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Implementing E-Commerce from Logistic Perspective: Literature Review and Methodological Framework

Ilenia Zennaro *, Serena Finco, Martina Calzavara and Alessandro Persona

Department of Management and Engineering, University of Padua, Stradella San Nicola 3, 36100 Vicenza, Italy; serena.finco@unipd.it (S.F.); martina.calzavara@unipd.it (M.C.); alessandro.persona@unipd.it (A.P.)
* Correspondence: ilenia.zennaro@unipd.it

Abstract: E-commerce is always more diffused as a selling channel around the whole world market, and its importance has increased and continues to increase with the COVID-19 pandemic emergency. It provides enterprises a lot of opportunities, as the importance of physical stores to sell goods is bypassed. However, it has also changed the role of logistics in the supply chain. For this reason, this work aims to identify the main logistics research areas related to e-commerce implementation and the factors and key performance indicators, which should be taken into account for each logistics research area, with particular attention to sustainable aspects. For doing this, a structured and comprehensive literature analysis is carried out. Keywords associated with e-commerce and logistics areas are matched to identify the most interesting works related to its implementation. From the analysis, five main research areas are identified: Supply Chain Network Design (SCND); Outbound Logistics (OL); Reverse Logistics (RL); Warehousing (WR); and IT and data management (E-IT). For each area, key factors, strategies and performance indicators have been identified. Finally, a methodological framework that summarizes the results of the analysis is presented; this is a useful tool for managers to implement or expand their e-commerce business. Many works are focused on one research area, carrying out critical factors, models, and methods to implement that topic. Instead, the methodological framework presented here summarizes multiple research areas from a logistic point of view, identifying for each one input and output variables and how they influence each other.

Keywords: e-commerce; supply chain network design; warehouse; last-mile logistics; reverse logistics; COVID-19; logistics and supply chain

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1. Introduction

Electronic commerce (e-commerce) includes any form of economic activity conducted via electronic connections [1] and, in the last decades, its growth has considerably changed the role of logistics in the supply chain. Moreover, the COVID-19 pandemic has surely impacted its growth: in fact, according to a recent analysis, it has been estimated that the global e-commerce market will reach more than $6388 billion by 2024, with an annual growth of about 13.5% [2].

There are several advantages for both customers and companies in using and implementing e-commerce strategies. By a customers' perspective, they can purchase when they have time, every day and in every slot of time, they do not require to be physically present in stores, they have more time for choosing and comparing products characteristics and prices of different online stores at the same time and, finally, they have an unlimited selection and a higher degree of personalization [3,4]. From a company perspective, opportunities in implementing e-commerce are mainly related to the possibility of reaching a larger platform of possible customers, a reduction in the number and in the dimensions of the physical stores and, finally, the possibility to collect and analyze in real-time data to map customers' behavior and create a direct communication channel [4].

By focusing on the features of typical e-commerce orders, Boysen et al. [5] identified the following features: small order scales; large items count; unexpected irregular order arrival patterns; seasonality demand peaks and high service level expectations. According to its features, a company that wants to apply e-commerce should properly change its structure to be reactive and efficient. E-commerce requires different solutions in terms of orders fulfillment (e-fulfillment), distribution channels, logistics, operation management, and Information Technologies (IT) systems. However, in most cases companies have both physical and online channels. In particular, according to the literature, when both channels exist, we can have two main categories: Multi-Channel (MC) and Omni-Channel (OC) systems.

In MC systems e-commerce and store supply are operated in parallel, while in OC systems customers can move freely, since they have the possibility of bringing their online order into a store too. In such contexts, several channels have been created and for this reason, now, the challenge consists of defining how multiple channels can be managed synergistically to provide a satisfactory customer experience [6]. MC requires the management of channels separately and data are not integrated and shared between them, while OC requires integrated channels with cross-channel objectives, and data and information are shared and integrated between channels. OC can be also called bricks and clicks or click and mortar [7].

Enterprises, industries and/or managers that decide to implement e-commerce as an additional channel (through MC or OC strategy) or as the only channel ("pure player" e-commerce) have to deal with many issues. Melacini et al. [6] focused on the questions related to e-fulfillment and distribution that arise from companies implementing OC, identifying three dimensions, i.e., distribution network design, inventory and capacity management and delivery planning and execution. Hübner et al. [8] focused on the main aspects that should be considered when a company moves from MC to OC and developed a framework to support managers considering inventory, picking and assortment management, delivery and return management and organization and IT systems.

The purpose of this work is to provide an innovative framework to support managers and enterprises of all sizes to efficiently implement e-commerce, after a deep and extensive literature review. The main contribution is related to a structured overview of the existing knowledge about e-commerce implementation, dealing with barriers, drivers, models and methodologies and, based on this, to the proposal of a methodological framework by considering all aspects of e-commerce adoption, from a managerial and logistics point of view. Therefore, in this work we will answer to two Research Questions (RQs):

RQ1: "Which are the main logistics research areas related to e-commerce implementation?";

RQ2: "Which influencing factors and key performance indicators should be taken into account for each logistics research area in e-commerce implementation?"

For RQ1 we will provide a comprehensive analysis of the current literature in e-commerce implementation, while RQ2 will be answered through the methodological framework. Previous works with similar purposes consider just a part of the whole problem. For example, the review of Agatz et al. [9] analyzed e-fulfillment models and MC distribution systems, evaluating two main areas, i.e., sales and delivery planning (delivery service design, forecasting, and pricing and transportation planning), and Supply Chain management (distribution network design, warehouse design, and inventory management). The framework of Ghezzi et al. [10] aimed to support the design of an e-commerce logistics strategy considering the main features of the logistics problem as product size and complexity, customer service level and inventory management. Also, Marchet et al. [11] presented a framework to support managers in passing from MC business to OC, considering aspects as delivery service, distribution setting, fulfillment strategy and returns management. Boysen et al. [5] presented a review of the main characteristics of e-commerce warehouses. However, no works focused on all the main logistics drivers that are instead included in our framework. Moreover, sustainable aspects in e-commerce implementation deserve to be investigated, given the importance they have recently acquired (packaging, pollution, environmental impact of reverse logistics etc.) [12,13].

The remainder of the paper is structured as follows. Section 2 presents an overview of the review methodology and defines the trends in the literature in terms of the distribution over time and the journals in which papers were published. In particular, the different steps adopted to conduct the literature analysis are described. In Section 3 the research areas that arise from the analysis are described, reporting main subjects, features, and models of each one. Section 4 presents the methodological framework for e-commerce implementation. Finally, the conclusion and proposals for further research are reported in Section 5.

2. Literature Review

2.1. Literature Review Methodology

The main objective of this research is to summarize the status of research concerning methods and approaches regarding e-commerce implementation, aimed at managers of SMEs and also big manufacturers (working with MC or OC strategies), or pure players (only e-commerce channel). Moreover, starting from the literature, a conceptual framework that summarizes the principal steps of e-commerce implementation is developed. Our literature analysis follows the procedure suggested by Neumann and Dul [14] and already applied in many literature reviews as [6,7,15–18]. This process includes data collection, descriptive analysis, categorization analysis, and, finally, data evaluation and interpretation, which plays an important role in defining the future research agenda. We performed a literature search in the Scopus database until June 2021. We used 60 search combinations of keywords (see Table 1), searching for the papers including these keywords in the title, in the abstract and/or in the keywords. Furthermore, a snowball approach was applied in the last step, by analyzing the references of each paper to find other useful papers, which did not emerge in the first search. In conclusion, a total of 355 papers have been identified as being of interest to our study.

Table 1. Keywords used in the systematic literature search.

Group A	Group B
- "E-commerce" - "Ecommerce" - "E-grocery" - "Egrocery" - "Multi-channel" - "Omni-Channel"	- "Warehouse" - "Picking" - "Route" - "Routing" - "Transport" - "Logistics" - "Reverse logistic" - "Inventory" - "Last-mile" - "Distribution center"

In Group A, we selected a list of six keywords linked to our research topic, that is, e-commerce, including also some synonymous or similar concepts (as e-grocery). In Group B, we listed ten keywords closely linked to the typical elements related to e-commerce implementation, from a logistics and supply chain network design point of view, and considering its principal processes, as: customers' orders; orders' fulfillment; orders' delivers; and product returns. Table 2 provides all the steps that were followed to carry out the literature research.

Table 2. Selection steps adopted for the literature review.

Step	Description	N° Papers
1. Database	- Scopus	
2. Years	- 1991–2021	
3. Keywords	- All possible combinations of words into Group A and Group B in Table 2 (60 combinations) - All papers linked to Group A - All papers linked to Group B	3243
4. Selection criteria	- Document type: Journal article or Conference article - Language: English - Research areas: ENG and BUSS area	1257
5. Exclusion criteria	- Papers published before 2001 - Papers regarding sales, marketing, and banking	584
6. Content analysis	- Reading of the 584 papers to evaluate whether the paper answered the research questions - Application of the snowball approach	332

Steps 1 to 3 have already been described. Step 4 deals with the selection criteria, which reduce the total papers from 3243 to 1257. In line with other existing literature analyses, we decided to consider only the papers written in English, which is the most widespread language of the scientific literature. We also decided to consider papers published in journals or conferences, and to focus our research only on engineering and business areas, since managers and practitioners will be the final users of our framework. The exclusion criteria of step 5 reduce the papers to 584. They deal with the exclusion of the papers published before 2001, which turned out to be not suitable for our research questions since they are more related to the general concept of e-commerce and rarely consider logistics aspects. Moreover, the papers regarding sales, marketing and banking research areas are not considered since they are outside the scope of our research work. While the selection and exclusion criteria were applied by reading and analyzing the title and the abstracts of the papers, the final step, dealing with the content analysis, was carried out by reading and analyzing the whole paper. Here, each paper was subjected to additional analyses in a joint manner, and all papers that did not consider our research topic were deleted from the final list, which composed of 321 papers. For these remaining papers, we analyzed their references to search other important articles with a snowball approach. Thus, 332 key papers turned out to be relevant for the e-commerce implementation study and they were analyzed in detail from a qualitative point of view.

