliest one is kept)
	Research overly focused on operational aspects without the urban perspective
	Research focused on related disciplines but with their own specific field of study (e.g., urban mobility)

3.2. Content Analysis

After identifying the 89 articles, each one of them was read in its entirety. The contents of each paper were summarized in a summary table. The following fields were completed for each article:

- Identifying details (title, author(s), year, etc.);
- Research hypotheses/questions;
- Data and methods employed;
- Type of impact considered;
- Conclusions.

The impacts that e-commerce-related last-mile logistics systems can have on cities were classified as economic, social, environmental, and technological (Figure 2). This classification system adds to sustainability theory's TBL [17] a fourth—technological—impact, defined as the contribution to or impact on the creation of product, process, and service innovations [18]. Hence these selected papers were classified into the four categories shown in Figure 2, as discussed in Section 4.

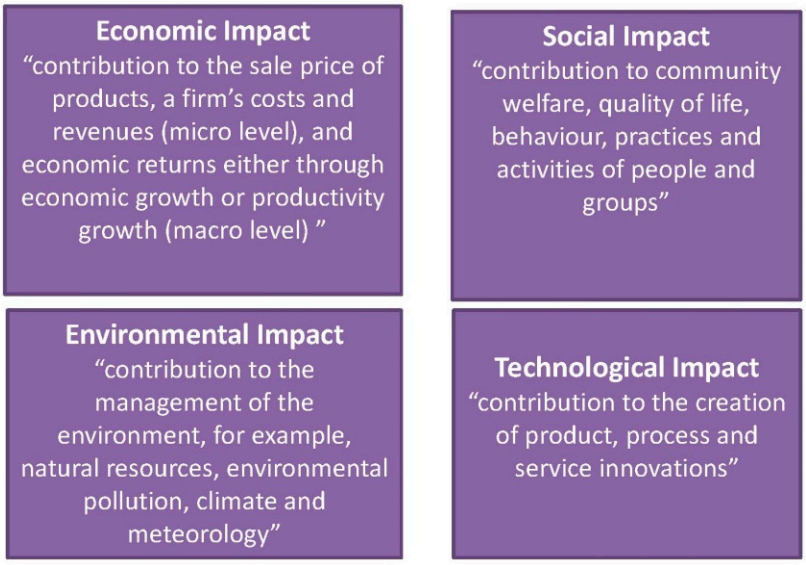

Figure 2. Types of e-commerce-related last-mile logistics impact on cities. Source: [17] and [18].

4. Results

Our review of the literature shows that the impact of e-commerce-related last-mile logistics systems on cities is a still-nascent field of research that has nevertheless seen rapid growth in recent years in terms of the number of academic articles published.

To present this literature in structured form, we have taken into account these four types of impact on cities arising from e-commerce-related last-mile logistics, although this classification cannot be considered to be exhaustive. Some of the articles refer to more than one type of impact and therefore appear in more than one section. The summarized results of the review are presented below, broken down by impact type.

4.1. Economic Impact

According to the European Science Foundation [18], "economic impact" can be defined as the "contribution to the sale price of products, a firm's costs and revenues (micro level), and economic returns either through economic growth or productivity growth (macro level)".

Our review of the literature shows that two of the aspects most studied by authors are the cost associated with urban freight distribution systems and the potential optimization to make them more efficient. Some authors [55,56] suggest algorithms to optimize distribution systems

based on intermediate distribution points (i.e., a two-echelon, or a hub and spoke, logistics system). These intermediary systems permit the consolidation of a number of shipments and their joint distribution [57]. Some results point to a reduction in final delivery costs in these systems of between 5% and 16% compared with a traditional distribution system [55]. Others, however, conclude that when there is a high customer density, the economic impact of such a strategy is rather small [58]. With regard to the location of the distribution centers, 13 subcriteria of the economic, social, and environmental dimensions were evaluated to determine the optimal location for said centers in China [39]. The authors gave objective and subjective weighting to each of the criteria and considered whether the aim was to maximize or minimize them. For instance, the goal could be to minimize factors such as the price of acquiring land (economic), the impact on the ecological landscape (environmental), and the impact on traffic congestion (social/economic) and to maximize others like the possibility of expansion (economic), natural conditions (environmental), and harmonization with regional economic planning (social).

