

Article

Reverse Logistics and Urban Logistics: Making a Link

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Abstract: This work is aimed at analyzing potential links between reverse logistics and urban logistics and describing opportunities for collaboration between both areas of research. A description of the current state-of-the-art is provided in order to highlight the main challenges faced by both disciplines. For example, regarding reverse logistics, new recovery options, marketing strategies for recovered products, and legislation issues on the return of products in specific contexts; in regards to urban logistics, long-term planning, stakeholders' engagement, information management, efficiency, reliability and safety, and new business models are some of such key challenges. Despite the growing interest shown in both logistics areas and their relevance for companies and consumers, reverse logistics and urban logistics are two concepts that are still somewhat unknown and, above all, treated as being relatively separated. However, there exist some aspects where the two disciplines converge and that may represent opportunities for collaboration, for example, the proper treatment and management of urban waste, and the efficient management of commercial refunds and returns. In addition, other key issues, such as land use, city typology, infrastructures, and stakeholders' engagement should be further analyzed in order to keep advancing in the description of links between both areas.

Keywords: reverse logistics; urban logistics; waste management; commercial returns

1. Introduction

Reverse logistics (RL) is focused on the recovery of products once they are no longer desired (end-of-use products; for example, computers or mobile phones) or can no longer be used (end-of-life products; i.e., tires, and packaging) in order to obtain an economic return through reuse, recycling, or remanufacturing [1]. In recent years, RL has attracted the interest of academia and companies [2–6]. According to Wang et al. [7] (p. 666), “Reverse Logistics is a critical part of Supply Chain Management, and its scope has broadened significantly since its early introduction”. In a similar vein, Huscroft et al. [8], Guide and Van Wassenhove [9], and Hazen [10] consider that this increase in researcher and practitioner focus reinforces the emergence of reverse logistics as a key strategic capability for any organization within the supply chain. From an academic perspective, the growing interest in reverse logistics can be seen from the upward trend in the number of articles, monographs, and books published on this subject [4,11]. In this sense, Swanson et al. [12] analyzed 492 papers published in the period 1991–2015 in the field of supply chain management (SCM) to explore the evolution of this discipline by topic. They analyzed how topics have evolved over time, and which topics may be particularly promising for future research. That research categorizes reverse logistics as

a rapidly growing topic that reflects more recent issues and problems that researchers and practitioners are facing. Similarly, from a business perspective it should be noted that increasing the number of companies in all productive sectors are incorporating reverse logistics practices into their regular activity [2]. Just to mention a few data about commercial returns, according to Reverse Logistics Association [13] and based on the present growth rate for returns, by 2027 customers will return nearly \$1 trillion in merchandise annually. At the current rate of returns, it is estimated that e-commerce returns will be twice the \$336 billion in brick-and-mortar returns, representing \$634 billion by 2023. In short, RL can be considered as a relevant topic of research for academics in the field of SCM, and a challenging business area for companies and professionals, in such a way that SCM cannot be analyzed without considering the return flows described in the field of reverse logistics [9]. However, although a wide range of logistical problems and challenges has been addressed through the field of reverse logistics, to date urban logistics, as such, has not been one of them [14].

Transportation and delivery of goods constitutes a vital component for most economic and social activities taking place in urban areas [15,16]. Urban freight transport is not only essential for economic growth but also for a better urban environment. Due to globalization, e-commerce, and population and employment growth, freight volumes are increasing [17]. However, freight in cities is unpopular because of its negative impact on citizens, namely congestion, emissions, safety, and noise [16]. Similarly, ALICE/ERTRAC [18] consider urban freight transport as a very important component of traffic in cities, which significantly contributes to both noise and atmospheric pollution. Actually, road freight transport is a major generator of emissions including carbon dioxide (CO₂), particulate matter up to 10 micrometers in size (PM₁₀), and mono-nitrogen oxide (NO_x). In Europe, freight transport accounts for 25% of greenhouse gases and 50% of PM₁₀ from urban traffic [19], so although freight transport is a major enabling factor of urban economy, it also makes an important contribution to emissions, congestion, noise, and safety in city centers. Therefore, it seems necessary a more efficient and sustainable management of all the movements associated with the distribution of goods in cities [18]. Urban logistics (UL) is about finding effective and efficient ways to transport goods in urban areas while taking into account the negative effects on congestion, safety, and environment [20], so UL can contribute to making urban areas more productive and attractive [21]. Despite that some common issues can be observed within these two areas (for example, those related to managing solid urban waste and the design of networks for its collection, treatment, and disposal), to the best of our knowledge, there is no detailed analysis on this regard, in spite of some previous research that already highlighted the relevance of RL in urban contexts:

“Urban goods transport is defined as the delivery of consumer goods (not only by retail, but also by other sectors such as manufacturing) in city and suburban areas, including the reverse flows of used goods in terms of clean waste” [22] (p. 7).

“Of course, a city logistics system would also address the reverse movements, from origins within the city to destinations outside, as well as movements among origins and destinations within the city. Currently, however, only inbound distribution activities are generally addressed, following the imbalance between entering and exiting flows that characterize most cities” [15] (p. 5).