2.2. Literature across Journals

Through the literature across journals, we want to understand if there is a journal influence on our field analysis (Table 3 summarizes the journals with more papers). The analysis revealed that the top six journals contributed to about 30% of the total number of reviewed papers. Most papers have been published in international journals and many papers have been published in journals closely linked to industrial engineering, operational research and operation management. Twenty-five papers are published in the International Journal of Production Research, while eighteen papers are published in the International Journal of Physical Distribution and Logistics Management. Journals arising from the analysis are of various natures, from logistics to transport, from SC management to data systems, i.e., they cover a lot of subjects due to the nature of e-commerce. This demonstrates that our research topic and our research questions cover a wide scope of e-commerce, with a perspective that has not been fully considered yet from an academic point of view.

Table 3. Distribution of papers across journals.

Journal	N° of Papers	Years	%	%Cum
International Journal of Production Research	25	2007–2021	7.6%	7.6%
International Journal of Physical Distribution and Logistics Management	18	2001–2020	5.5%	13.1%
Computers and Industrial Engineering	18	2001–2021	5.5%	18.5%
Transportation Research Part E: Logistics and Transportation Review	17	2003–2021	5.2%	23.7%
Sustainability	16	2016–2021	4.9%	28.6%
International Journal of production economics	13	2004–2021	4.0%	32.5%
European Journal of Operational Research	12	2007–2021	3.6%	36.2%
Journal of Cleaner Production	11	2016–2021	3.3%	39.5%
International Journal of Retail and Distribution Management	10	2001–2020	3.0%	42.6%
Omega	9	2005–2021	2.7%	45.3%
IEEE Access	5	2019–2021	1.5%	46.8%
Industrial Management and Data Systems	5	2002–2017	1.5%	48.3%
Journal of Intelligent Manufacturing	5	2013–2020	1.5%	49.8%
Transportation Science	5	2005–2019	1.5%	51.4%
IISE Transactions	4	2019–2020	1.2%	52.6%
Mathematical Problems in Engineering	4	2014–2021	1.2%	53.8%
Research in Transportation Business and Management	4	2014–2021	1.2%	55.0%
Transportation Research Part B: Methodological	4	2018–2020	1.2%	56.2%
Transportation Research Part D: Transport and Environment	4	2018–2021	1.2%	57.4%
Others	143	2001–2021	42.6%	100.0%

2.3. Literature over Time

Figure 1 considers the literature development over time. We have considered both conference and journal papers. One can notice there was a stable pattern from 2001 to 2014. After 2014 it is possible to note an increasing number of publications with an average of 13 papers published for each year. From 2017 the number increases until now, with 74 publications in 2020 (2021 covers till June 2021). Clearly, the interest in e-commerce is increasing year per year, as expected.

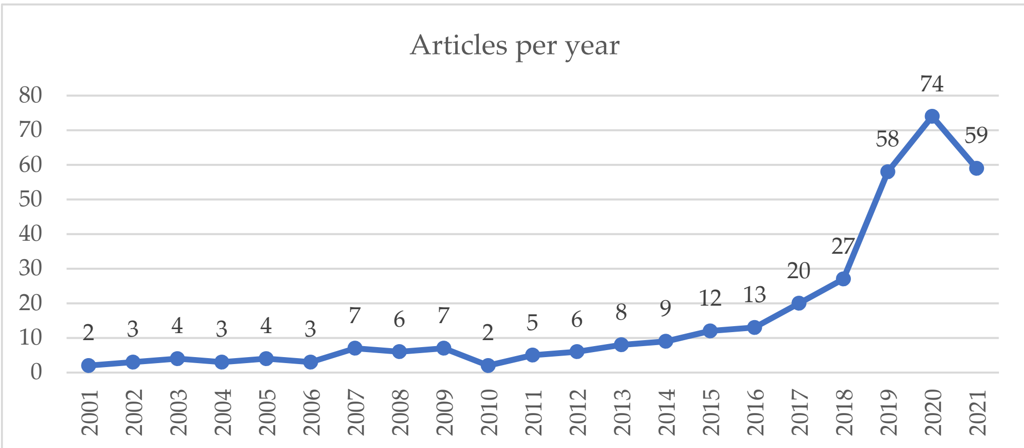

Figure 1. N° of articles per year (till June 2021).

2.4. Categorization of Topic Areas

The content analysis of the 332 papers reveals the possibility of categorizing them according to their main research area and the applied methodology. We individuate five main research areas, according to our research objective: Supply Chain Network and Design (SCND); Outbound Logistics (OL); Reverse Logistics (RL); Warehousing (WR) and E-commerce IT and data management (E-IT). As reported in Table 4, OL is the predominant research area, with the 37% of papers published. The main issues of this area, regarding our research topic, i.e., e-commerce, are about last-mile delivery, vehicle routing problem, outsourcing decisions and impacts on the environment. Secondly, there is SCND, which covers 28% of the papers. It covers a great number of issues, from key factors, drivers and barriers for e-commerce implementation to e-commerce strategies, models and approaches for SCND, facilities locations, warehouses and distribution centers (DCs) features. WR covers the 17% of works that can be divided in order, picking models and optimization, level of automation and warehouses performance indicators. RL, which can be considered complementary to OL, covers 11% of the records and considers issues as RL strategies, re-design of SC, and sustainability aspects. Finally, E-IT covers the 7%, discussing IT technologies and the importance of customers' data management and analysis.

Table 4. Classification per research area.

Research Area	N° of Papers	Years	%
Outbound Logistics (OL)	122	2001–2021	37%
SC and Network Design (SCND)	93	2001–2021	28%
Warehousing (WR)	57	2007–2021	17%
Reverse Logistics (RL)	38	2002–2021	11%
E-commerce IT and Data management (E-IT)	22	2003–2021	7%
Total	332		

Table 5 instead presents a classification of the papers according to the used methodology approach, considering the totality of papers, and also divided per research area. Seven main methodologies have been individuated: mathematical model; conceptual research; survey; case study; literature review; conceptual framework; and simulation model. Mathematical models are the most used method with 45% of papers, especially in the OL research area, while conceptual research covers 25% of the total, mostly in SCND and OL research areas. The remaining papers are about surveys, literature reviews, and case studies.

Table 5. Classification per applied methodology.

Classification	SCND	%	OL	%	RL	%	WR	%	E-IT	%	Tot	%
Mathematical model	35	38%	60	49%	18	47%	36	63%	1	5%	150	45%
Conceptual research	29	31%	28	23%	8	21%	3	5%	14	64%	82	25%
Survey	5	5%	10	8%	6	16%	4	7%	2	9%	27	8%
Case study	11	12%	9	7%	2	5%	2	4%	3	14%	27	8%
Literature review	6	6%	10	8%	1	3%	4	7%	0	0%	21	6%
Conceptual framework	6	6%	1	1%	3	8%	1	2%	2	9%	13	4%
Simulation model	1	1%	4	3%	0	0%	7	12%	0	0%	12	4%
	93		122		38		57		22		332	

Figure 2 shows how papers are distributed per year, divided per research area. The trend is similar for all research areas, confirming the general trend of paragraph 2.2. In recent years, the interest in OL, SCND and WR increased; the research areas of E-IT and RL, instead, have a more constant distribution of papers per year. This is due to the nature of the research areas, as the first three are strongly related to the initial implementation of e-commerce, while the others are considered later.

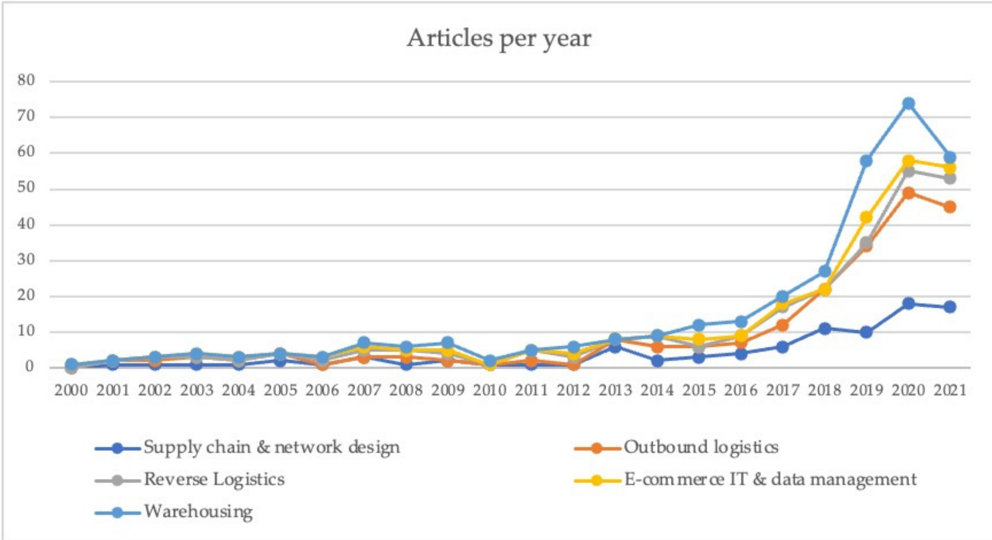

Figure 2. Articles per year per research area (till June 2021).

In the following section each research area is presented and discussed; for each one the principal key factors, the strategies and the key performance indicators are pointed out.