Another related aspect is the operational and economic efficiency of different freight distribution scenarios. Some authors analyzed improvements in the ratio of goods vehicle parking spaces in certain areas [49,59,60]. Others studied the economic efficiency of moving from a vehicle-based delivery system to a customer-pickup-based one [44,61–63], which would entail benefits chiefly for the logistics operator. The literature has also analyzed the operational efficiency of using bicycles for delivery and even the mass use of pedestrians themselves (the so-called crowd logistics) [40,50,64,65], as well as the economic impact of using mobile depots, night-time deliveries, and direct delivery into the trunks of consumers' vehicles [10,66,67]. In many cases, even though such measures proved to be more efficient economically, it was concluded that political decision makers' capacity to facilitate urban logistics via specific measures was the key determining factor for success.

Again, from an economic perspective, some authors have focused their analysis on the savings entailed by selling products online rather than in traditional brick-and-mortar outlets. From the consumer's point of view, the savings arise because they gain access to goods at more competitive prices. Retailer savings come from three different sources: the chance to offer products with a higher margin, the ability to provide service with a wider geographic scope, and the possibility of obtaining a better return on distribution centers and stock management [68–71]. Nevertheless, online retailing and home deliveries also give rise to costs that customers are often unwilling to bear [72].

Table 2 summarizes all these aspects:

Table 2. Literature on the economic impact of e-commerce-related last-mile logistics.

Areas	Aspects Analyzed	References
Effects on the costs associated with the use of intermediary urban distribution systems	Optimization of urban distribution systems by means of the use of a two-echelon system	[39,55–58]
Effects on the costs of different systems and of freight transportation and delivery	Balance or efficiency of goods vehicle parking places	[49,59,60]
	Pickup by customers	[44,61–63]
	Use of bicycles	[64]
	Crowdsourcing	[40,50,65]
	Mobile depots and night-time delivery	[10,66]
	Delivery into car trunks	[67]
Effects on costs for customers and retailers	More competitive prices	[70]
	Larger geographical market	[69]
	Greater return on distribution centers and stock management	[68–71]
	Difficulties in internalizing e-commence costs	[72]

4.2. Social Impact

According to the European Science Foundation [18], this impact is defined as the "contribution to community welfare, quality of life, behavior, practices and activities of people and groups".

Firstly, interest is focused on how the increase in e-commerce has led to a change in consumer habits and behavior to make last-mile delivery a more beneficial process for cities and their inhabitants. One of the great problems of last-mile logistics lies in the fact that customers are often absent at the time when orders are delivered (the so-called failed deliveries), requiring additional trips entailing more traffic, noise, pollution, and cost overruns for logistics companies. Two of the solutions with the greatest consensus are the use of delivery lockers or pickup point systems [44,62,64,73–76]. These have a great potential for reducing the problems of e-commerce home delivery. They also contribute towards reducing urban freight transport costs by consolidating deliveries, reducing stops, and minimizing distances [56]. However, they do entail an impact upon consumer habits and behavior. A number of authors examine people's potential acceptance of pickup lockers and the factors that may increase it [15,44,63,77–80]. Their studies conclude that security, location, and traceability are key factors when planning a network of pickup points. They go on to say that more work needs to be done to make consumers aware of the advantages of such a service by communicating the environmental and social impacts involved, as well as the flexibility it offers [44,63]. The same authors even suggest incentivizing the use of this system with discounts, or even penalizing home deliveries.

If we regard as "social impact" aspects associated with people's quality of life, infrastructures, and health risks due to noise and accidents [1,39], we can see that public policies and last-mile logistics systems are not always aligned. Many city authorities are transitioning towards new mobility models with a greater emphasis on public transport and other nonpolluting options such as bicycles. However, said infrastructure policies come into direct conflict with current systems governing last-mile logistics [81], with a more intense use of private vehicles, and thus with the interests of the leading stakeholders involved. Therefore, to be able to reduce vehicle numbers, pollution, and prices together [5], there is a need for collaboration between the different stakeholders, namely manufacturers, logistics services providers, citizens, and the public sector, not to mention good planning measures and compliance monitoring. The authors of [82] analyzed 48 potential public sector initiatives that could be used to improve freight activity in cities, grouped into four types (infrastructure management; parking/loading areas management; vehicle-related strategies, and traffic management). The results showed that most of these initiatives reduce congestion but increase delivery costs. This points to the need for administrations to consider the other stakeholders involved to obtain information on the complexity of the initiatives' impacts and the trade-offs involved.