“RL is another trend in the relation between freight and urban citizens. Particularly, the RL of waste management linked to the reuse, recycling and disposal of products for citizens’ homes” [16] (p. 116).

For this reason, the main objective of this work is to describe and analyze potential links between reverse logistics and urban logistics in order to identify opportunities for collaboration between these two disciplines. By taking advantage of the knowledge previously generated in both areas, this research is aimed at identifying new challenges that can be jointly faced in the future.

After this introduction, a background on reverse logistics and urban logistics is provided in order to highlight the main characteristics of recent contributions on this regard. Then, a description of several opportunities for collaboration between both areas are explored, with the aim of providing insights for further research. Finally, some conclusions and further research will be discussed.

2. Background

In order to describe potential links between UL and RL, the methodological approach depicted at Figure 1 was conducted. First of all, a document searching process was carried out in January 2019. As usual in this sort of procedures, several databases were utilized: Web of Science (www.webofscience.com), Scopus (www.scopus.com), and Google Scholar (<https://scholar.google.es/>). As options of searching, documents articles, book chapters, reviews, and books were employed, all of them in the English language. The terms “Reverse Logistics” and “Urban Logistics” were used in the title, abstract, and keywords to carry out the document search. In order to double check that all the aforementioned type of documents published on these topics have been found, several synonyms for both terms were included in the searching process. Thus, “reverse flows”, “closed loop supply chain”, “product recovery”, and “commercial returns” were considered as a synonym for “reverse logistics” [2,4,23]. On the other hand, “city logistics”, “last mile delivery”, “urban freight”, and “urban delivery” were used as a synonym for “urban logistics” [24].

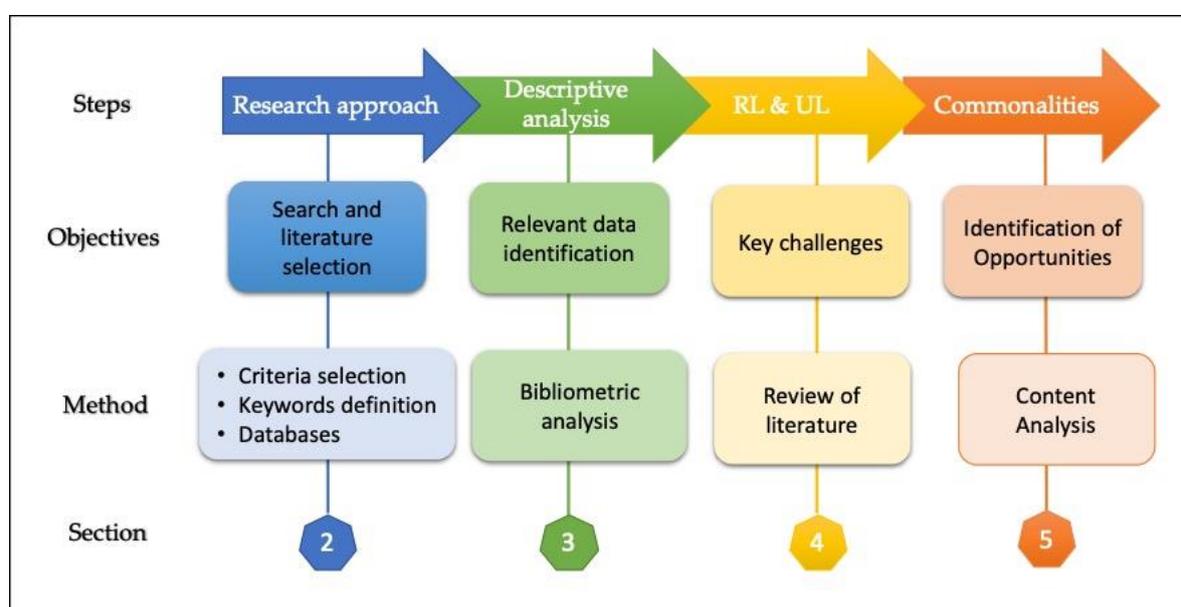


Figure 1. Methodological approach.

Only six documents jointly studying both fields of research (reverse logistics and urban logistics) were identified (Table 1). Certainly, just a few papers and focused on different topics: Urban waste management, e-commerce product returns, reverse supply chain design issues, and stakeholder engagement. A brief description of such papers is provided in the following paragraphs.

Regarding urban waste management problem, Buhrkal et al. [25] describe cost optimal routes for garbage trucks to collect customers' waste within a given time window while minimizing travel costs. By using an adaptive large neighborhood search algorithm (ALNS) and applying it to Danish garbage collection companies, they show that the previously established routes can be improved. Therefore, reverse supply chain design issues are also considered in the paper. Although the proposed methodology seems to be effective, other applications to different contexts would be necessary in order to confirm its proper performance. Moreover, the development of practical implications not only for waste collection companies but also for other relevant parties is missing. Soto et al. [26] use the continuum approximation methodology to solve a network problem related to the number and locations of recycling centers (design issues) for solid waste to be installed in a specific urban region in Chile (waste management). The main objective is to maximize benefits and minimize costs from both private (recycling companies) and social (households and individuals) perspectives. The results confirm that the optimal solution means a great social contribution but an investment with low profitability

in private terms. Although some interesting ideas arise from the study, they are not sufficiently developed. Moreover, the proposed methodology is applied to a very specific context, so it might limit the generalizability of the outcomes. Similarly, Costa-Salas et al. [27] acknowledge reverse logistics as a crucial strategy in addressing the challenges involved in urban waste collection operations. By using integrated simulation techniques and optimization methods, the authors analyze a reverse logistics system to collect discarded tires in a Colombian city (waste management). Although specific city characteristics, such as the topography of the city (e.g., hilly roads) and the neighborhood accessibility are considered, the results are quite general and mainly focused on the fleet sizes and the transport routes described in the problem (design issues).