3. Discussion

This section reports the discussion of the results of the analysis. Through the literature review, papers are clustered in five main research areas related to logistics. Firstly, we discuss how to implement e-commerce by a SC and Network design perspective. Secondly, our attention moves to transportation and delivery systems and strategies. We categorize outbound and reverse logistics strategies. Then, warehousing activities (i.e., picking, storage, refilling, and other activities) are investigated. Finally, e-commerce IT and data management are presented as the last research area of logistics interest; in fact, it aims to collect all previous information and to carry out useful instruments. For each research topic influencing key factors and strategies are presented and discussed. In the Appendix A, Table A1 reports all abbreviations and acronyms used in the manuscript.

3.1. Supply Chain and Network Design

The first step of e-commerce implementation is the study and the definition of the supply network; this research area includes papers regarding SCND, i.e., the definition of the actors, networks, relations and strategies to manage it. Since e-commerce is a channel that allows reaching new or existent customers in different ways, it is important to define which kind of channel mode is more suitable, i.e., multi-channel, omni-channel or pure e-commerce. In the literature review 100 papers emerge related to SCND. Table 6 reports the main topics and the number of papers in this area. Food e-supply chain has been considered separately from the others SCND areas as food chains have very different features respect the other markets, due to food quality, safety and sustainability.

Table 6. SCND research area analysis.

Subject	N° of Papers	%	References
Key factors and processes influencing SC design	24	26%	[10,19–41]
Supply chain network design models and methods	42	45%	[7,42–82]
Facilities location	5	5%	[83–87]
Food e-supply chain	8	9%	[88–95]
Warehouse and DCs	14	15%	[15,96–108]

Almost 26% of the papers focus on key factors and processes influencing SC design [19–32]. Duffy et al. [33] individuated as principal processes in e-commerce the order fulfilment, the revenue generation/collection, the financial control, the information technologies, the business processes, the e-integration, the order generation, the 24/7 operation and the consumer behavior. McCole et al. [34] compared several firms in New Zealand, adopting and non-adopting e-commerce, and individuated six factors related to this phenomenon: response to technological environment (opportunities offered by technology); negative attitudes or impediments perceived to e-commerce; e-commerce capability; response to innovation; customer orientation and sensitivity to competitive environments. To and Gai [35] proposed a prediction model based on four main factors for online retailing adoption: relative advantage; competitive pressure; channel conflict; and technical resource competence. Ghobakhloo et al. [36] individuated three factors influencing e-commerce implementation as perceived relative advantage, cost and compatibility for the technological context, information intensity, CEO's knowledge and innovativeness and business size as organizational factors, and finally competition, supplier pressure, and support from technology as environmental factors. Ghezzi et al. [10] analyzed 28 case studies of leading B2C e-commerce enterprises and individuate some key managerial implications in B2C channel adoption, as product complexity (value, variety and obsolescence risk), service complexity (returns management, order cycle time, punctuality), and logistic strategies (inventory ownership and location, order picking policy, order delivery policy). Focusing on multi-channel SC, Hübner et al. [37] analyzed two main configurations, the integrated network (joint warehouses across channels) and the separated one (dedicated warehouses for online and store fulfilment). The first was competitive for the high product availability and more suitable for next-day delivery, lower inventory costs and no inter-warehouse transshipment, the second for their potentially shorter delivery time, a faster market entry, simplified operational processes and advantages through specialization. Li et al. [38] carried out a comparison between online and traditional retailers in terms of price, assortment and delivery time. They established that online retailers had a higher number of variants due to a lower inventory cost, and the pricing strategy depended by the assortment. If the product could be delivered quickly and at a relatively low cost, the online channel was preferred, whereas if delivery cost was high and customers were impatient, the traditional channel was better. Moreover, inventory costs and demand volume were the two main factors that influenced traditional retailers' inventory decision, while consumer patience and delivery cost influenced online retailers pricing strategy. Finally, Zhong et al. [39] focused on logistics in SC management and investigated three main aspects of logistics: self-support models, outsourcing models and supporting techniques such as warehouse management system (WMS), transportation management system (TMS), RFID. Recent studies focused their attention on environment and sustainable green SC; the analysis of Seebauer et al. [40] quantified carbon impacts of consumer choices of retail channel and shop location (where to buy) and extending footprint assessments of product choices (what to buy). The study of Pålsson et al. [41], instead, analyzed factors determining whether conventional trade with stores or e-commerce with home delivery is more energy-efficient; results revealed that the net effect of energy consumption was in the majority of the cases positive for the e-commerce channel, the proportion of unsold products and returned products seemed to have a major impact on the energy efficiency of different sales channels, and buildings had only a minor effect on the energy consumption difference.

After analyzing the factors influencing e-commerce implementation next issue regards SCND strategies and models, the most common subject of the analyzed papers (45% of the total). Distribution strategies are discussed, especially with regard to the centralization or decentralization of e-commerce inventory, and consequently its management [42–48]. De Koster [49] presented the main distribution strategies for online retailers starting from four types of companies, i.e., product manufacturers, traditional retailers and wholesalers, new internet companies with and without physical assets, and analyzing them by distribution channels, delivery area, and degree of outsourcing. He individuated four distribution strategies: from existing stores; from DCs also supplying conventional stores; from DCs directly to consumers; and hybrid structures. The delivery area, instead, could be regional, national or worldwide and the outsourcing level depended on the number of daily orders processed, i.e., less than 100 internet orders and more than 10,000 should be fulfilled in-house. Yao et al. [50] analyzed three main distribution strategies, namely centralized inventory (the manufacturer owns both the retail and e-tail channels), Stackelberg inventory (the manufacturer owns just the e-tail channel), and outsourcing (the manufacturer outsources the e-tail channel). The comparison of these strategies show that as the e-channel demand increased, the inventory level increased in the e-channel and decreased in the retail one, although in different proportions. Moreover, even if outsourcing could be expensive, the manufacturer can still receive higher profits. Wollenburg et al. [51] individuated and studied six different omnichannel distribution configurations: fulfillment of all online orders from the store; fulfillment of all online orders from the store or pick-up points; online DC for home delivery orders; online DC for all online orders; hybrid store; and online DC for online orders and integrated DC for all orders. The first two configurations were more suitable for low online order volumes and low capabilities in online fulfillment; the third, the fourth and the fifth were more suitable for medium online order volumes and medium capabilities in online fulfillment, while the last one for high online order volumes and high capabilities in online fulfilment. As previously reported, Taylor et al. [7] identified and classified omni-channel fulfilment strategies in BOPS, BODS, BOSFS, BOSTS, ship and get, BORIS and drop-shipping strategy (see Table A2 in the Appendix A). Gallino et al. [52] studied benefits and negative aspects of BOPS strategy as an increase in online sales, an increase in additional store sales from customers who use BOPS and buy additional products in store, and an increase in traffic. Yang et al. [53] compared different strategies, i.e., BOPS and BOSTS with the implementation of the quick response, which is an operational strategy that is based on a set of information technologies and expedited logistics, and aims to shorten lead time and enhance SC flexibility. They stated that for omni-channel enterprises implementing the quick response might be less convenient with BOSTS strategy. Wang et al. [54] presented a model that supported retailers in choosing their optimal cross-border logistics mode between overseas to overseas, domestic to domestic, and overseas to domestic modes. In the drop-shipping strategy, the e-retailer forwards orders to manufacturers who fulfil orders directly to customers for a predetermined price; the advantages are savings in holding costs, taxes, material handling, storage and obsolescence costs [55]. Moreover, in this strategy the manufacturer/wholesaler covers the costs of any over-stocking due to wrong forecasts of the final demand [56]. Khouja et al. [57] evaluated e-retailers inventory management in order to satisfy customers' demand, as drop-shipping cannot be used to satisfy the whole demand. Some works carried out models to apply efficiently drop shipping strategy, as Chen et al. and Kamalapur et al. [58,59].

A lot of methodologies and models have been developed for SC configuration in the e-commerce context [60–70]. Cheshmehgaz et al. [71] presented a model that aimed to minimize response time and transportation cost, and facility cost, considering potential suppliers, DCs, and deterministic demand from consumers. Zair et al. [72] presented a model for resource allocation in SC for only e-commerce enterprises and click and mortars ones, which aimed to reduce costs, improve customer satisfaction and maintain benefits of e-retailers. Gupta et al. [73], instead, developed a price optimization problem integrated with the inventory control and e-fulfillment problems with multi-objectives as profit maximization and lost sales minimization. The model of Arslan et al. [74] considered the uncertain nature of multi-item online orders, store sales, and capacities and defined the allocation of orders, the inventory positioning, the delivery schema, and inbound flow pattern decisions. Bayram et al. [75], instead, presented a model focused on ship-from-store strategy, which aimed to define from what location to fulfill an online order when it arrived to guarantee faster delivery, lower shipment costs, higher in-stock probability, increased sales, and higher customer satisfaction. BODS strategy reduces delivery lead-time, delivery costs and improves logistics service level; it is modelled and analyzed by the works of He et al. [76], in a dual-channel SC. BOPS strategy, instead, shortens waiting time for consumers after ordering and gives them the opportunity to return the product immediately if they do not want it; Lu et al. [77] model investigated optimal order-quantity and inventory allocation for meeting dual-channel demand with BOPS strategy, including in-store demand and limitation of total inventory-space. Some models, in particular, focus on the e-commerce demand and fulfillment problem [78–80]. Mutlu et al. [81] presented a model for e-commerce demand shaping considering e-commerce marketing efforts and store service levels; the model of Cui et al. [82] focused on the multi-item joint replenishment-distribution problem with stochastic lead-time and demand.

Another important issue in SCND is *facility locations*, which is discussed by 5% of the papers of this research area. Baglio et al. [83] developed a framework for facility study based on four main aspects: location; external spaces; building; and internal area. Xiao et al. [84] presented a study focused on logistics facility locations, which were based on three main aspects: economic factors for SC reorganization (such as technological advances, new business models, changing demand and economic growth); policies and regulations for the location choice (as employment growth, tax contribution, negative externalities and industrial connections); and resource endowments for the reproduction of logistics space (land availability, transport accessibility, labor pool and market coverage). Models about facilities location and inventory policy are presented by Heitz et al., Li et al. and Wang et al. [85–87].

