Trends of Environmentally Sustainable Solutions of Urban Last-Mile Deliveries on the E-Commerce Market—A Literature Review

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Abstract: The growth of e-commerce has increased urban freight transport, bringing negative externalities of emissions, pollution, noise, congestion, and habitat loss. There is a visible effort to make the urban last-mile (LM) deliveries more sustainable, mainly in the environmental aspects; however, the related literature lacks a synthesis of the up-to-date research trends and available solutions. This paper reviews relevant literature following SRL methodology in terms of topics related to green LM deliveries on the e-commerce market in urban areas, and identifies trends and the research gaps in this field. In addition, current research topics and existing solutions within the e-commerce market, which increase its environmental sustainability are presented. The findings provide an accurate and comprehensive synthesis of research in green LM e-commerce deliveries in cities, identify current and emerging interests of researchers worldwide, and discover areas requiring further studies. The topics of ICT and smart solutions, customer behavior, and performance assessment certainly seem to be underestimated in the current research. In practical terms, it is a source of knowledge and guidelines on the current developments regarding the existing solution for the LM e-commerce deliveries in the urban area, which might help local governments, freight operators, and other stakeholders of last-mile logistics to improve their sustainability.

Keywords: environmental sustainability; e-commerce; environment; last-mile delivery; urban delivery; green last-mile; systematic literature review

1. Introduction

According to the United Nations, already over 55% of the human population lives in cities, and by 2050 the share will increase up to 68%. This ratio is even higher in Europe, where 74.5% of the population live in urban areas [1]. The connection between trade and urbanization is unambiguous [2]. The increasing number of city inhabitants, often well-paid ones, leads to increasing demand for housing, services, and goods. The demand for goods has been the driving force for developing retail trade, first in traditional brick-and-mortar shops, and recently also in online shops. In the digital world, goods can be purchased anywhere, and having been transported across the globe, they are delivered to the final customer, mainly in the cities. The final part of this journey, last-mile delivery, seems to be the most problematic one in terms of cost, efficiency, and pollution [3].

The online trade started in 1992, when the National Science Foundation lifted its ban on commercial use of the internet, which after the introduction of the first browser, gave rise to the massive development of e-commerce in 1993 [4,5]. Since then, internet usage has been growing in global terms. It amounts to 63.2% in 2020 worldwide, and in Europe, it is 87.2% [6]. The infrastructure, such as broadband internet access and connection speed, is improving. In addition, the development of smartphone functionality has increased the popularity of e-commerce. However, particularly relevant to the change in shopping habits and the increase of e-commerce revenues are the processes of simplifying checkout and payments and delivery optimization [7]. Between 2014 and 2019, e-commerce sales figures grew by nearly 300%. According to the US figures, online sales now account for 21% of
total retail purchases, compared to 5.1% in 2007 [8]. The demand for last-mile delivery is expected to grow by 78% by 2030, which will increase the number of delivery vehicles in 100 cities around the world by 36% [9]. What is more, the COVID-19 pandemic additionally contributed to the dynamic expansion of e-commerce [10].

As with any human activity, online trade exerts pressure on the environment, particularly on the urban environment, where the majority of the population resides. Logistic services, also those connected with last-mile deliveries of online shopping, are a significant contributor to increased emissions; there is an expected rise by one third. In addition, city congestion related to last-mile deliveries is predicted to rise by 21% by 2030 [9]. It seems that our cognitive abilities, which were helpful in the past for humans to survive, such as hyperbolic discounting—the preference for short-term temporary reward over larger but later ones—might lead to disastrous consequences. The temptation of convenience, one click-shopping, and a high rate of returns are severely detrimental to the environment. It seems that humans often do not consider the long-term effects of their actions enough, especially regarding their consequences on the environment. Nevertheless, some studies suggest that online shopping might be more eco-friendly than conventional shopping [11]; especially in non-food shopping, the CO$_2$ emission favours home deliveries [12]. Nevertheless, the fact that increasing last-mile deliveries connected with a surge in the e-commerce market takes its toll in the environment is unquestionable.

Despite a growing research interest in the area of last-mile logistics [13,14], the applied research perspectives have not been focused on efforts to make e-commerce last-mile deliveries less burdensome for the environment. Therefore, there is a need to search for green solutions for last-mile deliveries on the e-commerce market. The analysis of relevant literature revealed that the presentation of current trends and solutions regarding environmentally sustainable last-mile deliveries on the e-commerce market in cities is fragmented. Thus, the perception of the most important research areas and green solutions for urban LM e-commerce deliveries is hindered. The existing contributions focus on the logistics [15,16] or engineering management perspective [14], whereas the aspects connected with environmental protections are not emphasized enough. Most of these articles refer to cost reduction, not to protecting the environment [17]. The only review referring to e-commerce environmental implications covers the literature up until 2014 [18]. However, since that time, numerous studies on green last-mile deliveries have been conducted, and new possibilities of green deliveries have emerged. What is more, there has not been any review considering the environmental aspects of e-commerce LM deliveries strictly limited to urban areas. Therefore, this article aims to review current research articles following SRL methodology in terms of topics related to green last-mile deliveries on the e-commerce market in urban areas, and to identify trends and the research gaps in this field. The author’s objective was to provide answers to the following research questions:

- **RQ1**: What are the characteristics of scientific literature—authors, journals, sources—related to environmentally sustainable solutions for urban LM deliveries on the e-commerce market?
- **RQ2**: What are key research areas and trends in the field of environmentally sustainable solutions for urban LM deliveries on the e-commerce market?
- **RQ3**: What are the literature and research gaps related to environmentally sustainable solutions and tools for urban LM deliveries on the e-commerce market?

The first part consists of the introduction to the paper’s scope and a presentation of its objective. In the second part of the paper, the author presents the development, the connections, and interdependencies between the notions of sustainability, city logistics, last-mile logistics, and e-commerce. The following part presents how the data was collected and provides information on the applied methodology. Next, the current research’s core is presented, pointing out the main research areas and methodology. Then, the findings are discussed against previous studies, and opportunities for further research are suggested. The final part contains conclusions and limitations.
2. Literature Background

The issue of sustainable development has gained much interest from researchers, society, and politicians. The key concept has been developed by the UN Brundtland Commission, which defined sustainable development as “development that meets the needs of the present without compromising the ability of future generations to meet their own need” [19]. The commission was created “to address growing concern about the accelerating deterioration of the human environment and natural resources and the consequences of that deterioration for economic and social development” [20]. All definitions of the concept emphasize the need to integrate the three fundamental components of sustainable development (SD): environmental protection, economic growth, and social equity [21]. They are also referred to as the three pillars of sustainable development [22]. Given the alarming reports on the global natural environment’s condition, the environmental issues are gaining increasing attention [23].