Table 1. Characteristics of articles published on reverse logistics–urban logistics.

| Reference | Topics | Context | Methodology | Limitations |
|-------------------------|--|-------------------------------------|---|--|
| Buhrkal et al. [25] | Urban waste management and Reverse supply chain design | Denmark | Waste Collection Vehicle Routing Optimization Problem | Practical implications for waste collection companies and other relevant parties are missing |
| Soto et al. [26] | | Chile | Optimization problem applied to a case study | Research applied to a very particular context so it would be difficult to generalize results |
| Costa-Salas et al. [27] | | Colombia | Simulation based on a case study | Case-specific results |
| Lemke et al. [28] | E-commerce product return | Poland | Survey | Supply perspective, a key factor in urban freight transport analysis, is not considered |
| Ndhaief et al. [29] | Reverse supply chain design | Not applied to any specific country | Location-allocation mathematical problem | Relevant factors are missed in the framework developed |
| Marcucci et al. [30] | Stakeholder engagement | Italy | Gamification | Results are highly dependent on the research context |

Lemke et al. [28] perform an assessment of the usability of parcel lockers in the last mile delivery system in an e-commerce context in Poland. They highlight the effectiveness of parcel lockers to minimize the negative impact of urban freight transport. However, the results are based on parcel locker users' perceptions, so they only consider the demand viewpoint. An integrated approach that entails both demand and supply perspective is missing, which might better capture the main factors that affect the urban freight transport.

Ndhaief et al. [29] propose an optimization model for locating city logistic platforms (urban city centers, UCC) based on combined forward and reverse flows. Although the consideration of such a reverse flow is considered crucial for the success of the model (improve the financial situation of UCC), no urban element or characteristics are included in the framework, so its contribution from an urban point of view seems quite limited.

Finally, the role of stakeholders in an urban freight transport context with reverse flows is analyzed by Marcucci et al. [30] by using gamification to stimulate sustainable behaviors. Specifically, the paper develops a gamification process to stimulate engage and participate in a plastic cap recycling initiative developed at an Italian university. Increasing the collection of recycled materials is the gamification objective, and the success of the urban freight transport considered is linked to stakeholders' participation. Although practical implications for policy makers regarding stakeholder engagement and behavior can be derived, results are highly depending on the context of research.

As it seems odd that such few articles focused on both reverse logistics and urban logistics jointly, it may be reasonable to assume that other topics regarding both disciplines have been studied

separately. Probably, there is limited RL data used in UL study because in UL studies, the separation of RL transport is not easy to capture; moreover, decisions that affect production of RL data might not be considered as important as UL data. Due to that, a discussion about the main characteristics of the research on both areas was carried out, based upon the researchers' experience and several literature reviews recently published on both topics, in order to provide a description of the main challenges they will face in a near future. As a result, some useful insights are provided in the following section.

3. Reverse Logistics and Urban Logistics

3.1. Reverse Logistics

The concept of reverse logistics has evolved in the last decades, and different authors have highlighted the evolutionary process being experienced by this discipline [31–34]. According to Rubio and Jiménez-Parra [35], the origins of RL date back to the seventies, where some contributions on raw material recycling were published (see, for example, Guiltinan and Nwokoye [36]; and Ginter and Starling [37]); however, these first papers used to employ terms such as reverse channels or reverse flows as a way of illustrate the movement of materials and products from consumers to recyclers, in the opposite direction to the traditional forward flow in the Supply Chain (SC). Then, in the nineties, the first definitions of RL appeared (see, for example, Rogers and Tibben-Lembke [34]; Pohlen and Farris [38]; Stock [39]; and Kopicky et al. [40]) at the same time, significant contributions from engineering and operations research fields provided a new approach to this concept (see, for example, the pioneer paper by Fleischmann et al. [41]). Among the definitions for RL, one of the most acknowledged was provided by De Brito and Dekker [32] who define reverse logistics as “the process of planning, implementing and controlling backward flows of raw materials, in process inventory, packaging and finished goods, from a manufacturing, distribution or use point, to a point of recovery or point of proper disposal”. Finally, a holistic and strategic approach became predominant in the 21st century, making an explicit recognition of the joint existence of forward flows (from producer to consumer) and reverse flows (form consumer to producer). This is the source of the closed-loop supply chain (CLSC) concept that can be defined as “a supply chain, or a supply network, where, in addition to the typical flows of materials from suppliers to end customers, there are return flows of products (post-consumption or use) to the manufacturers” [42]. In this way, supply chain management is understood as a whole, where the links between traditional logistics operations (forward flows) and reverse logistics operations associated with return flows need to be considered.