Along the same lines, a number of authors [64,83] advocate the implementation of a cargo bicycle distribution system as a way of reducing the externalities of e-commerce-related last-mile logistics on cities. They also provide a series of recommendations for using these cargo bikes as a cost-effective and efficient solution, encompassing regulatory frameworks, strategic town planning and modifications to infrastructure, the provision of pilot programs, and partnerships with digital platforms for knowledge and data transfer. Along other lines, different authors [84] have analyzed how to take advantage of excess public transport (metro) capacity to transport documents, parcels, and other time-sensitive items as quickly and securely as possible, optimizing transport costs, congestion, and noise emissions. This could certainly be a field of growing interest in the next few years.

Lastly, one further aspect analyzed by different authors is the use of crowd logistics for last-mile delivery [40,50,65,73,85] under the umbrella term of mass social transportation. It would reduce costs, boost reliability, increase speed, and reduce pollution. Once again noteworthy is the role to be played by administrations in reducing the potential risks of using crowd logistics services [42].

Table 3 summarizes the social impact of e-commerce-related logistics.

Table 3. Literature on the social impact of e-commerce-related last-mile logistics.

Areas	Aspects Analyzed	References
Changes in consumer habits in the last-mile delivery process	Use of lockers or pickup points and factors increasing consumer acceptance.	[15,44,56,62–64,73–80]
Changes in people's quality of life, infrastructures, and the risks associated with noise and accidents	Analysis of the conflicts between the administration's interest in being more sustainable and last-mile operations.	[5,81,82]
	Implementation of a cargo bike distribution system or greater use of public transport.	[64,83,84]
	Mass social transport or crowd logistics.	[40,42,50,65,73,85]

4.3. Environmental Impact

According to the European Science Foundation [18], environmental impact can be defined as the "contribution to the management of the environment, for example, natural resources, environmental pollution, climate and meteorology". Unlike the previous cases, a large number of studies have taken into account the environmental impact on cities of the increase in last-mile logistics due to the boom in e-commerce.

Much of the literature analysis uses algorithms to simulate the optimization of routes in urban freight distribution to achieve savings in journey times, in distances travelled, in vehicle usage, in waiting times, in energy consumption and, as a result, in CO_2 emissions [32,36,46,47,57,61,67,86–89]. The general idea is that the use of optimized routes would not only entail a positive environmental impact, but also entail greater operational efficiency (economic impact) and greater operational sustainability (social impact).

To reduce the environmental impact of last-mile deliveries in cities, there is a need for an overall reduction in the private consumption of goods. Nevertheless, the projections based on current trends point to completely opposite behavior [90]. Given this, if the aim is to limit environmental impact, any solution would require endogenous technological change, such as the use of more energy-efficient vehicles. Cargo bikes once again appear as a sustainable alternative to motor vehicles for urban freight distribution [64,91]. Research has also been carried out into electric vehicles [57,88], including electric cargo trikes, together with the use of technological innovations that also help improve urban deliveries [66]. One example of this is urban transshipment based on operations with mobile devices. Once again, most of these studies highlight the role of the public administrations and technology to reach a change of paradigm.

Pickup/access points that, as we have seen above, reduce failed deliveries and improve shipment consolidation have also been analyzed from the standpoint of environmental impact [61–63,76,92]. The conclusions reached indicate that the potential benefits of these pickup points may be diminished by the increase in trips made in private cars to and from them. However, a compact distribution of these pickup points might well encourage people to use active transport modes, such as walking or cycling, when sending or receiving items bought online [62,63,79]. The same is the case with the use of crowd logistics, which could be a more ecological alternative to traditional urban transport. Of course, this is the case only when the crowd involved uses sustainable forms of transport and optimizes its route itineraries [40,50,93]. The digital platforms operating behind these systems play a key role in this latter aspect: the shift towards more sustainable forms of transport depends upon the orientation and preferences embedded in their business models.

Another aspect analyzed by the literature is the conflict that tends to arise between the economic impact sought by the various stakeholders and the social and environmental impacts arising. In this regard, a compound index has been proposed that attempts to reconcile economic, environmental, and social aspects in the evaluation and selection of urban freight transport options, thereby improving global decision-making [94]. Along the same lines, other authors [84,95] have analyzed how an

underground logistics system could eliminate the conflict between economic development and traffic pollution in cities, thereby boosting both their global competitiveness and their sustainable development.

Unlike what some may believe, the net effect on energy consumption is positive for e-commerce, compared with traditional sales channels [96–100]. In other words, e-commerce consumes less energy. The factors taken into account by these authors are returns and product wastage, buildings and warehousing, packaging (more in the case of e-commerce), and the movement of people and goods (greater in the case of traditional channels). Nevertheless, e-shoppers are more likely to visit stores to research and test products prior to their purchase (omnichannel shopping), compared to consumers that purchase only in-store, which considerably increases the external CO_2 costs they produce.