Finally, further considerations have been carried out in the case of the *food e-supply chain*, where quality and freshness of products play a crucial role. Keys factors of food SC are food quality, food safety and sustainability [88]. Dello Stritto et al. [89] presented a strategic framework for a food and beverage e-supply chain. Yu et al. [90] proposed a model for SCND for fresh agri-products (FAP) in an e-commerce context. Recently, Cuicui et al. [91] individuated principal food e-SC risk as quality risk, logistics risk, information risk, cooperation risk, and after-sales risk. Many recent works are focused on food e-SC due to the rapid development of fresh products e-commerce demand, caused also by the COVID-19 emergency [92–95].

Inventory Level Management is a key function in the SC network (15% of papers). DCs and warehouses support various processes as storing goods, processing products, assembling shipments, etc. For these reasons, their location in the SC and their management strategy are fundamental for e-commerce success. Higginson et al. [96] identified five roles of DCs: make-bulk/break-bulk facilities (large incoming loads are disaggregated and mixed in outbound shipments); cross-docking facilities (short-term storage); transshipment facilities (take out a shipment from a vehicle and load in another); assembly facilities; product fulfillment center (respond to product orders from the final consumer); and depot for returned goods. Randall et al. [97] individuated nine factors that influenced the decision to couple the ownership of fulfillment capabilities of an e-commerce store: the variety of products; the demand uncertainty; the number of retailers in the channel; the firm's mean revenues; the relative gross margin; the firm age; the product size/weight; the product obsolescence and; the cost of capital. Results show a strong negative relation between fulfillment ownership and product variety and weight/size, and a strong positive relation with the firm's age and gross margin. Models and methods have been carried out to configure DCs in relation to e-commerce, focusing on the inventory level management and inventory location [15,98–103]. Alawneh et al. [104] presented a multi-item inventory model considering warehouse capacity, demand and lead-time uncertainty for a dual-channel warehouse, in which the structure is divided in a fulfilling online orders area and storing and fulfilling offline orders area. Other important considerations have been carried out about integration in SC; Song et al. [105] studied three levels of integration in omni-channel retailing, as information, process and organization integration. Focusing on warehouses and transports integration in SC, Mason et al. [106] developed a discrete event simulation model for a multi-product SC to examine the potential benefits of the global inventory visibility strategy, in order to integrate transports and warehouse functions. Other models, instead, focused on full integration of SC to maximize total systems performance and minimize inventory costs [107]. Finally Vafaei et al. [108] studied the most suitable distribution channel according to the product type and the number of vehicles for transportations, presenting a model for the sustainable distribution network design; the objective functions of the model were: minimization of transport costs; purchasing vehicles and buildings' costs; minimization of carbon emissions; and maximization of job opportunities.

From this discussion several aspects that need to be considered in SCND emerge; as first, internal and external key factors that influence SCND, secondly, key elements that need to be defined for SCND and, finally, extra key elements for e-food SCND.

Table 7 summarizes these principal key factors (internal and external) and key elements. Moreover, the table aims to answer RQ2 concerning this research area.

Table 7. Principal key factors and elements of SC design.

Internal Key Factors	External Key Factors	Key Elements for E-SC Design	Key Elements for Food E-SC Design
Innovation	Technological Environment	Channel Strategy (MC, OC, B, etc..)	Food quality
Information management	Competition in the market	Fulfillment and distribution strategies	Food safety
CEO's knowledge	Customers orientation and patient	(BOPS, BODS, BOSFS, etc..)	Food sustainability
Business size	Supplier pressure/support	Outsourcing	
Product complexity	Demand Volume	Factory location	
Inventory cost		Sustainable initiatives	
Delivery cost			

3.2. Outbound Logistics

The second important issue of e-commerce implementation refers to outbound logistics (OL), as it provides the movements of goods through the SC till the final customer. Logistics is part of the supply chain processes that plans, implements, and controls the efficient and effective forward and reverse flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customer requirements [109]. Outbound logistics covers many aspects that need to be considered in e-commerce implementation, as it is a fundamental part of many e-commerce supply chain processes. Logistics in the e-commerce context is characterized by fragmented and fluctuant volumes, high-speed flow, variety of delivery options, and direct to consumer deliveries. On the other hand, the freight market is characterized by a shortage of drivers, low margin, fierce competition, and strict constraints and regulations [16]. Due to these factors, new trends arise, as shared economies, crowd-shipping and vertical win-win solutions.

Table 8 shows the main research subjects in outbound logistics related to e-commerce, which can be categorized into: last-mile logistics; vehicle routing problem (VRP); outsourcing issue related to third-party logistics (3PLs); logistics pooling phenomenon; environmental impact of transports; new trends and technologies; and packaging process. The first issue regards the Last mile delivery, hence, the home delivery logistics, that covers 16% of papers of this research area. The ability to fulfil and deliver online orders on time is fundamental for e-commerce success. Some papers discuss the main issues and key elements of the last mile [110–112]. Xu et al. [113] focused on the "not at home at the delivery time" problem, which could be a problem both for e-tailers, as it causes higher operating costs, and for customers, as they should re-collect the order from a distributor depot or wait for a delivery that did not arrive or replan another day for delivery. Huang et al. [114] studied the impact on delivery cost varying, number of orders and location density, demonstrating that the impact is lower when both the number of orders and the local density are high. Recently, one of the main challenges of last-mile is the "same day delivery", i.e., to deliver an order the same day it is received. Factors and functions affecting this strategy are: operations management; variety of available fleet; facility location; logistics strategy; IT infrastructure; human resources; facility layout; and communication structure [115]. Shorter delivery time involves companies changing their inventory management and policies, with expected higher costs in shipping and not using trucks' maximum capacity, with several environmental impacts [116].

Table 8. Outbound Logistics (OL) research area analysis.

Subject	N° of Papers	%	References
Last mile delivery	20	16%	[16,109–127]
VRP	28	23%	[128–155]
3PLs	8	7%	[156–163]
Logistics Pooling	7	6%	[164–170]
Environmental impact	27	22%	[17,171–196]
Last-mile for e-food SC	4	3%	[197–200]
New trends and technologies (reception box, parcel lockers, etc.)	22	18%	[201–222]
Packaging	6	5%	[223–228]

Many configurations of last-mile have been studied, based on different variables as trip duration, costs, number of vehicles, ways, time-windows, city-center restrictions and many others [117–124]. Lim et al. [125] defined three configurations of last-mile logistics: push-centric, in which the vendor is responsible for the delivery function till the customer; pull-centric, in which the customer is responsible for the collection and transportation of the order; and hybrid systems, in which efforts between both parts are required. The study of Bergmann [126] considered the integration of last-mile delivery with the first-mile pick-up with shared vehicles routes, in order to increase operations efficiency (+30%). Steinker [127] studied the impact of weather on e-commerce operations, especially in last-mile activities, finding that including forecasting weather data in planning operations can lead to fewer sales forecast errors. Finally, Allen et al. [111] studied the importance of walking, which can account for 62% of total vehicle round time and 40% of the total round distance.

Most of the works are focused on vehicle routing problems (VRP), i.e., 23% of the total (Table 8). The VRP can be described as the problem of designing the least-cost route for a fleet of vehicles from a specified depot to a set of geographically scattered customers such that each route begins and ends at the depot, each customer is visited only once by exactly one vehicle, all the vehicles have the same capacity, and the total demand serviced by a vehicle must not exceed its capacity. Principal VRP related to e-commerce that arises from the study of literature are reported in Table A1 in the Appendix A. An interesting strategy is to have a different price for home delivery based on a time slot in order to influence customers' choice behavior concerning the offered time slots, such that cost-effective delivery schedules can be expected and profit is maximized [128,129].

Often logistics activities are outsourced to external enterprises, i.e., to third-party logistics providers (3PLs). Logistics activities comprehend transportation, warehousing, inventory management, order processing, information systems and packaging. The choice of the LSPs partner is a diffused issue in the literature [156–160]. The use of 3PLs is influenced by the duration of the relationships, the geographical dispersion of customers and vendors, the type of goods traded and the type of contracts [161]. Nuengphasuk et al. [162] proposed a framework for LSPs' selection based on several factors, i.e., cost, relationship, quality, information and equipment systems, flexibility, delivery, professional, financial position, location, and reputation. Considering an e-retailer that outsources its logistics activities to an LSP, Ponce et al. [163] modeled the choice of the level at which the retailer can enter the supply chain of the 3PLs, i.e., from warehousing to only transportation, considering delivery time and costs.

Logistics Pooling is the common usage of logistics resources (material, human and immaterial) between organizations. Using collaborative transportation among SC is an increasing trend due to the rise in e-commerce [164]. This strategy has been investigated in many works, as in [165–170].