As previously was mentioned, in a similar way to the growing academic interest in this field, reverse logistics and CLSC have enormous economic potential [4,9,11,43,44]. Actually, currently, it is difficult to find supply chains with more or less presence of reverse logistics [45], and enterprises, such as Apple, Canon, Caterpillar, Dell, Electrolux, Hewlett-Packard, IBM, and Kodak have already developed and implemented reverse logistics systems to collect and manage end-of-use products (EOU), end-of-life products (EOL), and commercial returns. This interest in implementing reverse logistics systems is usually attributed to three factors that act as drivers for companies: (1) Obtaining competitive advantages, (2) environmental legislation, and (3) the pressure exerted by different stakeholders [42,46]. These factors are known as the triple bottom line: profit, planet, and people.

Firstly, from an economic viewpoint, companies may get a competitive advantage by using EOL products as inputs in their production process, generally with a less cost than the original raw materials, but also, by accessing to new market segments (as a way of increasing revenues) in which environmentally aware consumers are willing to meet their needs with re-manufactured, reused, or recycled EOL products. Secondly, from an environmental perspective, a strict legislation arises in order to be sure that waste generated and its management and proper disposal are priorities in our developed societies [47]. In this sense, some initiatives carried out in the context of waste reduction can be considered as pioneers, namely the Dual System in Germany (1992) and the National Packaging Protocol in Canada (1990) [48]. As a result, other measures were implemented by companies to cope

with legislation requirements, such as the principle of extended producer responsibility (EPR) and the development of systems for collecting and properly managing EOL (see for example, Rubio et al. [49]). Thirdly, from a social viewpoint, increasing awareness about the negative impact of human activity on the environment (e.g., causing shortages of raw materials, pollution, climate change, etc.), also leads to increasing pressure exerted by different stakeholders on companies and organizations to implement measures aimed at developing suitable systems for resource and waste management [46,50]. Reverse logistics is, therefore, a key factor for the supply chain management and logistics activity [51].

In order to provide a closer point of view to this topic a document searching process on the reverse logistics topic was carried out using the Scopus database. As options of searching, documents articles, book chapters, books, reviews, and editorials were employed, all of them in the English language. In order to refine the searching, two requirements were considered. Firstly, the term “reverse logistics” and/or its synonyms (“reverse flows”, “closed loop supply chain”, “reverse supply chains”, “product recovery”, and “commercial returns”) should be included in the field “title document”. Secondly, the term “literature” or “literature review” or “framework” or “challenges” should appear in the “title, abstract, or keywords” field. The search period used was from 1976 to 2018. As a result, a total of 528 documents were identified. Although, it is in the beginning of the 1990s when it seems to arise the number of documents publishes on that topic, the majority of them (89%) were published from 2008 to 2018. Regarding the country or region of origin, it is noted that around 65% of them were published by institutions located in ten countries: United States (16.8%), India (11.6%), China (8.4%), United Kingdom (5%), Iran (4.8%), Germany (4.1%), Brazil (3.8%), Canada (3.6%), France (3.5%), and Denmark (3.2%). Finally, regarding the type of document, most of them were articles (87.3%), followed by reviews (7.2%), book chapters (4.5%), books (0.6%), and editorials (0.4%).

In spite of this interest on RL, many authors agree that there are significant challenges that still require special attention and further research [11,52]. Among these challenges, we could highlight those that are shown in Table 2.

Table 2. Key challenges for reverse logistics.

| Challenges | Topics | References |
|--|---|--|
| New opportunities related to the return of products and new recovery options | <ul style="list-style-type: none"> Treatment of the uncertainty associated with product recovery processes Establishment of consumer incentives to recover EOU products Analysis of the cost structure of the acquisition and collection and the recovery of the value of the returned products Design of products to facilitate their recovery and the corresponding recovery networks | Prahinski and Kocabasoglu [52] Rogers and Tibben-Lembke [34] Rubio et al. [23] |
| Marketing strategies for recovered products | <ul style="list-style-type: none"> Development of markets for recovered products Establishment of pricing strategies and policies for recovered products Development of suitable distribution channels for recovered products Analysis of the impact of sales of re-manufactured products on sales of new products (cannibalization) | Ferguson and Souza [42] Guide and Van Wassenhove [9] Jiménez-Parra et al. [53] Souza [11] |
| Specific legislation on the return of products in certain contexts | <ul style="list-style-type: none"> Application of EPR principle to both electric and electronic equipment, packaging, and containers Implementation of mechanisms for the a more efficient recovery of EOU and EOL products Development of methods for making reuse and recycling activities easier and more effective | Rubio et al. [49] Subramoniam et al. [54] Walls [55] |

3.2. Urban Logistics

According to the United Nations Organization [56], 55% of the world's population lives in urban areas and it is estimated that this figure will reach 68% by 2050, for a total world population estimated around 7.75 billion people. Furthermore, it is necessary to highlight the existence of great disparity in urbanization levels by geographical area, with the regions of North America (82%), Latin America and the Caribbean (80%), and Europe (74%) being the most urbanized.