The aspect most emphasized by the literature is the key role of the administrations when it comes to implementing urban freight transport policies that take the characteristics of the place into account to reduce said impact [60,101–105]. Indeed, a study considering transport policy measures implemented in 129 European cities showed that the appropriate choice of measures (cargo bikes, clean fuels and vehicles, territorial logistics planning, optimization of routes, mobile storage units, off-peak deliveries, urban distribution systems), and even their optimal combination, can achieve substantial reductions in energy consumption and carbon footprints. By way of example, a good combination of measures can give rise to savings of between 60% and 70%, compared with the 20%–30% obtained with individual measures [86].

Table 4 summarizes all these aspects:

Table 4. Literature on the environmental impact of e-commerce-related last-mile logistics.

Areas	Aspects Analyzed	References
Use of urban distribution route optimization algorithms	Savings in journey times, distances travelled, vehicle usage, waiting times, energy consumption, and CO_2 emissions	[32,36,46,47,57,61,67,86–89]
Use of more energy-efficient vehicles and/or processes	Cargo bikes	[64,91]
	Electric vehicles	[57,88]
	Delivery lockers or pickup/access points	[61–63,76,92]
	Crowd logistics	[40,50,93]
	Underground logistics	[84,95]
Conflicts of interest between the different stakeholders involved	Conflict between environmental and economic impacts	[84,94,95]
	Traditional channels vs e-commerce	[96–100]
	The role of the administration	[60,101–105]

4.4. Technological Impact

According to the European Science Foundation [18], technological impact can be described as the "contribution to the creation of product, process and service innovations". In our analysis, in addition to the impact categories given by the TBL, we have also felt it necessary to study the technological impact of the increase in last-mile logistics on cities. The reason for adding this is the increasing role that technology appears to play in the production of suggestions and alternatives to traditional urban logistics. Indeed, many of the proposals made in the literature entail the implementation of a specific technology or the practical implementation of some product, process, or service innovation.

We can regard the delivery of goods by means of the use of delivery lockers [44,106] or the use of crowd logistics services [42,50,107] as process innovations. Their philosophy represents a process innovation, but, at the same time, their implementation entails the use of technological applications that gather data from sophisticated sensors in real time and that permit the calculation of optimal transport networks for connecting people [85]. GPS systems and their associated navigation devices, as Internet of Things (IoT) technologies, are good examples of this [108]. This all obliges the different stakeholders to move forward in terms of their technological skills.

The impact of a traffic management system (TMS) on journey times and routing decisions is one of the topics analyzed in the literature [89]. The TMS dynamically controls traffic flows, monitoring emission levels in hot spots and reacting, should certain thresholds be exceeded, by changing the traffic strategy. Courier, express, and parcel (CEP) companies are particularly affected by decisions taken by TMS. The authors show that logistics operators' reactions to and anticipation of possible changes in TMS strategy significantly reduce journey times (by up to 16%). Therefore, close cooperation between TMS (administration) and CEP companies can lead to a win/win situation for both and also for the general public.

Lastly, disruptive technology has been playing an important role in the logistics industry in recent years in the form of digital platforms. This technology has brought with it new business models based on online marketplaces and the appearance of new actors disrupting the market. One example of this are the home delivery start-ups [109], which stand in stark contrast to traditional competitors in terms of responsiveness, technological development, and asset utilization.

The literature analyzed makes it clear that the use of some kind of technology is a basic and crucial requirement to be able to boost—or at least maintain—the flow of people, goods, and services in cities, while at the same time mitigating and balancing environmental, economic, and social impacts [55,67,85]. This does not mean that our society is in a position to actually do so. The development and implementation of some technologies, such as drones for home delivery [45] or sidewalk autonomous delivery robots (SARDs) [110], will depend upon a change in mentality embracing all the stakeholders involved, from organizations to each individual member of the public. There is even a need to implement legislative measures to ration the use of airspace for drones or the use of streets for SARDs, as their use could create new externalities and potential issues related to safety and the occupancy of public space. Thus, even though we know that they would cut operating costs, reduce the amounts of fuel required, and eliminate traffic and parking problems, many of such technologies are still far from being a reality. Table 5 summarizes technological impact of e-commerce-related logistics.

Table 5. Literature on the technological impact of e-commerce-related last-mile logistics.