Considering the impact of transport on the environment, the development of e-commerce has greatly increased the volume of last-mile delivery and also caused the increase in pollution and traffic congestion [171,172]. The transportation impacts of e-commerce are presented by Mokhtarian et al. [173], who studied changes in shopping mode, changes in the volumes of products purchased, changes in per capita consumption, and demographic changes, finding that the impact of transports is negative. In fact, e-commerce will not substitute conventional stores, but they will probably continue to expand and co-exist. Not only regulations, but also customers are more susceptible to environmental aspects; the survey of Ignat et al. [174] revealed that displaying environmental and social impacts of last-mile deliveries influence e-commerce customers, and generally makes them more likely to choose more sustainable solutions. Many more studies consider the environmental impact caused by the increasing volumes of last-mile deliveries and returns [175–193]. Brown et al. [194] performed a comprehensive comparison between conventional shopping involving customers pick-up versus e-commerce shopping involving last-mile delivery to customer's home in terms of carbon emissions. Their analysis individuated a break-even number of customers under which last-mile delivery resulted in higher carbon emission than conventional shopping. Lin et al. [195] compared three different configurations of last-mile (hub-and-spoke, Same-Day Delivery (SDD) with a commercial fleet, and SDD with crowdsourcing) not only in terms of time costs, fuel costs but also considering carbon emissions. The work of Giuffrida et al. [196] compared Click and Collect strategy (C&C) with Mobile shopping in store (MSiS), highlighting the weight of logistics activities from an environmental point of view. C&C, used when customers buy online and collect orders to the physical store, resulted more sustainable than MSiS, used when consumers order an item via mobile by scanning its QR code in the retailer's showroom, and the product is delivered at home. The literature review of Mangiaracina et al. [17] analyzed not only transports but also warehousing, packaging and distribution network design as areas that affect sustainability; they carried out major key performance indictors used as "energy use", "gas emissions", "waste generated" and "traffic mileage".

Particular attention is required by the food e-SC. Fikar [197] proposed a decision support system for delivery routing that considered the problem of food losses in e-grocery deliveries. This is needed since in traditional brick and mortar operations customers select products based on quality and expiration date, while in e-groceries this selection is done by the provider, impacting on both food waste and customer satisfaction. Prajapati et al. [198] presented a clustering-based routing model to manage vehicle routing for last-mile operations of fresh food in e-commerce; the principal objective is the time reduction, high quality of service level and response time reduction. The work of Tsang et al. [199] considered parcel shipments with multi-temperature requirements for food e-commerce; their model, called the Internet of Things-based multi-temperature delivery planning system (IoT-MTDPS), considered factors related to fresh food quality and arrival time window. Finally, Beitzen-Heineke et al. [200] studied the effect of a zero-packaging policy in e-commerce food SC, finding that applying this policy can increase resource-efficient behavior in suppliers and consumers due to the reduction in packaging and food waste.

Recently, innovative solutions have been introduced in the last-mile to minimize costs, to improve delivery effectiveness and customer satisfaction and to decrease the environmental impact. These innovative solutions are reception boxes, i.e., boxes installed at customers' house in which parcels are delivered, parcel lockers, i.e., boxes owned by a retailer or a logistic service provider used by different customers, pick-up points, i.e., places that provides storage/delivery services, crowdsourcing logistics, i.e., when last-mile delivery activities are outsourced to a common network of people, drones, i.e., unmanned aerial vehicles in which parcels are loaded, trunk, i.e., parcels are delivered in the trunk of the customers' car, dynamic pricing, i.e., when the price of delivery change based on different time windows [201]. Parcel lockers are an effective solution to the "not-at-home" problem and to speed up deliveries, avoiding address searching [202]; Deutsch et al. [203] presented a model for parcel locker network that maximizes the total profit, also considering the loss of potential customers who are not willing to travel for service. Punakivi et al. [204] compared reception box and parcel lockers with simulation, and the results show that the parcel locker solution was more attractive in terms of cost savings. Anyway, the reception box strategy results in more convenience than home delivery with a two-hour time window [205]. Collection and Delivery Points (CDPs), i.e., pick-up points, are increasing their popularity as a great solution to avoid failure of in-home delivery, complex routing planning and traffic delays, allowing customers to collect and returns products at the same time [206–208]. Comparing parcel lockers and CDPs, delivery through parcel lockers seems to be simpler and more immediate; the service is open 24 h per day, there is no queue and human contact and costs are limited. On the other hand, there are limitations in parcel dimensions and number, in the withdrawal time and drivers training could be needed [209]. Janjevic et al. [210] presented an innovative method of integrating CDPs in the design of the SCN, considering facilities and CDPs' location and routing costs. Recently, Milioti et al. [211] compared home delivery with the pick-up in-store and pick-up from lockers strategies, and the results indicated that home delivery appeared to be clearly preferable to the others, especially in weekly orders. Crowdsourced delivery is a system of employing contractors to carry out deliveries using their own vehicles, going from warehouses, stores, or fulfillment centers to the customer; it is an emerging sharing economy that can be an effective tool to mitigate problems of last-mile logistics [212]. Wang et al. and Huang et al. [213,214] proposed models to configure and plan deliveries with a crowdsourcing strategy. Guo et al. [215] presented a methodological framework to adopt crowdsourcing logistics for last-mile deliveries, considering five basic principles as the small-scale pilot, community-based approach, low added network complexity, low additional investment level and co-functionality. Simoni et al. [216] studied the potential impacts of crowdsourcing delivery on traffic and emissions. The results showed that this strategy had a higher negative impact than corresponding deliveries by public transit, however, limiting the deviations and providing adequate packing options could significantly improve its impact.

Automated technologies in last-mile delivery represent an opportunity to develop more efficient systems characterized by the integration of different and complementary modes; two interesting possibilities are the truck-robot systems [217] and the truck-drone systems [218,219]. Robots are characterized by much slower speeds and can perform several consecutive deliveries compare to drones; on the other hand, drones may need additional licenses for the use of airspace. Based on these features, soon, robots seem to be more suitable for deliveries of low-value items in dense urban environments whereas drones could be more appropriate for high-value items in remote or rural areas [220]. Another interesting solution to avoid traffic, decrease transportation costs, and reduce carbon emissions is the use of cargo bikes and delivery points [221]. Finally Kapser et al. [222] studied the users' acceptance of automated delivery vehicles (ADV) as a new technology for last-mile distribution. They find that price sensitivity was the strongest predictor of behavioral intention, followed by performance expectancy, hedonic motivation, perceived risk and social influence.

Another important aspect of parcel delivery is packaging optimization. Packaging is present across the different shopping channels, and it can be considered an opportunity to see the pack as a tool to integrate the customer experience across shopping channels, using new technologies and design [223]. Ahire et al. [224] developed a process to optimize the mix of carton size of a big distribution center, aiming to reduce shipping, material and labor costs. Also Singh et al. [225] presented a model for carton mix optimization, applied to international LSPs. Freichel et al. [226] investigated trends of packaging in OC, identifying three main areas: OC packaging design (protecting goods, customers satisfaction, sustainable solutions); packaging in the logistics process (efficient distribution, ship-from-store solutions); and packaging as an integrator between channels (universal packaging, integration of materials and information). Yang et al. [227] proposed a machine learning approach to optimize shipping box design. Finally, it is important to consider aspects related to sustainability in packaging, particularly focusing on its growing expansion due to e-commerce, on the widespread phenomenon of overpackaging and on the use of non-renewable materials as plastics. Escursell et al. [228] examined new trends in sustainable packaging as the use of natural biopolymer as cellulose, the introduction of effective guidelines and policies to avoid overpacking, and the promotion of circular packaging.

From the discussion of this research area, key elements related to OL implementation and different strategies arise. Regarding the key elements, it is important to consider the last mile configuration, the not-at-home problem, the environmental impact, the route optimization, the outsourcing aspect and, finally, the packaging. Once these previous elements are defined, the most suited strategy can be proposed. Table 9 summarizes the principal key elements and related strategies for OL in the e-commerce context.

Table 9. Key Elements and strategies for OL.

Key Elements of OL	Strategies
Last-mile configuration	Pull-centric, push centric, or hybrid
Not at home Problem	Parcel lockers, CDPs, etc.
Environmental impact	Electric vehicles, bikes, drones, logistics pooling, etc.
Route optimization	VRP models
Outsourcing	3PLs classification
Packaging	Shipping box optimization models

3.3. Reverse Logistics (RL)

Reverse logistics (RL) is defined as the goods returned from the consumer back to the seller or manufacturer; returned products may be resold or disposed of permanently [229]. As reported in Garcia [230] at least 30% of e-commerce sales are returned, against the 9% of physical stores. In online sales, goods that are delivered may look different from pictures/descriptions and, consequently, they tend to have a much higher return rate than brick-and-mortar sales [231]. Moreover, RL has become a managerial priority due to the value involved and the potential impact on customer relations. In fact, many firms adopt a liberal returns strategy to keep customer satisfaction high, and others focus on returns management due to environmental regulations, requiring retrieval or recycling [232]. In this section, RL in e-commerce is presented and its main aspects are treated, as RL strategies, its influence on SCND, customer satisfaction, RL outsourcing, returned products policies and sustainable RL (Table 10).

Table 10. Reverse Logistics research area analysis.

Subject	N° of Papers	%	References
RL processes and strategies	19	50%	[229–247]
SCN Re-Design	12	32%	[248–259]
RL outsourcing	2	5%	[260,261]
Sustainable RL	5	13%	[262–266]

RL processes include authorization of returns, transportation, acceptance of returned products, product disposition and information management. Product returns processes are generally complicated, inefficient, and lacking in sustainability; they can be a cause of losses to the business, especially if returns data are not systematically collected, monitored, or reported to management [233]. RL strategies aim to increase RL processes' efficiency and have a key role in the e-commerce business, as they deeply influence customers' purchase decisions [234]. The study of Stock et al. [235] assessed that product returns processing can result in returns in profitability and competitive advantage through cost reduction, higher product recovery rates, and higher customer service levels. Skinner et al. and De Koster et al. [232,236] individuated five main policies for returned products disposition, i.e., destroying, recycling (resell at a lower value), refurbishing (repair and resell as used), remanufacturing (repair and resell as new) and repackaging (sell as new) Each policy had different impacts on economic performance, operational responsiveness and operational service quality. In order to support reverse logistics operations, such as defining the value and the need of reconditioning of products, many frameworks and matrixes have been carried out [237–243], which are different from others for the market context and the variables included (for example customer perception and environmental impact). The work of Ramanathan [244] analyzed the relationship between the performance of companies in handling product returns and customer loyalty; it revealed that handling product returns played an important role in shaping customer loyalty for low-risk products and also for high-risk products, although not for products with a medium level of risk. Also the study of Griffis et al. [245] analyzed the relationship between a customer's experience of product returns, considering employing transaction cost and consumer risk. Their results show that the returns management process can significantly and positively influence repurchase behavior. Rao et al. [246] focused on the reasons that could make a purchase more return-prone, as the perceptions of scarcity conditions in inventory availability and the reliability in deliveries of customers' orders. Geethan et al. [247] developed a performance evaluation analytic for reverse logistics methodology to facilitate decision making from the perspective of an enterprise engaged in RL, and carried out some performance metrics that can be employed to be successful in returns handling, as gatekeeping, customer satisfaction and lifecycle stage.