As the number of urban areas increases, this heightens certain economic and social problems caused by large population agglomerations, traffic congestion, and atmospheric pollution, which impacts on both the quality of life and health of the population and the efficiency of the logistic activities of companies [21,57]. For instance, according to the European Environmental Agency (EEA) [58], in 2016, the transport sector contributed 27% of total EU-28 greenhouse gas emissions, which represented a 26.1% higher relative to 1990. Similarly, the World Health Organization (WHO) is also warning about the ambient air pollution generated by transport in our cities. According to this entity, the transport sector is one of the main sources of air pollution, for which evidence on direct effects on mortality as well as on respiratory and cardiovascular disease is firmly established. Transport is a major source of emissions of urban air pollutants with 60% of cities in Europe exceeding WHO air quality guideline levels for particulate matter [59].

Given this situation, it seems necessary to find a balance between the urbanization process and sustainable development, with special emphasis on city planning that promotes the economic and social development of cities whilst also searching for solutions to reduce the negative impact on the environment [60]. In this regard, both the public authorities and companies must be able to work together to achieve the aims pursued by both parties; that is, to improve the quality of life of the citizens through good mobility management and the suitable and efficient management of commercial activity [61]. Urban logistics can play a very important role in the search for that balance [21].

Regarding this topic, a document searching process was also conducted. In this case, 136 documents were identified using the same database and the same options of searching as in the case of reverse logistics. The requirements taken into account to refine the searching were: (1) The term "urban logistics" and/or its synonyms ("city logistics", "last mile delivery", "urban freight", and "urban delivery") should be included in the field "title document", and (2) the term "literature" or "literature review" or "framework" or "challenges" should appear in the "title, abstract, or keywords" field. The search period used was from 1984 to 2018. Approximately, it was in 2011 where it could be observed an increasing tendency in the number of documents published on that topic. However, the majority of them (81%) were published in the period 2013–2018. With respect to the country or region of origin, it can be highlighted that almost 60% of them were published by institutions located in Italy (12.9%), United States (7.9%), United Kingdom (6.7%), France (6.2%), Netherlands (6.2%), Sweden (6.2%), Belgium (5.1%), Canada (3.9%), and Germany (3.9%). Regarding the type of document, around 83% were articles, followed by book chapters (9.6%), reviews (7.4%), and editorials (0.7%).

Nevertheless, in recent years, some papers providing a general overview of the current state of the research on urban logistics were published. In this sense, Crainic et al. [15] provide a brief history of urban logistics, highlighting milestones and defining fundamental concepts such as consolidation (related to the activities developed at the city distribution centers, CDC) and coordination of operations developed by different stakeholders at different levels of participation and engagement. A systematic review of literature on urban logistics was carried out by Lagorio et al. [24], who analyzed 104 papers published in 24 different journals in the period 2000–2013. As a main result of this review, three main areas of possible investigation for the next future were identified: (1) stakeholder engagement, (2) urban logistics ecosystem, and (3) common frameworks and data sharing platforms. According to Savelsbergh and Van Woensel [20], the challenges of city logistics change continually, so a review and discussion of these challenges is provided, namely population growth and urbanization, e-commerce, sharing economy, speed in deliveries, climate change, and sustainability. Additionally, some opportunities for research are identified: network design, omni-channels logistics, delivery systems, stakeholder

cooperation, and sustainability. Finally, Rose et al. [62] developed a systematic literature review, from different academic disciplines, highlighting the gaps regarding the defining features of urban logistics and proposing a framework of urban environmental factors affecting logistics operations. A remarkable contribution of this investigation is the definition of the concept of urban logistics in which an explicit mention to the existence of reverse flows occurring within urban systems is made. This way, according to Rose et al. [62], urban logistics is defined as “that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services, and related information between the point of origin and point of consumption in order to meet customers’ requirements, as influenced by complex interactions among densely populated social systems and associated infrastructure”.

Recently, new trends in urban logistics have also been reported. For example, those related with the decentralization of logistics hubs and facilities (logistics sprawl) and its implications for land use planning, freight transport, and employment [63]. Another relevant issue is related to freight transport management and the role played by public authorities to improve freight transport activity in urban areas. Holguín-Veras et al. [64] highlight the “tremendous need to conduct research that assess the effectiveness, advantages and disadvantages” of public policies on freight transport, and analyze different initiatives carried out in different countries regarding infrastructure, parking/loading areas, vehicle-related strategies, traffic management, as well as financial approaches, logistical management, and demand/land use management [65]. Certainly, the goal of the research and practice on urban logistics should be to achieve a city that is liveable and healthy for everyone; to create a human city, maybe not perfect or even smart, but warm and welcoming, where it is nice to live and visit [66]. Obviously, although these challenges deserve further discussion, they are beyond the limits of this research.

As stated before, other terms commonly used to refer to urban logistics are city logistics and urban freight transport. However, the latter, along with the logistics activities around it, has acquired special relevance in recent times due to the fact that it forms an essential part of the GDP in developed economies and has very important effects on all sorts of companies [24].