Areas	Aspects Analyzed	References
Deployment of a new technology	Real-time data collection technologies/GPS devices/satellites/IoT	[55,67,85,108]
	Traffic management systems (TMS)	[89]
	Drone-based or SARD-based deliveries	[45,110]
	New business models based on digital platforms	[109]
Process innovations	Self-pickup services	[44,106]
	Crowdsourcing	[42,50,85,107]

5. Discussion

The state of the art regarding the impact of e-commerce-related last-mile logistics on cities shows that, although not all of the impact types have received the same degree of treatment in literature, all four dimensions (economic, social, environmental, and technological) have been at least partially covered. Environmental impact has been the dimension most frequently dealt with, followed by social and economic impacts. Technological impact has probably been the least-analyzed dimension to date. However, this does not mean that it has not been taken into account. Technology is frequently analyzed as a key tool in the formulation of proposals and alternatives to traditional urban logistics, and this frequently entails an economic, social, or environmental impact in itself.

One of the aspects analyzed from the standpoint of its impact is the use of intermediary distribution points that permit the consolidation of shipments and their combined distribution (a two-echelon logistics system). Our review shows that these intermediary distribution systems have a positive impact in the three areas [10,37–39,56,57].

Our analysis also reveals that lockers, pickup points, and mobile depots can have a positive impact from a number of perspectives and for all the stakeholders involved in urban logistics. Logistics operators see a reduction in the number of journeys, failed deliveries, and vehicles to be used (economic). For citizens, there is a reduction in logistics flows (social and environmental). For omnichannel retailers, the services on offer are diversified (economic). In this regard, there is a need to develop mathematical and probabilistic methods that permit the design of smart systems (technological) encouraging high utilization of these assets and high levels of consumer satisfaction [106]. The use of lockers by logistics operators instead of end customers (B2B) is an alternative option to be considered.

Furthermore, our review also highlights how, to mitigate the negative impact of urban logistics, there is a need for the creation of collaboration networks between the different stakeholders [5]. Producers, sellers, logistics services providers, and consumers need to work together in the search for last-mile solutions. Within a context increasingly marked by sustainability demands made by the administration, and by society itself, logistics collaborations become crucial. Combinations of formulas that optimize the impacts for all stakeholders will be those that are most easily adopted.

Based on the results of the review performed, a move from traditional distribution systems to ones that combine different pickup and transportation scenarios is the most beneficial from the standpoint of all impact types. An ideal scenario would contemplate the use of cargo bikes, electric vehicles, lockers, and pickup points, as well as the use of car trunks, mobile depots, night-time deliveries, and even idle time of citizens themselves (crowd logistics) [10,40,61,64,65,67]. To achieve this, it is important to properly understand and acknowledge the concerns of the different stakeholders. The success of these solutions depends on e-commerce stores offering and promoting these options, in addition to e-shoppers' acceptance of them, and retailers' interest in hosting these solutions. Incentives regarding their use could be integrated into public urban policies, as their use would reduce the negative effects of urban freight transport on mobility [50,63]. Only in this way can successful urban logistics policies be implemented. But, obviously, these interested parties will commit to a new measure only if it does not imply any negative consequences [111], or if its positive consequences outweigh the negative ones.

The literature also highlights the importance of increasing the different stakeholders' awareness of the needs and premises of the other parties. This should facilitate a gradual improvement in those policies, taking account of the complex interactions between the stakeholders involved. In this regard, the potential facilitators and obstacles identified are essential in achieving joint strategies in the implementation of urban transportation measures [10]. Future research should use them as a framework when performing a priori and ex ante analyses of the viability of any new measure.

Another aspect identified by numerous authors is the role to be taken by the public authorities as decision makers [112]. The literature shows they must play an active and engaged role in improving freight distribution in urban areas, particularly with regard to reducing its environmental impact. It also highlights how they need to act as facilitators for the implementation of initiatives helping to ensure a positive economic, social, and technological impact. A comprehensive understanding of the complexity of CL makes it easier for local authorities to identify and implement measures and create packages of policy tools that facilitate, limit, or manage the distribution of e-goods on different levels of regulation and allow for a stronger link between transport planning and land use [99]. In this latter regard, a number of authors examine how the public administrations can, through the required use of technology, influence the modal shift in urban logistics. The transition towards the smart city, with its repercussions on sensorization and data collection, cannot afford to ignore the importance of urban logistics systems. The implementation of traffic management systems would be one example in this regard [89], as would underground logistics systems [84,95].