After defining the processes and strategies of RL, *SCN re-design* should be considered. Many models have considered re-designing the SC in order to efficiently manage the RL process [248–256]. Lin et al. [257] proposed a decision model for an RL service provider under the context of uncertain, multi-period, multi-type returned/recycled products and multiple processing facilities environments that aimed to determine the optimal quantities of customer orders and optimal processing quantities of returned products for each facility. Niknejad et al. [258] proposed a model to solve the inventory control and production planning problem of an integrated RL network, which consists of a traditional forward production route, two alternative recovery routes, including repair and remanufacturing, and a disposal route. Batarfi et al. [259] studied a supply chain system composed of production, refurbishing, collection, and waste disposal processes. They compared two selling strategies applied to the system, a single-channel strategy, and a dual-channel strategy, and findings demonstrated that in both strategies, the more generous the return policy is, the higher the demand, the selling prices, and the overall profit. Moreover, findings also indicate that adopting a dual-channel strategy is more profitable.

An important decision is related to outsourcing RL processes, as it is a relevant part of logistics costs. Serrato et al. [260] developed a Markov decision model to help a firm to decide whether to follow an outsourcing strategy for its RL activities or not, considering the length of the product life cycle and the variability in the rate of returns between consecutive periods. Results showed that the higher the variability in return volumes is, the more the convenience in outsourcing RL. The work of Agarwal et al. [261] proposed a Multi Criteria Decision Making (MCDM) model for evaluating and selecting the best 3PL for Reverse Logistics using the fuzzy technique for order preference by similarity to ideal solution.

Finally, government regulations, customers' behavior and corporate image have posed more attention to sustainable aspects of RL. Focusing on green SC management and RL, ad hoc models have been developed for network design [262–264]. Chen et al. [265], inspired by the concept of crowdsourcing, proposed an innovative solution to collect the e-commerce returned goods from final consumption points back to retailers, i.e., using taxis in an integrated way. His solution can simultaneously migrate the negative economic, environmental and social impacts of RL. Aćimović et al. [266] proposed a survey-based study, which encompassed a sample size of 228 participants and final consumers, and results indicate that the influence of RL on green SC competitiveness is dependent on the product return option and is mainly negative with Serbian consumers, since the perceived quality is lower compared to new products.

From the discussion of this research area, key elements that should be considered in RL and consequent strategies arise. RL strategy is influenced by logistics costs, management costs and re-working costs; moreover, the level of outsourcing, the customer experience and sustainable aspects need to be considered as key elements for RL strategy definition. Table 11 summarizes the key elements and strategies of RL.

Table 11. Reverse Logistics research area analysis.

Key Elements of RL	Strategies
Logistics costs	Destroying
Management costs	Recycling
Re-working costs	Refurbishing
Customer experience	Remanufacturing
Outsourcing	Repacking
Sustainable aspects	

3.4. Warehousing (WR)

Warehousing, defined as the intermediate storage of goods between two successive stages of a supply chain, and its basic functions like receiving, storage, order picking, and shipping, are essential components in any supply chain [5]. After network design, forward and reverse logistic definition, the next step is determining the design and management of warehouses. Nowadays, warehouses are not only centers for storage but also centers for value-added activities, like assembly of orders, packing, and repair operations. Warehouse design and management have a key role in improving the efficiency of operations, reducing employee fatigue, and improving customers' service levels [267]. The ever-increasing sales volumes of e-commerce gave rise to a new generation of warehouses, which must face the special needs of online customers, and, consequently, new features as small orders, large assortment, tight delivery schedules, and varying workload. E-commerce warehouses, also called Internet Fulfilment warehouses (IF-warehouses) have different characteristics compared to traditional distribution centers [268]. They are characterized by a higher number of stock locations (200 times more), of items stocked (15 times more), of order per day (10 times more) and inventory data records (2000 times more). Eriksson et al. [269] compared traditional DCs to Online Fulfillment Centers (OFCs), focusing on similarities, such as full assortment and different temperature zones needed, and differences, as home delivery, next-day delivery, many orders with few items.

From the literature analysis, 57 papers discuss e-commerce warehousing (Table 12).

Order picking is the most labor-intensive and costly activity for almost every warehouse, as it covers 51% of the total warehouses' costs [270,271]. Order picking strategies comprehend layout design, storage assignment and routing methods, order batching and zoning. The work of Dallari et al. [272] presented a classification of order picking systems in general and individuated five picking strategies: picker-to-parts; pick-to-box; pick-and-sort; parts-to-picker; and automated picking. Each strategy depends on the context variables as items variability and volumes, orders per day, stock locations; moreover, channels that would be served should be considered (traditional warehouse, F-warehouse or hybrid one). To reduce order picking time two main aspects should be considered, i.e., the storage assignment and the picking activity optimization, that comprehends the policy, the routing, the order batching and sorting activities. Many works present models and methods for storage assignment optimization [268,273–278]. IF-warehouses are often characterized by an explosive storage policy, i.e., all items are dispersed to bins throughout the warehouse after their arrival, to reduce picking travel time [279,280].

Table 12. Warehousing research area analysis.

Subject	N° of Papers	%	References
Order picking strategies	29	51%	[267–270,272–296]
Level of automation	23	40%	[5,271,297–317]
Warehouse performance	5	9%	[18,318–321]

Concerning picking optimization, e-commerce companies often use manual order-picking systems, since they can provide the required flexibility and scalability [281]. Many manual order picking systems have been studied and applied to IF-warehouses [282]. Order batch picking is one of the most common and effective strategies [283–285]. Moreover, pick-and-pass systems are commonly used in IF-warehouses; their configuration is composed of a picking line divided into picking zones and each zone is assigned to a picker, connected by a conveyor. Pan et al. [286] presented an analytical model to study the pick-and-pass system (picking line) and also considered the storage assignment; they evaluated three different configurations and carried out principal influential parameters that are the starting position, the picking policy and the storage assignment strategy. Then, Pan et al. [287] proposed an order batch picking approach applied to a pick-and-pass system, based on a group genetic algorithm to balance the workload of each picking zone and minimize the number of batches. The work of Schrotenboer et al. [288] incorporated the restocking of returned products in order of picking routes; they presented a hybrid genetic algorithm to determine routes for the simultaneous pickup of products to be delivered and the place of returned items to storage locations. Another interesting picking strategy is the local return strategy, in which the pickers' routes can be adjusted during its execution with the addition of new items that are near to the ones of the existing list, i.e., in a local area near the picker. Guo et al. [289] analyzed through simulations the local return strategy and conclude that this strategy can improve system performance by reducing the average throughput time, although it is influenced both by the storage strategy and the size of the return area. A similar strategy is proposed by van der Gaast et al. [290], with a "Milk run order picking system"; in this system, pickers can pick orders in real-time during the picking process, as soon as they arrive. In their simulation model they compared the batch picking strategy showing that it can reduce the order throughput time significantly. Liang et al. [291] proposed a mixed-integer mathematical model to study the wave-picking strategy, an effective policy in which item-batching, loading assignment, and picker routing problems are considered simultaneously. In this system, groups of orders (waves) placed by customers arrive simultaneously, waiting to be picked. Finally, Dąbrowska et al. [292] presented a model of the picking process in the e-commerce industry to evaluate the route selection algorithms using the time criterion, the number of collisions occurring on the routes and the average distance between picking points. In order to accelerate the whole order fulfillment process, orders should be picked and delivered to customers in a very short time; with this goal, both warehouse and distribution operations have to be performed in an efficient and effective way, consequently, they should be considered simultaneously. Zhang et al. [293] proposed an integrated online order batching and distribution scheduling problem with fixed delivery departure time, in which the maximal number of orders had to be completed before vehicles departure time. Also the work of Moons et al. [294] considered the integration of the order picking route with the delivery problem, proposing a record-to-record travel algorithm to solve the integrated order picking and vehicle routing problem. Batch picking, zone picking, and pick-to-box policies require an additional activity, i.e., the sorting of all items to make the final order. Kong et al. [295] presented a model to balance picking simultaneity and sorting punctuality. Here, the picking of several orders were carried out by different pickers in different zones in the same wave, and then they finished at the same time window in the sorting process. A particular warehouse configuration is the Cellular warehousing (CW) system, which is composed of multiple cells (like single warehouses), each one responsible for dealing with certain order items with strong similarities, and a consolidation cell that is set up for orders that need several warehousing cells fulfilling together [296].