Environmental issues have been one of the central roots in the definition of sustainable development and are often referred to as environmental sustainability. The term focuses on the environmental integrity and preservation of limited natural resources. This principle ensures that human activities do not harm the earth’s land, air, and water resources. It acknowledges that human activities can result in significant negative environmental impacts, such as ozone depletion, greenhouse gas emissions, waste generation, decreased biodiversity, and pollution [24]. In the search for opportunities to make cities more sustainable, considerably more attention has been directed towards the issues connected with combating environmental externalities and developing eco-friendly practices [25], many of which refer to logistic operations; green logistics [3,15,26], including the last-mile deliveries on the e-commerce market [27].

The growth in e-commerce has remodelled the distribution of goods in urban areas [28]. The term e-commerce, understood as internet-based business to customer (B2C) transaction, was coined by Kalakota and Whinston [29] as “electronic commerce includes any form of business activity conducted via electronic means, which might range from products/services information to selling and/or buying products”. The turning point in its development was the release of the World Wide Web in 1992, when the National Science Foundation lifted its ban on the commercial use of the internet. Once the first browser was introduced, the massive development of e-commerce began in 1993 [4]. The essence of e-commerce is the advertisement and procurement of goods and services over the internet [30]. E-commerce covers all forms of interactive business transactions enabled by electronic means logged to the internet. E-commerce is growing because of the increasing number of businesses and individuals who have access to the internet (in 2020, that number amounted to almost 60% of the world’s population) [31]. The number of ways in which businesses can conduct transactions electronically with other organizations, governments, and customers has contributed to the growth as well. In addition, the development of smartphone functionality has increased the popularity of e-commerce. However, particularly relevant to the change in shopping habits and the increase of e-commerce revenues are the processes of simplifying checkout and payments and delivery optimization [7].

The development of e-commerce, especially B2C, causes an increase in the demand for home deliveries, resulting in the surge of environmental and social costs of goods transportation [32]. As most e-commerce customers live in urban areas, city logistics stakeholders are impacted by online shopping’s externalities. Although the study of freight distribution in urban areas began almost 50 years ago, only relatively recently have the environmental issues been recognized as an important research area. The last twenty years brought a serious rise in the attempts to solve the environment-related issues concerning the distribution of goods in cities [33]. There is research suggesting that the change in urban freight flows and vehicle movements induced by the growth of online purchases, using a wide range of delivery services such as home delivery, pickup-points, or click and collect systems, may not necessarily harm the environment in comparison with traditional shopping [34]. However, there is no doubt that along with the significant rise in e-commerce,
the environmental problem such as increased traffic volume, CO\textsubscript{2} emissions, congestion, and noise become issues requiring immediate action. Recent changes in urban delivery, such as parcel delivery vehicles blocking lanes, e-grocers and food delivery services, result in a demand surge for last-mile delivery, which is expected to grow by 78\% globally by 2030 [9].

Last-mile deliveries fall into the scope of city logistics [35]. The most common transport mode in urban areas is road freight transport, which causes the most severe environmental externalities related to delivery [36]. Last-mile delivery in cities is responsible for increased traffic volume, congestion, noise, and air pollution [17]. It also exposes conflicting interests of city logistics stakeholders, involving private organizations (haulage and shipping companies, logistics operators), public organizations, NGOs, and the general public [37]. As private companies’ interest is apparent, it is less evident in the case of public authorities or the general public. Even though studies suggest a strong customer preference for home delivery [38,39], it seems that recently e-commerce customers began to realize the environmental burden of last-mile e-commerce deliveries. The quickest delivery mode is still the most popular one. However, there is a visible tendency showing that, when customers are informed of a delivery option that is less harmful for the environment, some shoppers will choose such a method [40]. Stakeholder pressure along with factors such as environmental regulations, company size, industrial sector and geographical location, internationalization, position in the value chain, strategic attitude, managerial attitudes and motivations, manager’s characteristics, and human resources are relevant environmental and organizational variables. These variables frequently appear in the research related to the factors motivating organizations to become more environmentally sustainable [41,42].

In the literature review, the author concentrated on e-commerce last-mile delivery solutions, aiming to reduce the environmental impact of the last-mile delivery of online purchased goods. The scope of the identified solutions included different approaches; some solutions concentrated on the use of alternative means of transport such as electric vehicles and bikes, some on new delivery methods such as parcel lockers or crowdshipping, some approached the issue from the organizational point of view and attempted analyses to optimize vehicle routing or the implementation of time windows for deliveries. Even if, in the opinion of the author, the solution did not address the issue of reducing the environmental impact of urban last-mile deliveries in urban areas but only partially addressed the issue, it was included in the review as long as the result of its implementation was beneficial for the environment. Therefore, any urban e-commerce last-mile delivery solution resulting in relieving the environmental burden is considered environmentally friendly.

3. Methodology

The author concentrates on a review of the approaches to the environmental sustainability of e-commerce concerning urban LM deliveries. This study aims to perform a systematic review of scientific articles related to green last-mile delivery on the e-commerce market in urban areas. It describes existing research trends, and identifies research gaps in this field. For the purpose of bibliographic analysis, VOSviewer software was used. The research includes peer-reviewed journals and conference papers published in English from two databases: Scopus and Web of Science. The author’s objective was to provide answers to the following research questions:

- **RQ1**: What are the characteristics of scientific literature—authors, journals, sources—related to environmentally sustainable solutions of urban LM deliveries on the e-commerce market?
- **RQ2**: What are key research areas and trends in the field of environmentally sustainable solutions for urban LM deliveries on the e-commerce market?
- **RQ3**: What are the literature and research gaps related to environmentally sustainable solutions and tools for urban LM deliveries on the e-commerce market?
The findings provide an accurate and comprehensive synthesis of research in green urban LM deliveries in e-commerce, identify current and emerging interests of researchers worldwide, and discover areas requiring further studies.

The literature covering green last mile-delivery problems on the e-commerce market in urban areas can be found in various disciplines and areas. The abundance of available papers and the availability of publications from every corner of the globe requires a well-designed approach, enabling a thorough and logical assessment, clustering, and mapping [43]. To obtain a comprehensive picture of the methodology suggested by Tranfield [44] was adopted. This approach has been widely used in various social sciences research [45–47]. The paper attempts to present quantitative and qualitative analyses of the identified relevant literature. For the purpose of the paper, the author decided to perform the research in the following steps (Figure 1):

1. The first step was to obtain a set of research papers from the accessed databases based on the selected criteria. Scopus and the Web of Science (WOS) databases were selected, and the list of keywords and their synonyms was created.