Regardless of the term used to refer to urban logistics, the appropriate management of the logistics activity in cities may contribute to creating an urban freight transport system that is more efficient, safer, and more respectful of the environment and human health [21]. For years, this has been an issue of special interest both to researchers and to public authorities and companies [67–69]. This interest has also increased recently due to several reasons [24]: the development of new forms of consumption (e.g., e-commerce); changes in consumer attitudes, tastes, and preferences (e.g., greater awareness about environmental issues); and the growing evolution of technology that allows for new ways of supplying goods (e.g., the use of drones or electronic vehicles with greater autonomy). Table 3 summarizes different challenges existing in the field of urban logistics.

Table 3. Key challenges for urban logistics.

| Challenges | Topics | References |
|--|---|---|
| Long-term planning of cities | <ul style="list-style-type: none"> Promotion and development of logistics in town planning processes following a systematic or holistic approach Network design | European Commission [60] Lagorio et al. [24] Rose et al. [62] Savelsbergh and Van Woensel [20] |
| Stakeholder management and cooperation | <ul style="list-style-type: none"> Inclusion of all stakeholders (companies, public authorities, consumers, etc.) in urban logistics projects, making them part of the decision-making process Interactions between logistics networks, community social networks, and governance networks in urban areas | Aditjandra and Zunder [70] Clott and Hartman [71] Lagorio et al. [24] Rose et al. [62] Savelsbergh and Van Woensel [20] |

Table 3. Cont.

| Challenges | Topics | References |
|---|---|---|
| Improvement of data and information management | <ul style="list-style-type: none"> • Transparency and information availability (type, quantity and variety of goods, distribution companies, time windows, etc.) • Application of new technologies to obtain real-time information on urban freight transport (restrictions on noise, emissions or dimensions of the vehicle, traffic conditions, etc.) • Development of collaborative or common data exchange platforms to improve information and its availability | ALICE/ERTRAC [18] Castellón-Torres et al. [72] European Commission [60] Lagorio et al. [24] Merchán et al. [73] Savelsbergh and Van Woensel [20] |
| Research on efficiency, reliability, and safety | <ul style="list-style-type: none"> • Energy efficiency, improvement of air quality, and reduction of noise pollution. Negative externalities management • Improvement of customer satisfaction through the timely supply of products and improvement of the reliability of the urban logistics system • Increasing safety and protection for both people and goods • Use of environmentally friendly vehicles and the integration of forward and reverse deliveries to further reduce freight movements and related emissions | ALICE/ERTRAC [18] European Commission [60] Savelsbergh and Van Woensel [20] |
| New business models and services | <ul style="list-style-type: none"> • E-commerce management, which requires more freight movements forward and reverse activities (commercial returns) and the integration of both flows • Sharing economy, in terms of collaborative consumption and collaborative business, by sharing assets and capacities, data, and platforms | Lagorio et al. [24] Savelsbergh and Van Woensel [20] Abraham et al. [74] |

4. Areas of Collaboration Between Reverse Logistics and Urban Logistics

Despite the wide range of problems and challenges faced by reverse logistics, so far urban logistics has not been one of them [14]. However, some very interesting connections can be observed between these two logistics areas (Figure 2). These links deserve special attention, because they can be considered as the basis for collaboration between both areas. Specifically, it is worth highlighting the importance of reverse logistics in urban contexts in terms of both urban waste management and the management of commercial returns [18,60], so these topics will be discussed as follows.

Obviously, other topics can be also considered to make a link between UL and RL. For example, regarding public infrastructures, some examples can be mentioned such as the development and promotion of urban consolidation centers, and the use of alternative transport modes like tram and underground. Stakeholder engagement is another key issue that can be utilized to further research on the management of supply uncertainty in RL networks, for example, on how to increase waste collection rates. Land use management is also a relevant topic in UL with potential extensions to RL in issues such as the use of mini-warehouses or parcel lockers for commercial returns. A tricky situation on this regard may be the difficulty to generalize such solutions to any city, because the relevance of these impacts varies per city area and the associated scale, with differences between large conurbations and small- or medium-sized cities [70].