Generally, IF-warehouses are more suited to automated solutions than traditional ones. The level of automation can be total or gradual as it can be applied to the whole process or to a part of it (i.e., stocking, picking and sorting activities). Custodio et al. [297] classified automated technologies in automated storage, robotic and transportation systems, which have the common goals of reducing picking time, controlling the inventory level in real-time, and estimating material position for faster decision-making. Some works present models about automated storage/retrieval systems (AS/RSs) for e-commerce warehouses, as they not only reduce labor costs but also increase safety and efficiency [298–300]. Another common technology used in automated storage is the shuttle-based storage and retrieval system (SBS/RS); main benefits of these systems compared to the previous ones are the possibility of subsequent expansion if needed, optimization of the space due to the minimal overrun dimensions and high throughput performance [301]. The works of Wang et al., Lerher et al., Tappia et al., Wang et al., and Zhang et al. [302–306] presented and discussed a model for SBS/RSs application. Azadeh et al. [307] analyzed the performance of autonomous vehicle-based storage and retrieval system comparing horizontal systems (i.e., shuttle based systems) and the vertical ones (i.e., OPEX systems). They assessed that with one load/unload point, vertical systems produce a similar or higher throughput with a lower operating cost. Bozer et al. [271] compared two automated systems for order picking as AS/RS with aisles for picking and Kiva system, that is a system in which items are stocked in racks and carried to pick stations (parts-to-picker) by an automated guided vehicle. Their results found two equivalent configurations, i.e., with the same throughput. AS/RSs can bring high efficiency although they may be limited in flexibility when it comes to dealing with order disparities in size, shape, weight, volume, and mechanical properties. Another interesting technology is represented by robotics, which promises to strike a balance between efficiency, scalability and flexibility. Recent industrial developments use mobile robots to achieve robotic picking methods including parts-to-picker, parts-to-robot, robot-to-parts solutions [308]. Bogue et al. [309] presented and summarized some of the principal warehouse robots, such as the freight robot, the Fetch robot, the Robo-Stow, the LocusBot, and described their applications. Many other works presented models for scheduling robotic solutions in order picking with different applications and technologies to the ones of [310–316]. Boysen et al. [5] analyzed different warehousing systems suitable for e-commerce, i.e., mixed-shelves storage, batching, zoning and sorting, dynamic order picking, AGV-assisted picking, shelf-moving robots and advanced picking workstations, with an increasing automation level, respectively. Recent studies are focused on pickers' activities, since IF-warehouses are more subject to body fatigue, feelings of monotony, dissatisfaction, and demotivation. Ponis et al. [317] analyzed the behavior of pickers in introducing augmented reality (AR) in the picking process to support them in the execution of their tasks and for increasing their motivation, with positive results.

IF-Warehouse performance can be evaluated with various parameters. Onal et al. [318] individuated as key parameters of the order fulfillment time, the storage utilization, the picker utilization rate, and the transient inventory level. Focusing on pickers' performance, Zeng et al. [319] evaluated four main aspects as working quantity, working accuracy, working timeliness, and working normalization.

Based on the previous considerations, three categories of factors should be considered for warehousing design [320,321]: external factors (as customer requirements, product and order characteristics and volumes), internal corporate factors (as the warehouse role, major suppliers and last-mile strategy) and internal warehousing factors (as storage assignment strategy, picking strategy and level of automation). Focusing on internal factors, other variables that should be considered related to automated systems are Jaghbeer et al. [18]: the throughput; the operational efficiency; the lead time; human factors and costs.

From the discussion of this research area, different key elements arise regarding warehousing, such as products characteristics, customer requirements, volumes, and suppliers.

Their consideration is important when considering them in choosing warehousing strategies, like the picking policy, the level of automation and the storage strategy. Finally, performance indicators that could be used to analyze the efficiency of the warehouses are Throughput per time, Operational efficiency, Lead time, warehousing costs. Key elements, strategies and key performance indicators are summarized in Table 13.

Table 13. Key elements, strategies, and performance indicators of e-commerce warehousing.

Key Elements of Warehousing	Strategies	Performance Indicators
Customer requirements	Picking strategy	Throughput per time
Product characteristics	Level of automation	Operational efficiency
Order characteristics	Storage strategy	Lead Time
Volumes		Warehousing costs
Suppliers		Picking time
Last-mile strategy		Human factors

3.5. E-Commerce IT and Data Management

E-commerce IT and Data management (E-IT) offer businesses increased competition, lower prices of goods and services, the choice of comparing products from different vendors, and easy access to various vendors anywhere and anytime [322]. The growth of e-commerce has required logistics organizations to improve the flow of information both internally and externally, i.e., the integration of logistics information systems (LIS) and supply chain information systems [323]. Regardless, implementing IT can meet several barriers in a company, related to internet security concerns, loss of information sharing and legal legitimacy issues [324]. White [322] individuated several barriers to IT implementation, especially for SMEs, as the company size, lack of technical, human, and financial resources, organizational culture, lack of infrastructural facilities, lack of knowledge of IT solutions and how they work, and managers' perception of security and reliability. We identify two main issues related to e-commerce IT and data management, i.e., IT technologies which can be used and consumer information data management (23%), as described in Table 14.

Table 14. E-commerce IT and data management research area analysis.

Subject	N° of Papers	%	References
Information and communication technologies (ICT)	17	77%	[322–337]
Consumer information	5	23%	[338–342]

Information and communication technologies (ICT) allow the dissemination of information among the various parties in the e-supply chain. They comprehend software, hardware, telecommunication and information systems and applications useful to produce, analyze, process, package, distribute and store [325]. The proper use of ICT enables faster execution of tasks, accelerates data preparation, increases the reaction speed to market needs, automates information processing, supports decision-making processes, and improves the quality of customer service [326]. From the point of view of LSPs, four main IT systems are used, as SC software, like ERP systems, web, and mobile applications, i.e., platforms with related members of the chain, RFID, for monitoring materials movements, and emerging digital tools, i.e., solutions for real-time operations and workforce engagement [327]. Many works study ICT application in the e-commerce context [323,328–330]. Kembro et al. [331] studied trends, implications, and challenges of ICT for omni channel systems, individuating five main ICT for logistics management as ERP, Warehouse Management Systems (WMS), Warehouse Control Systems (WCS), Warehouse Execution Systems (WES) and Distributed Order Management Systems (DOMS). They stated that the use of DOMS, WCS and WES would increase to cover extended network and to allow more automation, while isolated WMS will need real-time updates and synchronization systems to meet customer demand. The main drivers for WMS improvements are shorter lead times, the increased need to sort multiple incoming and outcoming flows, a higher degree of automation and the need for real-time inventory management. Wanganoo et al. [332] studied IT for last-mile deliveries, dealing with the growing use of Global Positioning Systems (GPS) for location tracking, Transport Management Systems (TMS) for optimizing the process of planning transport activities, and Internet of Things (IoT) systems, that allow LSPs to optimize customer service, and optimized their network. Information sharing through SC is fundamental in the e-commerce environment [333–335]. Ahmad et al. [336] developed a database management system that would be centrally visualized by the partners of the SC. Gružauskas et al. [337] focused on a collaborative technological strategy that promoted information sharing to improve forecasting accuracy and inventory control for better alignment of demand and supply. They studied the influence of information sharing on forecasting accuracy in different market sizes, demonstrating that information sharing increased the forecasting accuracy in multiple scenarios. Moreover, consumer integration was beneficial in a perfect competition market, while its positive effect was less significant in an oligopoly market.

Consumer information management and analysis are essential to process in e-commerce business [338,339]. Enterprises can identify consumer preferences and coordinate new product development through consumer information analysis [340]. Customer data warehouse and mining are able to provide the structure of recording of the whole of customers' information, the flow of detecting the important customers systematically, the change of identifying the individual and valuable customers in the whole name list of customers or discovering the loyal customers. Chang et al. [341] developed a model that use data warehouse and data mining technologies to analyze the customers' behavior, aiming to create the right customers' profile and make more effective marketing strategies. Finally, the work of Hurtado et al. [342], with the idea of using consumer behavior data to perform predictive analysis, proposed a novel conceptual model embracing the anticipation of e-commerce's demand based on the data collected by digital marketing, enabling predictive planning for the distribution of products.

From the discussion, many ICTs turn out to be useful tools for e-commerce. Table 15 summarizes principal ICTs like SC software, web and mobile applications, traceability systems and digital tools, with some examples.

Table 15. Useful ICTs for e-commerce.

ICT	Example
SC software	ERP, WMS, WCS, WES, DOM, TMS
Web and Mobile application	e-commerce platform
Traceability systems	RFID, GPS
Digital tools	e-commerce transactions

4. Framework

After the discussion about the main logistics research areas related to e-commerce implementation, Figure 3 presents a methodological framework that summarizes the principal key factors and the variables that should be considered. The framework is divided into four sequential steps that are, respectively, SCND, OL and RL, WR and E-IT. Each step is composed by "Input key elements", that should be considered in the analysis, and "Output key elements" as results of the step, that influence the subsequent ones. Each step refers to the previous analyses of each area.