2. Secondly, the titles and abstracts were read to exclude irrelevant papers, followed by a full-text analysis. As a result of cross-reference, an additional set of articles was added to the analyzed collection.

3. In the following step, the bibliographic network visualization was performed using the VOSviewer application, enabling the analysis in terms of collaboration of the authors, graphical distribution, and keyword co-occurrence.

4. Furthermore, in the fourth step, the main research topic and the existing environmentally friendly e-commerce last-mile delivery solutions were identified, emerging trends and research gaps were indicated, and opportunities for further research were indicated.

All the analyzed publications were retrieved from Scopus and WOS databases. They contain information collected for over a century, with weekly updates, and each of them covers a set of over 20,000 academic journals. Conference papers and research articles published in English in academic journals were selected for the literature review [48]. The articles in peer-reviewed journals undergo a strict and rigorous review process, which ensures their quality. The author excluded reviews and book chapters as e-commerce, and its green aspects are relatively new. Only one book chapter was identified as dealing with the topic to a limited extent. The author used the following keywords: green city logistics, green urban logistics, green city freight, green urban freight, green last mile, green delivery, and e-commerce. The papers for the analysis were selected based on combining the keywords using the advanced search option provided by the database operators.

The study covered all relevant papers within the timespan 1994–2021. The timespan was chosen due to the fact that in 1992 the National Science Foundation lifted its ban on commercial use of the internet, which gave rise to the massive development of e-commerce [29]. Thus, in 1994, people were able to start shopping online. Even though such a wide time span was set, it appeared the papers that discussed the issues of e-commerce...
LM deliveries and at the same time included environmental issues appeared only after 2009. The description of the search and the inclusion criteria are presented in Table 1.

Table 1. The characteristics and the summary of the search.

<table>
<thead>
<tr>
<th>Database</th>
<th>Scopus, WOS</th>
</tr>
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<tbody>
<tr>
<td>The final number of papers analyzed in the review</td>
<td>126</td>
</tr>
<tr>
<td>Analyzed fields</td>
<td>Title, Abstract, Keywords (green AND (city OR urban) AND logistic) OR TITLE-ABS-KEY (green AND “city freight”) OR (green AN “urban freight”) TITLE-ABS-KEY (green AND “last mile”) OR (green AND delivery) TITLE-ABS-KEY (“e-commerce”)</td>
</tr>
<tr>
<td>Search phrase</td>
<td>(green AND “city freight”)</td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
</tr>
<tr>
<td>Source Type</td>
<td>Peer-reviewed journals</td>
</tr>
<tr>
<td>Time interval</td>
<td>1994–2020</td>
</tr>
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</table>

The implementation of the review process following Evangelista [15] is presented in Figure 2. The WOS database search gave 875 results, which were further narrowed down to articles with open access published in English. The remaining 136 articles were analyzed in terms of WOS categories to exclude irrelevant categories such as physics or geography. The next stage was analyzing abstracts, which gave the final set of 80 articles that mentioned e-commerce issues and environmental issues within city logistics and last-mile delivery. As a result of the abstract analysis, irrelevant articles were excluded. In the following stage, the whole body of articles was analyzed. A similar procedure was performed for the Scopus database. The original search gave 64 results, however having applied the abovementioned criteria, the final number was 38 regarding Scopus.

Figure 2. The implementation of the literature review process.

In the next step, all the selected papers’ titles and abstracts were read, analyzed, and it was assessed whether or not they should be included in the article collection, at which point another four articles were considered irrelevant, and eight duplicates were removed. Finally, in the last stage, 18 cross-referenced articles were added to further analysis. Thus,
the final number of publications regarding urban e-commerce LM deliveries retrieved within the search “title/abstract/keyword” amounted to 126 papers.

As the green e-commerce LM delivery in urban areas is rarely discussed by researchers entirely from the environmental point of view, the corpus includes papers discussing e-commerce LM deliveries in the urban environment in terms of sustainability, as long as they included environmental issues.

4. Descriptive Analysis

The distribution of papers over the period 2009–2020 is presented in Figure 3. It is visible that environmentally friendly e-commerce deliveries in urban areas are getting increasing attention. The continually worsening condition of the quality of life in cities in terms of noise and pollution, in addition to the increasing interest in e-commerce on the part of consumers and e-tailers are the reason for the growing involvement of researchers analyzing, describing, and looking for solutions to the problem of green last-mile deliveries. Urban deliveries of goods bought online are getting increased attention as the volume of e-commerce, in general, is growing [39]. Consequently, the environmental issues connected with delivery, especially in urban areas, become more severe [49]. The cities are congested with poor air quality, leading to respiratory diseases and low quality of life in urban areas. In the figure, one can notice that, after 2015, there was a significant increase in the number of published papers; in 2015 (7), in 2016 (10), 2017 (12), 2018 (26), 2019 (45), and in 2020 already 23 have been published and some are planned for 2021. The notable rise after 2015 might have been caused by adopting the United Nations Framework Convention on Climate Change in Paris that drew attention to the issue of climate change and CO2 emissions [50], which consequently led to a profusion of papers after 2018.

![Figure 3. The number of papers by year. Source: own elaboration.](image)

The author considered the first author’s affiliation to assign the research works by country. The classification of articles based on region shows that Europe has the most significant share in researching the ecological impact of e-commerce deliveries in urban areas, and implies that Italy and Belgium have published many articles. China, the United States, Brazil, and Germany are in the following positions (Figure 4). This distribution implies that e-commerce is highly developed in these countries. Consequently, environmental problems
are the most visible and severe and cause the most significant discomfort for the residents. Thus, the research and analyses have begun to improve the situation and lower the environmental impact of e-commerce deliveries. Italy’s strong position is quite surprising when the results are compared with the e-commerce data [7]. In terms of the urban population share, the UK, the US, France, Spain, and Germany are above the European average. The UK and Germany also have the most significant revenues in European e-commerce markets. Globally, China had the highest revenue in 2019 (862.6 billion US dollars), whereas the United States and Europe had revenues at a similar level, approximately 360 billion US dollars. In Europe, Belgium claims the most significant cross-border e-commerce market share at 30%, and the consumption per head in the US is 11 times higher than in China [7].

**Figure 4.** The number of papers in terms of geographical classification. Source: own elaboration.

The following figure (Figure 5) presents the journals, which publish papers connected with green e-commerce deliveries in urban areas. The most popular source title is Sustainability, with 37 papers published which discussed the problems of last-mile e-commerce deliveries in the urban areas and the impact on the environment. The second most popular was European Transport Research Review with eight papers. The successive three popular titles were IEEE ACCESS, Research in Transportation Business and Management, Transportation Research Part D: Transport and Environment, with four publications. Multiple sources contained one paper from the corpus selected for analysis.