6. Conclusions

This paper provides an integrated view of the different types of impact created by e-commerce-related last-mile logistics on cities. It provides an overview of the themes addressed in the literature and proposes a framework to classify such impacts. This theoretical framework contributes

to the identification of the issues involved and to the improvement of the current understanding of the different types of impacts upon the different stakeholders involved, as well as their interrelations.

6.1. Implications for Research

The results of this study show that there has been little study of the impact that these new distribution systems have on cities and that greater attention therefore needs to be paid. E-commerce has seen very high growth rates in recent years, a trend that will be accentuated by the impact of COVID-19, which has led to a further increase in Internet purchasing. The most widespread assumption is that part of this increase will be irreversible. Last-mile logistics will only become even more important, thereby leading to an inevitable change in the way in which today's cities are operating. We cannot continue to ignore the potential consequences or impacts of this phenomenon on urban systems and on the different stakeholders involved. Research currently under way on last-mile logistics needs to take into account the potential impact that these processes may have. Only with the creation and dissemination of knowledge can the right public policies be developed to mitigate the externalities and contribute to improving the system's global sustainability.

6.2. Implications for Managers and Policymakers

The different works analyzed depict a scenario of transition in which the impact of e-commerce-related logistics is increasingly evident. This has direct implications for businesses, which need to try to improve their procedures and reduce the externalities of their processes. This study has described different initiatives that might transform the current state of the sector. The rate of implementation of the different initiatives may have significant repercussions, with it being important to transition towards a model in which more efficient and sustainable systems become the norm.

Public administrations also need to take on a leading role in this matter. In view of international climate agreements and the political desire to progressively decarbonize the economy, it is clear that the boom in e-commerce-related logistics needs to be examined carefully. Public managers must develop policies that facilitate innovation towards new systems and services that are more sustainable and efficient, and a myriad of such policies and measures have been implemented in recent years. Setting regulations for loading and unloading parking, creating pilot projects to set urban consolidation centers, limiting freight vehicles' access to urban areas, testing new vehicles in pilot programs, or defining specific working hours for logistics operations are just a few of them. Economic incentives for individuals are even on the table as a way of encouraging the modernization of urban vehicle fleets. However, these managers also need to accompany the different operators in this transition to ensure that they accept the new regulations and commit to complying with them. Dialogue between private stakeholders and public administrations is crucial in this regard. Public policies should be drafted on a consensual basis, especially when logistics operators are the ones that are directly affected by them. Trying to impose specific unilateral measures tends to have unexpected and, more importantly, undesired outcomes.

Finally, it is especially important to foster a positive economic impact while also mitigating the social and environmental externalities. This does not, however, make any less important the debate on implementing new types of taxes and tolls to regulate urban freight operations. There is a great deal of discussion about who ultimately should be paying for the delivery costs—the customer or the seller—but whatever the case, it is obvious that new options to minimize social and environmental impacts, with their associated algorithms, should also be offered to the buyers. By doing so, citizens' awareness of the implications of their consumer behavior would be strengthened.

6.3. Limitations and Concluding Remarks

As with any research, this review is subject to limitations. Firstly, we have attempted to perform an exhaustive analysis of everything that has been written on the subject, but it is clear there is little to go on. Although we make this shortcoming clear in our study, it limits the repercussion of our

article. Secondly, although the keyword structure was refined and discussed amongst researchers, it is possible that some relevant contributions have not been covered by our search. Other types of urban, or city, logistics not related to e-commerce might have been overlooked, although this was not the intention; the aim was to intensify our focus on e-commerce-related practices. Moreover, the research only includes articles published in English; articles published in other languages may potentially be relevant as well.

Another important limitation is the fact that many articles tackle the issue of impact as part of a broader cross-cutting review, with it not being the main focus of their research. This means that, in many cases, we have had to slightly alter the focus of the subject. In this regard, we encourage researchers and practitioners to facilitate a discussion on the scope of the impact of last-mile logistics on cities. The results of this review clearly show that more research is needed. There is a need for qualitative studies (interviews with the different stakeholders involved: businesses, public administrations, and the general public), as well as quantitative ones helping us better measure the impacts of e-commerce-related logistics on cities. An interesting exercise would be trying to classify all the impacts according to the areas and stakeholders they affect. This would provide a clearer picture of where these impacts are causing real conflict and where this could be easily mitigated. Only in this way will it be possible to hone public policies and work on raising the awareness of the public and the companies involved.

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