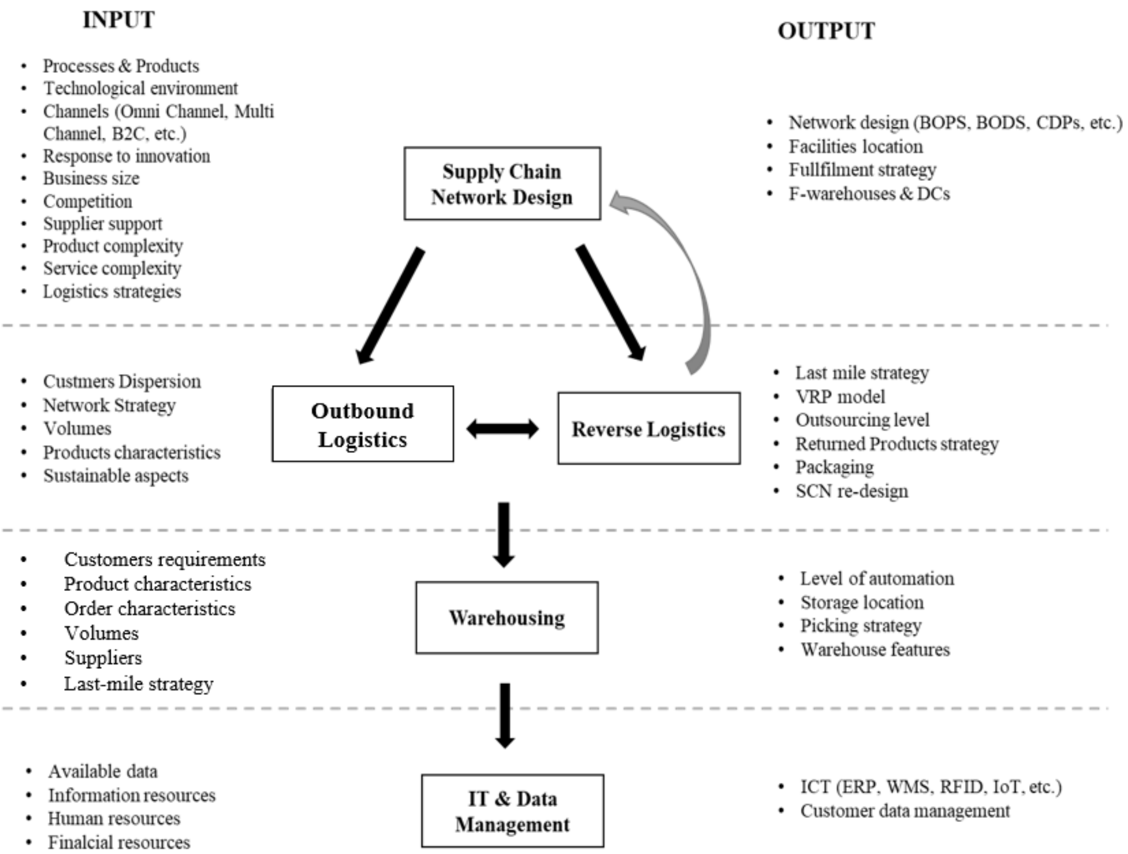

Figure 3. Methodological framework for e-commerce implementation.

The first one regards the SCND and its development: the definition of the channels; the characteristics of the product; the service complexity; the business size; the market response should be deeply analyzed to carry out the network design, the facilities location, the definition of F-warehouses and DCs features and the fulfilment strategy. Then, logistics aspects are considered; starting from customers' dispersion, volumes, product characteristics and sustainable aspects it is developed, the last-mile strategy, the VRP model, the level of outsourcing, the packaging optimization, the reverse logistics strategy and, if necessary, the re-design of the network. At this point, warehousing is considered, in order to define the warehouse features (not the location, that is defined in the SCND), the level of automation, the picking strategy and the storage level and location, based on the previous steps. Finally, IT and data management aspects are analyzed to individuate the necessary software to support the supply chain and the customers management.

5. Conclusions

This works aims to answer to two relevant RQs. Firstly, which are the main logistics research areas related to e-commerce implementation (RQ. 1). Secondly, which influencing factors and key performance indicators should be considered for each logistics research area in e-commerce implementation (RQ. 2). For doing this, a structured overview of the existing knowledge about e-commerce implementation, barriers, drivers, models, and methodologies has been developed.

5.1. Main Insights

The analysis of the literature highlighted five main logistics research areas for e-commerce implementation: supply chain network design; outbound logistics; reverse logistics; warehousing; and IT systems and data management (RQ. 1). For each area, key factors, strategies and performance indicators have been identified. After a structured discussion, a new methodological framework has been presented to answer RQ. 2. The framework summarizes the main steps for e-commerce implementation and, for each step, the main key factors that should be considered are presented as Input together with the main output key elements.

The framework is a useful support for managers in implementing e-commerce, to collocate their business based on input variables, and to define output based on this. Many works are focused on one research area, carrying out critical factors, models, and methods to implement that topic. The methodological framework here presented, instead, summarized all research areas from a logistic point of view, identifying for each one input and output variables and how they influence each other.

5.2. Limitations and Future Research Agenda

This analysis is limited to the logistics research area; it could be interesting to extend it to other research areas and to compare the results. New key performance indicators, best practices, and strategies can be carried out. Moreover, it could be interesting to consider customers' perspectives, i.e., how customers' satisfaction influences e-commerce projects.

Finally, based on the qualitative and quantitative analysis provided in the study, four areas that deserve the attention of further research and to build the future research agenda for e-commerce implementation from a logistics point of view have been identified:

(1) In the first three logistics research areas, i.e., SCND, OL and RL, sustainability plays an increasingly important role. Starting from SCND, environmental impacts should be considered in determining facilities positions and strategic policies. Anyway, few works consider sustainable aspects and related savings in their models and framework; legislation and local funds about environmental impact might have an economic impact and influence the SCND so that they should be further investigated. With the focus on OL and RL, new technologies for the last mile, packaging configurations and materials, and RL policies have a great impact on environmental aspects. Many works are focused on the samehome delivery problem, or on the not-at-home one, investigating at first the economic aspect. Few works are focused on the determination of the environmental saving in terms of CO_2 emissions [343]; however, this aspect should also be deeply investigated;

(2) Another important issue that arises from the analysis is the importance of warehousing configuration. Many models, solutions, and strategies are investigated and sometimes compared to each other. Regardless, there is a lack of a comprehensive framework that should support management in warehousing configuration, focusing not only on the level of automation, picking strategy, and storage policy singularly, based not only on product and order characteristics and also on OL and RL strategies and costs;

(3) Another important aspect of warehousing that needs to be further investigated is the impact of human factors and of the ageing workforce on warehousing performance. As arose from the literature, manual order picking is deeply diffused in IF-warehouses, due to its high flexibility. Since this strategy is deeply influenced by human performance, human factors and the ageing workforce should be further investigated in determining the performance of these systems;

(4) Finally, as shown during the recent COVID-19 emergency, the importance of disruptions, cost, and proactive and/or preventative strategies in SCND emerges. In fact, preventative and proactive strategies might decrease the impact of a disruption in terms of costs in the SC [344].

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Appendix A

Table A1. Main Delivery and Vehicle Routing problems in the e-commerce logistics (based on our survey).

Problem	Definition	Description	Cit.
DVRP	Dynamic VRP	allows new orders to be received as the working day progress	[130,131]
DVRSP	Dynamic VRSP vehicle routing and scheduling problem	Considers both routing and scheduling problem	[132,133]
TSMP	Time slot management problem	given service requirements and average weekly demands for each zip code in the delivery region, the problem is to define the set of time slots to offer in each zip code to minimize expected delivery costs while meeting service requirements	[134,135]
LS-MPT-HFFVRSPTW	Load specific of multiple products types within heterogeneous fixed fleet vehicle routing and scheduling problem with time windows	considers multiple types of products and vehicles, transport conditions, and time windows.	[136]
VRPMTW	vehicle routing problem with multiple trips and time windows	which is different from VRP as it considers multiple trips starting from the depot during a scheduling period and each customer must be served in a given interval time	[137–139]
CVRPOAT	capacitated vehicle routing problem with order available time	takes all the assumptions of CVRP, except the order available time, which is determined by the precedent order picking and packing stage in the warehouse of the online grocer	[140]
VRPTW and pallet loading constrains	vehicle routing problem with time windows and pallet loading constrains	Considers both loading and scheduling problem	[141,144,324]
OCVRP	VRP in omni channel	considers a group of retail stores served from a distribution center using a fleet of vehicles and, in addition, products are distributed to consumers from some of these retail stores based on product availability at inventory and using the same fleet of vehicles	[145,146]
I-OP-VRP	integrated order picking-vehicle routing problem	picking lists and vehicle routes are determined simultaneously; moreover, it considers the additional cost of allowing customers to choose a preferred delivery time window using the integrated order picking-vehicle routing problem.	[147]

Table A1. *Cont.*

Problem	Definition	Description	Cit.
I-OP-DPMC	integrated order picking and delivery problem with multiple delivery zones and limited vehicle capacity	This problem considers order picking problem integrated with vehicle routing poblem, divided in different delivery zones with limited capacity of vehicles	[148]
CLS-STW	city logistics sync with sliding time window	a special type of time window, of which only the window size is defined	[149]
PDPTW	pickup and delivery problem with time windows	Vehicle routing problem, in which vehicles carry out simultaneously different routes from multiple collection point (depot) and multiple final customers (for B2C and O2O joint distribution networks)	[150–153]
MVRPSPDTW	vehicle routing problem with simultaneous pickup and delivery with time windows from multiple depots	Vehicle routing problem, in which vehicles carry out simultaneously different routes from multiple collection point (depot) and multiple final customers wwith time window	[154]
RECL	Rural e-commerce logistics problem	characterized by a long transport chain and low consumption density	[155]

Table A2. Acronymous.

Acronymous	Definition	Acronymous	Definition
3PL	Third-Party Logistics	G2B	Government To Business
B2A	Business To Administration	G2C	Government To Consumer
B2B	Business To Business	G2G	Government To Government
B2C	Business To Consumer	IoT	Internet Of Things
BODS	Buy Online, Deliver From Store	LSPs	Logistics Service Providers
BOPIS	Buy Online, Pick Up In-Store	MSiS	Mobile Shopping In Store
BOPS	Buy Online, Pick Up In-Store	O2O	Online To Offline
BORIS	Buy Online, Return In-Store Strategy	QR	Quick Response
BOSFS	Buy Online, Ship From The Store	RFID	Radio Frequency Identification
BOSS	Buy Online, Ship From The Store	SC	Supply Chain
BOSTS	Buy Online, Ship To Store	SCM	Supply Chain Management
BOUPS	Buy Online, Pick Up In-Store	SCND	Supply Chain Network Design
C&C	Click and Collect	SDD	Same Day Delivery
C2A	Consumer To Administration	SME	Small And Medium-Sized Enterprise
C2C	Consumer To Consumer	STS	Ship To Store
C2G	Consumer To Government	TMS	Transport Management System
CDP	Collection And Delivery Point	WCS	Warehouse Control System
DC	Distribution Center	WES	Warehouse Execution Systems
DOMS	Distributed Order Management Systems	WMS	Warehouse Management System

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