In the next step, the qualitative analysis was conducted by the author. This analysis may serve as signposts for researchers who are new to the subject of LM urban deliveries in the e-commerce market. The papers were selected based on the most frequent citations. Table 2 contains a set of the most cited papers of the final sample with over 50 citations. This group of articles was published between 2010 and 2017. They appear to be the cornerstones of researching environmental issues within the area of last-mile deliveries on the e-commerce market. Since they are so often referred to by researchers, it seems that these study areas are the most popular among academics. The most commonly addressed topic is emissions, predominantly CO₂ [12]. The next most popular topics are the available options for reducing the negative impacts of urban freight transport [51,52], cost simulation of selected scenarios of LM urban deliveries [3], and some specific areas connected with the organization of deliveries, such as pickup points [53], stakeholders cooperation and collaboration [54], green vehicles [55] and crowdshipping [52].
Figure 5. The number of papers by source title. Source: own elaboration.

Table 2. The most cited papers referring to environmentally friendly solutions for urban last-mile deliveries on the e-commerce market.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Title</th>
<th>Journal</th>
<th>Times Cited</th>
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<tbody>
<tr>
<td>Morganti E, Dablanc L, Fortin F, 2014</td>
<td>Final deliveries for online shopping: The deployment of pickup point networks in urban and suburban areas</td>
<td>Research in Transportation Business and Management (2014) 11 23–31</td>
<td>95</td>
</tr>
</tbody>
</table>

The most cited paper discussing the carbon footprint of traditional and online retailing [12] is the second oldest on the list; its popularity is probably the result of both the year of publication and the issue of CO₂ emissions it deals with. It is the most frequently addressed aspect of environmental problems in terms of any city freight, including
e-commerce last-mile deliveries. Huge interest is visible in analyzing alternative delivery modes for online purchases, such as pickup points or cargo bikes [39,55]. A high position in terms of citation of the paper referring to crowd logistics is significant, especially that it is a relatively new topic in urban e-commerce last-mile deliveries. The interest in crowd-shipping is growing, which is visible in the number of papers published on the issue. It might be expected that this paper explaining different opportunities for the use of crowd logistics will gain even more significance for researchers pursuing this logistic solution.

5. Bibliographic Analysis

The first stage step of the bibliographic analysis was the cooperation between researchers. Co-authorship has been the most common way of cooperation so far [56]. VOSviewer verifies the number of publications where the authors occur together. The bigger the number of publications the researchers have co-authored, the stronger the authors’ link [57]. For the sake of the analysis, two was established as the minimum number of authors, and the minimum number of citations was 50. It was assumed that for a paper to be co-authored, it needs at least two authors. To be consistent with the earlier qualitative analysis, the author selected the minimum number of 50 citations to investigate the cooperation among the most cited authors. The full counting method was applied, which counts the total number of occurrences of an author (item) in all documents. The results were additionally ordered with the method of normalization–association strength. Twelve out of the total number of 340 fulfilled those criteria, and they created six clusters.

- Cluster 1: Bektas T., Cherrett T., Friday A., Piotrowska M.;
- Cluster 2: Iwan S., Kijewska K., Thomson R.G.;
- Cluster 3: Allen J., Browne M.;
- Cluster 4: Gatta V.;
- Cluster 5: Macharis C.;
- Cluster 6: Wang X.

The analysis showed that in the first three clusters, the researchers cooperate in relatively stable teams, and their cooperation is acknowledged by other academics who refer to them in their own papers. Clusters 4, 5, 6 consist of a single name, which means that those researchers cooperate with different scientific partners achieving good citation scores. Nevertheless, there are no links between the clusters, which might suggest that the degree of cooperation among researchers in the field of green last mile-delivery on the e-commerce market in urban areas is limited. In addition, there are only six authors who are the most cited and are regularly collaborating. Among these authors are: Allen J., Bektas T., Cherrett T., Friday A., Piotrowska M., Browne M. In this group, only Allen J cooperates closely with two research teams, cluster 3 and cluster 1. Another author (Macharis C.) is one of the most cited, but collaborates with various research partners.

In the next step looking for the answer to the RQ2, the analysis of 777 author and index keywords was performed. The corpus of 126 articles was analyzed, using the VOSviewer application to perform the keywords co-occurrence analysis. The full-counting method was implemented, which counts the total number of term (item) occurrences in all documents. The items are grouped into non-overlapping clusters, which means that each item may belong only to one cluster [57]. The higher the minimum co-occurrence, the fewer keywords are visualized in the network. However, to obtain a map with the keyword “environmental impacts,” the minimum co-occurrence of the keyword was four, and, as a result, 58 keywords met the threshold. The procedure was performed according to the instruction in the manual [57]. Nevertheless, in the course of analysis, certain keywords were removed (logistics, city, system, model, cities, urban, performance, framework, location, perspective, China, systems, network, simulation, models) to obtain a visualization of clusters with relevant keywords. The number of keywords needed to be reduced to obtain a clear visualization. The graphical result of the analysis is shown in Figure 6. The analysis showed graphically the links between the most frequent keywords, which enabled the classification of keywords into clusters marked with different colours.
Each cluster corresponds to one of the research fields [58]. As a result, the corpus was divided into five main groups:

- Cluster 1: carbon emission, commerce, delivery, electric vehicles, emissions, freight transportations, green logistics, impact, last-mile delivery, optimization, supply chain, sustainability, transportation, urban area, vehicle-routing problem;
- Cluster 2: behavior, city logistics, deliveries, goods, impacts, management, stakeholders, transport, urban freight transport;
- Cluster 3: e-commerce, electronic commerce, home delivery, last mile, last-mile delivery, supply chain management, urban logistics;
- Cluster 4: crowd logistics, crowdshipping, freight transport, mobility, sustainable development, urban freight, urban transport;
- Cluster 5: cargo bikes, cost efficiency, environmental impacts, vehicles.

Figure 6. VOSviewer keyword analysis: clusters. Source: own elaboration with VOSviewer software.

The analysis revealed that even though the articles mention green solutions for last-mile deliveries on the e-commerce market, they are never the central research area. The papers are focused either on city logistics and urban freight transport [59] in general, on sustainability within the deliveries and the possible emission problems [60] resulting thereof, or on the issue of e-commerce and its solution for delivering goods [61]. The phrase “environmental impacts” occurred only four times and is related to costs, efficiency [62], and alternative methods of delivery [53,63]. What is more, environmental impacts show no specific links with e-commerce or last-mile deliveries. However, the research often refers to impact or impacts, which usually signifies that they refer to environmental issues, mainly pollution [64]. Even though the interest in the issues is growing [65,66], they still seem to be treated as ancillary treads in the main research areas.