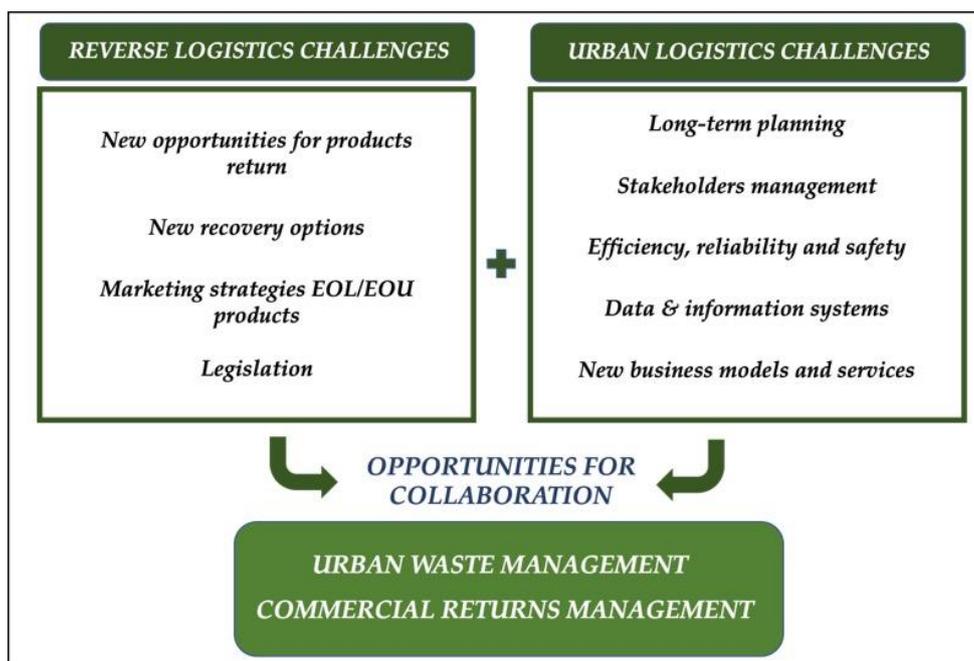


Figure 2. Challenges and collaboration areas for reverse logistics and urban logistics.

4.1. Urban Waste Management

Reverse logistics literature analyzes this topic in an extensive way. According to Agrawal et al. [2], research on reverse logistics network from a secondary market perspective was the most prolific topic in the period 1986–2015, which includes issues mainly related to the design of networks for recycling, reuse, and remanufacturing, and the collection planning.

Network design is an aspect of particular complexity in reverse logistics because of the supply uncertainty, in terms of quantity, quality and timing of product returns, the degree of centralization of testing and sorting, and the interrelation between forward and reverse flows [32]. In this vein, Bing et al. [75] describe the key issues addressed in network designing of waste recycling literature, such as: (1) channel choice (curb-side or drop-off collection), (2) network structure, (3) capacity design of facilities, (4) location of recovery facility and transportation links, (5) handle different composition of waste, (6) multi-modality strategy, and (7) balance emission and economic concerns.

Collection and management of products and materials (EOL and EOU) through their recycling, re-manufacturing or reuse is also a complex task that requires careful planning in relation to their collection, so that it is possible to recover most of the value that they still possess. For example, when recovering domestic used products for recycling, the choice of collection channel and the technology used depend, among other factors, on where that separation stage takes place; that is, in the consumer's own home or alternatively in specialized separation centers [76]. Moreover, urban waste management includes not only domestic waste but also industrial and commercial waste, which require various forms of collection and treatment, which differ from those usually applied to domestic waste [77]. For example, industrial waste can be bulkier; be generated with a different frequency; require the use of special systems for its collection (specific containers and different modes of transport); and require the use of certain safety measures, as is the case for hazardous waste (for example, toxic waste and infectious material). Regarding waste collection activities, Bing et al. [76] also describe several issues analyzed in the reverse logistics literature, namely: (1) number of waste stream collected, (2) collection frequencies, (3) dynamic routing and scheduling, (4) multi-compartment vehicle, (5) vehicle capacity, (6) road condition, (7) number of depots, (8) differentiated municipal waste tax, and (9) balance emission and economic and social concerns.

As pointed out above, an important aspect to consider with regard to the collection and treatment of urban waste is the supply uncertainty. Unlike forward logistics where the uncertainty is mainly related with the demand of products, in reverse logistics, the uncertainty comes from the supply side, in terms of the number of products to recover (quantitative uncertainty), their quality (qualitative uncertainty), and the time of their recovery (time uncertainty) [78]. This supply uncertainty largely determines the effectiveness of the reverse logistics network. Therefore, the stage at which this return process (product collection) begins is considered an essential element to be carefully considered when designing these logistical networks [41,79]. It should be noted that although aspects relating to the acquisition and collection of products entering the reverse logistics system have traditionally been analyzed, this continues to be a completely unresolved issue [78]. This problem is intensified in the case of cities as, because of the high level of people agglomeration, they become critical areas for the collection of waste, materials, and products (EOU and EOL).

In this context, the effectiveness of urban logistics and, therefore, the corresponding reverse logistics operations are conditioned by aspects relating to the type of city, its radial structure, the high concentration of commercial, and leisure and restaurant areas, as well as by the different objectives and interests of the main stakeholders, namely companies, residents, consumers, local authorities, etc. [80]. The local authorities, as well as other public institutions, tend to be legally responsible for managing municipal waste and, consequently, planning its sustainable collection and transportation. However, there is a growing trend for these institutions to outsource waste management to private companies [81].

4.2. Management of Commercial Returns

Commercial returns and refunds normally occur because the product purchased by the consumers does not meet their needs, has not been delivered in the right conditions, or does not meet their expectations. Due to this, a product return process, from the consumer to the manufacturer, must be created. This type of process has become very important in recent years, especially due to the appearance and development of (1) new business models based around the Internet (e-commerce), (2) new sales conditions (extension of product trial periods, elimination/reduction of shipping costs, product returns at no additional cost, etc.), and (3) new payment methods (via mobile, PayPal, virtual wallet, etc.).