In the following stage, the author examined the keywords in chronological order, shown in Figure 7. The environmental issues have been noted relatively early in developing the research on e-commerce and last-mile deliveries in cities [67], yet it has never become
an issue that raises researchers’ broad interest. The research focused first on e-commerce in connection with transport, cost, customer behavior and environmental impact [68], and supply chain management [3]. Later, the papers concentrated on city logistics, green logistics, and the issue of last-mile delivery appeared [69,70]. However, the aspects of the supply chain and the reduction of emissions were still present [71]. The issue of sustainability has been gaining increasing attention for the last three years; 50 papers mentioning this concept have been published since 2017, compared to five earlier ones out of the selected corpus. The search for sustainable last-mile deliveries resulted in the growth of interest in green logistics [15] and alternative methods of goods delivery, such as cargo bikes [60], crowdshipping [72], and electric vehicles [73]. Crowd delivery seems to be one of the hot issues recently. The papers referring to this notion appeared in 2017 for the first time, and the number is growing every year. The research sample contains three papers referring to crowdshipping published in 2020. The concept of sustainable development has recently turned attention to stakeholders, optimizing urban freight transport and lowering the emissions [74,75].

To find the answers to RQ2 and RQ3, the papers were classified according to the research topic they mainly address. The process consisted of two stages. First, all identified topics in the articles were listed. Then, after a thorough analysis, they were grouped into sets containing similar ideas; for example, in the first stage, topics such as stakeholders cooperation, collaboration, and intermodal transport were identified, yet having analyzed the common themes, they were finally classified to one group, named stakeholders collaboration. All other identified topics were analyzed in the same manner.

Nevertheless, a separate group was created for crowdshipping, which might be expected to be included in the stakeholder collaboration group. This decision was justified by the fact that crowdshipping is a very peculiar phenomenon, which was already pointed out in the earlier section of the paper, and it has been gaining a considerable amount of interest on the part of researchers and practitioners. Therefore, to observe the development...
of this topic, a separate group was established. It is worth mentioning that some papers referred to more than one topic; thus, they are listed in more than one area. Table 3 presents the identified topics along with the description of all issues included in each group. There is also information on the timespan showing the development over the years.

Table 3. The identification of main topic and research methods over time referring to urban-last mile deliveries on the e-commerce market.

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<tr>
<td>ICT and smart solutions</td>
<td>Designing and implementing information and communication technology. Intelligent, smart systems provide innovative applications and services to make transport and traffic safer, better coordinated, and more efficient.</td>
<td>[76]</td>
<td>[15,32]</td>
<td>[77–80]</td>
<td></td>
</tr>
<tr>
<td>Stakeholders collaboration</td>
<td>Discusses the LM delivery from the point of view of collaborative transport and stakeholders' involvement, i.e., freight quality partnerships. The topic also includes supply chain management issues. In addition, organizational logistic functions are included.</td>
<td>[76]</td>
<td>[51,54,55,81,82]</td>
<td>[15,59,62,64,69,85–93]</td>
<td>[74,94–97]</td>
</tr>
<tr>
<td>Crowdshipping</td>
<td>Delivering goods with the use of the crowd by sharing services and assets and for appropriate compensation.</td>
<td>[52,84,98,99]</td>
<td></td>
<td></td>
<td>[72,100–103]</td>
</tr>
<tr>
<td>Alternative places of delivery</td>
<td>All places where people can pick up their online ordered shopping, either staffed or unstaffed, open 24 h or only at certain times, including parcel lockers.</td>
<td>[53]</td>
<td>[38,70,83,93,104–108]</td>
<td></td>
<td>[61,101,109–113]</td>
</tr>
<tr>
<td>Green vehicles</td>
<td>The use of vehicles powered by less polluting fuels such as electricity, hydrogen, or gas. Bike deliveries and using trams or trains for delivering goods. The topic also includes the use of passenger transport to deliver parcels.</td>
<td>[68]</td>
<td>[51,55,114,115]</td>
<td>[32,49,69,107,108,116–122]</td>
<td>[60,65,100,110,113,123–130]</td>
</tr>
<tr>
<td>Last-mile delivery optimization</td>
<td>Optimization of vehicle routing paths or fleets to reduce costs, times, and emissions and infrastructural solutions such enabling consolidation as urban distribution centers (UDC), urban consolidation centers (UCC), transit points (TP), or micro-hubs.</td>
<td>[3,51,131–135]</td>
<td>[69,70,84,89,93,136–141]</td>
<td>[128,142–147]</td>
<td></td>
</tr>
<tr>
<td>Access restrictions</td>
<td>Includes all solutions to limit traffic in urban areas, such as off-peak delivery, time windows, road pricing, limited traffic zones.</td>
<td>[51,133]</td>
<td>[52,87,105,138,148]</td>
<td></td>
<td>[110,149–151]</td>
</tr>
<tr>
<td>Consumer behavior</td>
<td>The topic includes analyses of customers' shopping behavior and shopping trips, attitudes, and the attempts to model such behavior to make it more sustainable.</td>
<td>[12,68]</td>
<td>[38,152]</td>
<td></td>
<td>[66,113,150,153–156]</td>
</tr>
<tr>
<td>Performance assessment</td>
<td>Description of tools used for assessing efficiency such as benchmarking, KPIs, or comparisons evaluating which solution best fulfils the specified objectives.</td>
<td>[15,70,157]</td>
<td></td>
<td></td>
<td>[109,112,125,128,142,153,158,159]</td>
</tr>
</tbody>
</table>

The chronological analysis of topics correlates with the previously presented chronological bibliometric analysis of keywords. The earliest papers in the corpus discussed mainly environmental, social, and economic impacts of last-mile city logistics and supply chain issues [76]. Interestingly, quite early, the issues connected with customer behavior were noted [68]. Only after 2011 certain topics were investigated, such as collaboration between stakeholders [81], alternative places of delivery [53], electric vehicles [116], bike delivery [55], routing optimization [134], measures for limiting vehicle access urban areas [51]. After 2016 there is a significant increase in those areas. They are further developed, but also new topics emerge, such as collaborative transport [62], studies on consumer behavior, and consumer purchase habits [38]. The attempts to measure and assess the environmental
performance of certain solutions [138] might be the outcome of the recommendation for further research found in [15]. Another hot and new topic gaining a lot of research focus is crowdshipping [52]. This paper’s significance was shown in Table 2, where it belongs to the group of the most cited papers referring to urban e-commerce last-mile delivery. The following prospective research area is applying ICT and smart solutions to improve the efficiency of e-commerce last-mile deliveries in congested urban areas, at the same time causing a decrease in the number of road accidents and increasing safety in the streets. The possibilities of their usage to decrease the level of emissions and noise in cities might also be a worthwhile area of study within urban e-commerce deliveries.

In the analysis of the corpus, the research methodologies applied to study a particular topic were investigated. The final scope of identified methods comprised case study/interview, statistics and modelling, questionnaire/survey, experimental or pilot studies, literature review/SLR, simulation, empirical analysis. However, as presented in Table 4, the methodologies were grouped into literature studies following SRL methodology and empirical studies for the purpose of the review. The empirical papers were further divided into applying a quantitative, qualitative approach, and a group of papers using both approaches was identified. Simulations, questionnaire/survey, statistical methods, and modelling were included in quantitative research methods, whereas qualitative methodology covers case study/interview, experimental or pilot studies, and a participatory approach. As the paper in the corpus adopted more than one methodology, two methods per paper were identified. Since most papers contain some literature background for the purpose of the research, it referred either to a type of the article or its part. The most popular methodology applied to study urban e-commerce deliveries is case studies, focus interviews, and statistical methods. The statistical methodology has become a standard, and contrary to the findings of [14], is applied to all areas of study, even those earlier considered to be examined by qualitative methods, such as stakeholders involvement [160]. The use of statistics in research increased significantly after 2018, and that might be the expression of a strong desire to deliver objective research results, not biased by any subjective opinions. Although the quantitative methods prevail, the studies usually combine statistics with case studies or literature reviews. Interestingly, literature studies are supplemented with statistical methods [78,112,125,128] or qualitative methodology [49,54,55].

Transportation facilities and activities significantly affect environmental sustainability in several ways, presented in Figure 8. Naturally, reducing negative impacts caused by transportation, including last-mile deliveries, would improve urban areas’ environmental sustainability. The implementation of certain city logistics measures would enable us to reach the environmental goals. Following the list of transportation impacts on environmental sustainability, the author attempted to classify the articles regarding what problems and solutions they identify.

The framework suggested by Russo and Comi [162] was implemented; namely, environmental sustainability is addressed in terms of reducing pollutants, reducing noise, and habitat loss. This approach has been adopted because their numerous publications validate such a division of environmental sustainability impacts within city freight transport [86,163,164], which covers the problems generated by urban LM e-commerce deliveries. Not all environmental impacts can be easily measured. It is reasonable to concentrate on those for which it is possible to establish a set of quantitative and qualitative variables signifying impact. Pollution is the most commonly used indicator in the reviewed literature. Therefore, it is advisable to follow the well-established concepts and frameworks by the authors, who have great experience in this field.
Table 4. The identification of research methodologies referring to urban last-mile deliveries on the e-commerce market.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Literature Studies</th>
<th>Empirical Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Quantitative Research</td>
</tr>
<tr>
<td>ICT and smart solutions</td>
<td>[15,76,78]</td>
<td>[32,77–80]</td>
</tr>
<tr>
<td>Stakeholders collaboration</td>
<td>[15,54,55,76,91]</td>
<td>[39,62,85–90,92–96]</td>
</tr>
<tr>
<td>Crowd logistics</td>
<td></td>
<td>[72,99,101–103]</td>
</tr>
<tr>
<td>Alternative places of delivery</td>
<td>[38,61,93,101,105,106,109–114]</td>
<td>[53,83,104,107,108]</td>
</tr>
<tr>
<td>Green vehicles</td>
<td>[49,55,125,128]</td>
<td>[32,60,65,68,110,112,118–120,125,127–130]</td>
</tr>
<tr>
<td>Last mile Delivery optimization</td>
<td>[18,128]</td>
<td>[3,71,89,93,128,131,132,135,136,138–143,145–147]</td>
</tr>
<tr>
<td>Access restrictions</td>
<td>[87,105,110,138,150,151]</td>
<td>[51,52,133,148]</td>
</tr>
<tr>
<td>Consumer behavior</td>
<td>[12,38,66,68,113,150,152,153,156]</td>
<td>[155]</td>
</tr>
<tr>
<td>Performance assessment</td>
<td>[15,125,128]</td>
<td>[109,112,125,128,142,153,157–159]</td>
</tr>
</tbody>
</table>

Figure 8. Transportation impacts on environmental sustainability. Source: own elaboration after Online TDM Encyclopedia—Sustainable Transportation and TDM [161].

Apparently, out of three environmental sustainability areas, only one has been quite extensively researched and discussed in the literature: reducing pollution in cities, which seems to be one of the most severe problems in densely populated urban areas, as it is responsible for causing respiratory diseases. This reflects the local approach to the problem of increased transportation caused by urban freight and parcel transport. This local perspective also includes congestion, noise, and habitat loss. Still, the reduction of GHG would be beneficial, not only to improve the quality of life in urban areas, but also for its global consequences, as it would counteract global warming and climate change [154].

The corpus selected for the analysis refers to several solutions to the problem of improving the environmental sustainability solution for last-mile deliveries on the e-commerce market. The range of identified solutions to improve the environmental value of urban last-mile deliveries on the e-commerce market was collected in Table 5. As all of them were initially developed as innovative solutions, which have been put into practice, they were therefore grouped by the author following the classification of innovation adopted by the OECD [165]. The solutions, including electric vehicles [117], cargo-bikes [166], parcel lockers [167], and pickup points [101], were grouped as product solutions, since they are original and up-to-date ideas, often technological breakthroughs, which have not been before used in the urban e-commerce deliveries. Crowd-based solutions [98] and the concept of reducing shopping journeys [154] were grouped as process solutions as they refer to the re-modelling of the process of urban e-commerce last-mile deliveries. Urban distribution centers [168], time windows [169], night deliveries/off-hours deliveries [170],
and vehicle routing optimization [110] were classified as organizational solutions, since they require a significant change in the organization of urban e-commerce last-mile deliveries, such as the change in the working hours of the courier companies’ employees. It may appear that there already exist numerous possibilities, which, when implemented, would significantly decrease the negative impact of last-mile e-commerce deliveries in urban areas. To verify this impression, the author linked the solution with transportation impacts on environmental sustainability. The analysis revealed that the proposed solutions, even though they are innovative and promising, only partially refer to the problem. The issue of noise pollution or habitat loss due to building the infrastructure required to meet the growing demands of freight deliveries is barely noticed [148]. However, most of the solutions contribute to the reduction of noise. The main research focuses on finding methods and strategies to reduce pollution [86,171], and GHG emissions [131,147].

Table 5. Classification of environmental solutions in e-commerce last-mile deliveries and the environmental sustainability issues they address.