It is suggested that the trend for this type of return is increasing [82]. This logistics of returns is considered to be unwilling logistics [34] because it assumes that the effective sale of the product has not taken place, implying the consequent loss of its value, becoming a real problem for many companies [83]. This is especially true for those companies that do not have a large logistics budget and operate in countries where the volume of returns is considerable, as is the case for the U.S. where approximately 8% to 10% of all products are returned, this figure increasing to 30% in the case of products purchased online [84]. Product returns are a major challenge for retailers, who must balance returns management with customer satisfaction [85]. In addition, e-commerce has even increased the relevance of commercial returns policy for online retailers, who acknowledge returns management as an integral part of their service offering [85]. Some studies [86] indicate that at least 15% of e-commerce sales end up as returns compared with an estimated 8% of purchases made at brick-and-mortar stores. Even more, in certain periods such as Christmas, Black Friday, or Cyber Week the amount of online purchases expected to be returned can be above 45% [87]. Therefore, it seems necessary for companies to include this type of process within their logistics planning given that, in many cases, and especially for online purchases, it may determine the individual's purchasing decision [88]. A recent research on this regard [85] describes the progress made by research and leading companies in the development of effective programs as well as the challenges that remain.

This increase in commercial returns evidently involves a greater flow of products from the consumer to the manufacturer that need to be managed, transported, and delivered, which represents an increase in the complexity of the system and a greater negative impact on traffic, urban mobility and

the environment. Returns may be transported some 1000 km round trip from customer to the logistics centre [87], so new strategies are being considered, such as the use of decentralized warehouses with high-speed fulfillment. Hence the importance of achieving the greater integration of these direct and reverse flows to increase the overall efficiency of logistics activity [18]. In this sense, retailers can increase return management effectiveness by cooperating with third-party providers [85] and using technology [89]. Actually, many companies are already working on improving their product return service in order to be more efficient, making use of the new technologies [90]. However, it seems that there is still a long way to go in this regard [84].

5. Conclusions

This work is an attempt to identify a link and describe some commonalities between two very important areas of logistics activity: reverse logistics and urban logistics. Despite the growing interest shown in both disciplines and their relevance for companies and consumers, reverse logistics and urban logistics are two concepts that are still somewhat unknown and, above all, treated as being relatively separated. This is why this work gives some background on them through a brief description of the current state-of-the-art, in order to identify the different challenges to be faced by both disciplines in the near future, both separately and together. This emphasizes the main opportunities for collaboration between reverse logistics and urban logistics. The main conclusions obtained from this work are as follows.

Firstly, despite the wide range of reverse logistics issues analyzed in recent years and the growing interest that this subject has aroused, there are still significant challenges requiring further work, such as: the analysis of new opportunities related to product returns and different recovery options; the development and implementation of specific strategies for selling recovered products; and the study and development of more specific legislation to be applied to product returns.

Secondly, we highlighted the importance of proper logistics management in urban areas and the existence of certain key aspects that must be addressed in the near future, such as, for example: logistics planning in cities; collaboration between the different stakeholders; the development of new collaborative ways of exchanging data and information; and the development of research areas related to, for example, energy efficiency, reducing noise and atmospheric pollution, and increasing the safety and protection of people and goods, among others.

Thirdly, we identified the aspects where the two disciplines converge and that may represent opportunities for collaboration. All of this was carried out with the aim of contributing to the search for measures to resolve logistics activity problems seen in our cities. Among the main challenges to be jointly addressed by the two disciplines are those relating to: the proper treatment and management of urban waste; the recovery and management of materials and products (EOU and EOL); and the efficient management of commercial refunds and returns.

Certainly, other key issues of UL, such as land use, city typology, infrastructures, and stakeholder engagement should be further analyzed in order to keep advancing in the description of links between both RL and UL. Actually, land use and city characteristics significantly influence the performance of urban freight [70], which can be utilized in the decision-making process for waste management [91]. For example, regarding public infrastructures, some examples can be mentioned such as the development and promotion of urban consolidation centers, and the use of alternative transport modes like tram and underground for freight transport and waste management [92,93]. Stakeholder engagement is another key issue that can be utilized to further research on the management of supply uncertainty in RL networks, for example, on how to increase waste collection rates [30,94]. Land use management is also a significant topic in UL with potential extensions to RL in issues such as the use of mini-warehouses or parcel lockers for commercial returns [28,85]. A tricky situation on this regard may be the difficulty to generalize such solutions to any city, because the relevance of these impacts varies per city area and the associated scale, with differences between large conurbations and small- or medium-sized cities [70]. Similarly, regarding the role of end users in the logistics flow, some

innovative approaches in urban areas were devised [95], which also might be further analyzed in the context of RL as a way of stakeholder engagement for successful commercial returns.

Urban areas are a challenge for logistics. It is often difficult to provide effective solutions to logistics problems in cities, and not only because of logistical reasons. Obsolete municipal regulations, the absence of effective mechanisms in the event of non-compliance, improperly planned policies, and user behavior also have an influence on it [80]. Nevertheless, there exist clear commonalities between urban logistics and reverse logistics, not only from a research perspective but also from a business management point of view, which can foster the collaboration between them to face the challenges of the cities in a near future.

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