<table>
<thead>
<tr>
<th>Type of Innovative Solutions</th>
<th>Environmental Sustainability Solution in Last-Mile Deliveries in Urban Areas</th>
<th>Reference</th>
<th>Environmental Sustainability Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reduction of Pollution</td>
</tr>
<tr>
<td>Product solution</td>
<td>Electric vehicles [65,125,127]</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Cargo-bikes [55,63,128]</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Parcel lockers/pickup points [61,104,112,166,172]</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Process solution</td>
<td>Public transport [115,124,152]</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Crowdshipping [52,72,96,101,103]</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Customer behavior [155,166]</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Organizational solution</td>
<td>Time windows [84,138,149]</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td></td>
<td>Urban distribution and consolidation centers [60,64,137]</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Night deliveries/off-hours deliveries [86,117]</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vehicle routing optimization [131,139,147]</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

6. Discussion and Direction for Further Research

In line with other studies [17,173,174], the review demonstrated that the concept of sustainability has been a broadly adopted perspective for any urban last-mile e-commerce delivery [18,175,176] However, the analysis of relevant literature also provided evidence that the environmental sustainability of B2C deliveries has been investigated within a limited perspective so far. Apparently, out of three environmental sustainability areas, only one has been quite extensively researched and discussed in the literature: reducing pollution in cities [12,115,142]. The interest of researchers concentrates on the possibilities of reducing freight and parcel transportation in cities, which naturally would result in a decrease in the GHG emissions and pollution in the city [177]. The search for sustainable last-mile deliveries resulted in the growth of interest in green logistics and alternative methods of goods delivery, such as cargo bikes [8], crowdshipping [52], and electric vehicles [127]. Crowd logistics seems to be one of the hot issues recently; the number of papers has increased sharply in the last two years. The reduction in the number of vehicles delivering goods ordered online will improve the urban ecosystem’s condition and city residents’ quality of life in multiple aspects. Nevertheless, the remaining aspects of the transportation impacts on environmental sustainability, namely noise pollution and habitat loss, deserve equal interest and suggestions of viable solutions in green e-commerce last-mile deliveries in cities. Otherwise, the obtained result will not address all the challenges
posed by the increased number of B2C deliveries resulting from the expansion of the e-commerce market.

Addressing such challenges is not cheap. As Gray [178] claims, achieving sustainable objectives by business organizations, despite the optimistic company reports boasting about environmental investments, is a long-term process for the business to transform, which requires substantive outlays. Some papers, particularly those written from the perspective of supply chain management, demonstrate that implementing the discussed innovations would bring substantial financial gains/cost reduction, and the environmental issues are treated as welcomed externalities [85,158,179]. Any solutions supporting environmental sustainability presented as an innovation improving the environment’s condition and bringing benefits to the organization are more willingly implemented.

The review also demonstrated that some mature research streams, such as stakeholders’ involvement and management [14], still develop and gain interest. The management is analyzed from the perspective of city authorities and organization of SULP (Sustainable Urban Logistics Plan) [91,176], stakeholder interaction [15,160], or behavioral analysis [87]. A similar situation concerns green initiatives, understood initially as using electric or hybrid vehicles or fueled with biodiesel [18]. This topic has expanded significantly and now incorporates cargo bikes [55] or using public transport for deliveries [97]. Interestingly, even though the need for developing ICT tools supporting green action has been pointed out [15], the number of papers referring to such studies within urban LM e-commerce deliveries is relatively small. There are initiatives to use algorithms for developing delivery routes [142]. However, the number and the scope of them are limited, which is surprising considering the overwhelming presence of technology in the current world.

The author believes that based on the identified topics and their development over time, exemplified by the increasing number of publications concerning a given area, it is possible to extrapolate the trends of further research such as:

1. **Crowdshipping within the scope of e-commerce last-mile deliveries**

   Even though crowdshipping is a type of collaborative solution, in the author’s opinion, it is significant enough to become a separate trend in future research in developing green LM e-commerce deliveries. The issue is relatively new, as the first papers examining LM deliveries on the e-commerce market were published in only 2017, yet they are widely cited. The idea of crowdshipping is discussed concerning public transport passengers [99], private car owners [103], bikes [100], and neighbors [98] in scientific papers, but also implemented by business practitioners, for example, by Blue Couriers in New Zealand [180]. Some papers have investigated the stakeholder aspect of crowdshipping [72,102]. However, the practical aspects of crowdshipping and the conditions of becoming a viable alternative for LM e-commerce deliveries require further investigation. Many of its aspects need to be carefully examined to make it operate efficiently and make a difference in organizing environmentally-friendly e-commerce LM deliveries in urban areas. Therefore, it offers a broad scope for further research.

2. **Customer behavior**

   As stated before, the behavior of customers both of brick-and-mortar shops and online outlets have been within the scope of scientific interest for a few years [11,154]. However, interestingly, the recent developments shifts towards modeling the behavior of customers so that they select or exert pressure on other stakeholders to adopt more sustainable methods of last-mile e-commerce deliveries [156,181]. End customer behavior may largely influence the pro-ecological choice of distribution channel, and thus exert or relieve environmental pressures. Current studies research this behavior from the economic point of view [182], disregarding the environmental issues. Given the alarming state of the environment, research on methods to make customers more conscious of their shopping and delivery choices seems to be a promising avenue for further investigation, joining the organization of deliveries with marketing and psychology, for example, the nudging theory.
3. ICT and smart solutions

The next suggested research trend appears to be ICT and smart solutions applied to the delivery of online purchased goods safely and at the lowest economic, social, and environmental cost. A research gap regarding ICT tools in supporting green 3Pls action was noted by Evangelista [15]. It seems that ICT and smart solutions are only beginning to be applied within the scope of urban LM deliveries [79]. Thus, the topic of making use of ICT tools for improving the environmental sustainability of urban LM e-commerce deliveries is underrepresented. The current technological developments such as the Internet of Things, big data, and sensors fitted into vehicles and infrastructure allow real-time monitoring of various aspects such as fuel consumption, wear and tear of spare parts and components, the temperature of goods, working time of drivers, and emissions. Hence, ICT in decision support systems, energy-saving technologies, and big data analysis [32] may considerably improve the sustainability of LM e-commerce deliveries, reducing the environmental externalities through better route planning, fleet monument, or traffic control. These possibilities need to be investigated from the point of view of improving the environmental sustainability of LM e-commerce deliveries in urban areas. Therefore, the author recommends further studies in this area.

4. Performance assessment

The scope of solutions and tools to deliver online purchased goods to customers in cities is growing, and so are the challenges connected with the economic, social, and environmental aspects of those deliveries. Again, some earlier reviews pointed out the need to develop performance assessment measures concerning third-party logistic service providers [15]. Similarly, there are few such studies also within the scope of environmentally friendly urban LM e-commerce deliveries. There are numerous ideas on how to improve the sustainable aspects of urban LM e-commerce deliveries. These ideas include developing collaboration in intermodal transport [183] or as a horizontal collaboration [131]. However, the question of how to deliver the parcel within the shortest possible time at the lowest cost and with the least damage to the environment has remained unresolved so far. What is more, as it was pointed out by [17,132], there are aspects of environmental sustainability, such as land use, which have not been investigated. Little is known about the efficiency of the existing solutions in terms of those externalities. The effectiveness of the available solutions and tools needs to be measured, and the assessment methods need to be created. On account of the increasing number of studies attempting to develop such tools and methods, the author claims that this trend is on the rise.

5. Green vehicles

The analysis revealed that the number of papers devoted to green vehicles, including bikes, electric vehicles, public transport is well-developed, and the researchers’ interest seems to be growing. There are still questions and doubts about whether electric vehicles are actually green or if the implementation of such a fleet is cost-efficient [125,128]. Other solutions are examined, such as using public transport for delivering goods [115] or using bikes for delivery services [107]. A greener alternative is sought for fossil-fuel-based fleets, and as the problem is immense, it will generate an abundant amount of research in the following years.

7. Conclusions and Limitations

The purpose of the paper is to present a review of the relevant literature in terms of topics related to green last-mile deliveries on the e-commerce market in the urban area. The analysis focused on 126 articles extracted from Scopus and WOS databases published from 1994 to 2020. Previous papers referring to green urban e-commerce LM deliveries show some limitations regarding both the timeframe and the content, i.e., lack of recent publications [16,18] or the lack of discussing environmental sustainability in terms of urban last-mile deliveries of the e-commerce market [15]. This review aimed at filling this gap, and consists of two main parts: a descriptive analysis (i.e., year of
publication, journal title, geographic distribution) and qualitative analysis (i.e., areas of research, most influential papers, and the development of the interest in environmentally sustainable solutions in terms of urban last-mile deliveries of e-commerce market). The papers were mostly published in transportation and environmental journals. Most of the articles were published later than 2015, which might suggest that the adoption of the Paris Agreement [184] contributed to the growth of interest in environmental protection with particular emphasis on climate change and global warming. Hence, the majority of papers deal with the problem of emissions [75, 95, 110]. In terms of geographic distribution, the results are quite surprising, as the biggest number of papers originated in Italy, which is difficult to explain. China and the United Kingdom’s high positions reflect the size of the e-commerce market and its revenues in those countries. On the other hand, given the incomparable size of the e-commerce market in the US, the relatively little interest in research on green e-commerce deliveries in urban areas might be explained by the fact that until recently, neither the general public nor the legislators supported the idea of the CO$_2$ reduction and climate change [185].

The review also tried to identify main research areas and emerging trends. The most prominent area of research is last-mile delivery optimization, followed by green vehicles. As previous contributions suggested [14], the shift towards stakeholder management is visible. Stakeholder collaboration is a significant area of study, generating a large number of publications. The following eminent area of research is alternative places of delivery. The next area of research revealed by the review is the topic of access restrictions. Moreover, a similar level of interest is noted in consumer behavior, performance assessment, and crowd logistics. The fewest publications have been identified within the area of ICT and smart solutions.

The paper also attempted to identify the research gaps and possibilities for further studies. The topics of ICT and smart solutions, customer behavior, and performance assessment and certainly deserve further research and exploration. They seem to be underestimated in the current state of research. In the discussion on the environmental sustainability of the last-mile delivery on the e-commerce market in urban areas, one needs to address the issue of noise or habitat loss. The criteria of assessing those two aspects of environmental sustainability need to be developed in order to measure the initiatives undertaken to counteract those impacts. In the relevant, up-to-date literature, the issue of noise is acknowledged [59, 148], but it seems that it would need to be measured to what extent the noise created by increased traffic in cities is the result of e-commerce last-mile deliveries, and how it can be reduced. The third aspect, habitat loss, would need to be considered in researching the environmental impact of last-mile e-commerce deliveries. Until now, this aspect seems not to have been studied at all. The reason for that might be the problem with assessing this aspect as there are no criteria, which would have to be developed.

Having read the relevant literature and referring to her own experiences, the author believes that there might also be other aspects connected with the environmental sustainability of e-commerce last-mile deliveries in cities, such as the nuisance of light pollution generated by freight and parcel transportation, distribution centers, or parcel-lockers at night, especially in the case of implementing off-hour deliveries. The criteria of assessing those two aspects of environmental sustainability need to be developed to measure the initiatives undertaken to counteract those impacts.

The value and originality of the paper consist of: providing an accurate and comprehensive synthesis of research in urban green last-mile deliveries in e-commerce, identifying current and emerging interests of researchers worldwide, and discovering areas requiring further studies. The findings have a theoretical value, as they indicate the research areas in urban last-mile delivery on the e-commerce market that have not been fully explored so far and require attention on the part of academics. Its practical value is expressed as a source of knowledge and guidelines on the current developments regarding the existing solution
for LM e-commerce deliveries in the urban area, which might help local governments, freight operators, and other stakeholders of last-mile logistics.

In the subsequent works, following the findings of the review, the author intends to develop the literature studies into empirical research focused on green last-mile deliveries on the e-commerce market, within the trend of customer behavior. In addition, it might be interesting to conduct research into the rural last-mile deliveries on the e-commerce market, to investigate their specific problems and to compare them with urban deliveries. It might allow the identification of common issues and how they are addressed in each area.

Finally, some limitations should be noted. Even though best efforts were made to make the review comprehensive and all-inclusive, some papers might not have been included in the review, not by design. An additional limitation might be the keyword structure and the composition of the search phrase. Even though the selection of keywords was discussed among researchers, it is possible that, due to the search phrase structure and the use of search operators, some relevant contributions might not have been omitted by the search. Additionally, the search was limited to conference papers and research articles published in English in academic journals. Thus, potential relevant papers in other languages might have been overlooked. Another significant limitation is the fact that in order to include the most extensive possible sample of papers referring to the environmental impact of e-commerce last-mile deliveries in urban areas, some of the papers in the analyzed set were not exclusively referring to e-commerce deliveries. Nevertheless, as long as LM e-commerce was considered therein, they were included in the analyzed set. Despite those limitations, the author is convinced that the article offers an accurate account of the research on green last-mile deliveries on the e-commerce market in urban areas, and therefore, the results of the performed analysis are considered circumstintiated.

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