City logistics research streams: a systematic literature review

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Abstract: The pursuit of sustainable solutions for moving goods in urban areas with minimum impacts on the society and the environment is nowadays a broadly discussed subject. To better frame the research interests in this area, in this paper we discuss the main evidences emerged from a systematic literature review regarding the field of city logistics, which encompasses (but is not limited to) the transportation of goods inside and across urban centers. Following our research protocol, we collected and analyzed a corpus of papers from which we identified i) the most popular research methodologies adopted to study city logistics issues, ii) how research methodologies and topics have evolved through years, and iii) the emerging gaps. This study represents a starting point to understand the future evolution and topics to investigate concerning city logistics.

Keywords: City logistics, urban freight, last-mile distribution, systematic literature review

1. Introduction

In the last recent years, the discussion around city logistics subjects has gained momentum in both the scientific and the public administration fields: the pursuit of sustainable solutions related to the transport of goods in urban areas with minimum impacts on the society and the environment is nowadays a broadly discussed subject involving the scientific community as well as the policymakers.

In Europe, due to the high concentration of towns and cities with a historical legacy and urbanistic constraints, city logistics – for the purpose of this paper, also referred to as urban logistics or urban freight transport, encompassing the transportation of goods inside and across urban centers, thus concerning also the last-mile distribution – has been present for more than a decade in the EU guidelines as an important area of intervention with an exploitable potential for reducing CO2 levels (European Commission, 2001; European Commission, 2011) and for increasing the city livability by reducing the number of commercial vehicles throughout the urban area.

Further, this growing interest is driven by several other factors, such as:

- Greater awareness of the historical and artistic heritage, present in town centres (Puławska & Starowicz, 2014) that must be preserved and made accessible and enjoyable to tourists.
- Need to face an increasingly fragmented demand due to the spread of e-commerce (Teo et al., 2012), originating from increasingly populated cities and urban areas (it is estimated that around 2030, five billion people will live in cities; in Italy, by 2050 almost 79% of the total population will reside in urban centres, with an increase of over 10 percentage points compared to 2011).
- Need for better space management (i.e., reserved lanes, loading / unloading areas, pick-up points) in urban centres where in a relatively small space different activities can be located (i.e., manufacturing and commercial companies, retail and food shops, restaurants), generating a continuous flow of goods that must coexist with other transport flows (i.e., private, public, couriers) (Johansen et al., 2014).

Despite its importance for the society and the scientific community, the literature on city logistics is quite fragmented. Therefore, in this article we present the results of a systematic literature review aiming to provide an answer to the following research questions:

RQ1. What are the main subjects related to the city logistics area that have been most studied through years?
RQ2. Are there topics that have been abandoned and others that have become increasingly important?
RQ3. What are current gaps in the scientific literature regarding city logistics?

In pursuing our goal, we focused mainly on the high level design and implementation of the solutions rather than on policy making and civil engineering design.

In summary, in this paper we discuss the main evidences emerged from a systematic literature review regarding the field of city logistics. To this end, the paper is structured as follows: in Section 2, we provide details about the systematic literature review protocol. In Section 3 we report the main findings from the collected corpus of papers, distinguishing the main topics addressed and the
main research methodologies adopted. Then, in Section 4 we discuss other findings from the literature review, providing answers to the research questions. Section 5 concludes the papers highlighting possible future research directions.

2. The research method

To understand how research on city logistics has evolved over the last decades, we performed a systematic literature review (SLR for short in the remainder). An SLR is a research method originating from the field of medicine. A review earns the adjective systematic if it is based on a clearly formulated question, identifies relevant studies, appraises their quality and summarizes the evidence by use of explicit methodology. It is the explicit and systematic approach that distinguishes systematic reviews from traditional reviews and commentaries (Khan et al., 2003). In contrast to the traditional or narrative literature review, an SLR uses a more rigorous and well-defined approach to review the literature in a specific subject area. There are three main reasons for conducting an SLR: i) to aggregate and synthesise existing knowledge regarding a research topic; ii) to identify gaps in earlier research; iii) to provide background information to start investigating a new research topic. Moreover, an SLR provides a repeatable research method which, when applied properly, should provide sufficient detail to be replicated by other researchers. Furthermore, the detailed documentation of the performed steps within the SLR enables in-depth evaluation of the conducted study (Kitchenham & Breton, 2013). Finally, SLR is a trustworthy research method for multiple purposes.

We opted for SLR as a research method because of the nature of the research questions, which aim at understanding trends and detecting existing gaps in the scientific community. Furthermore, there is an already available body of literature that could be synthesised and summarized to improve future practices and possibility, encouraging higher levels of research methods. In this study, an SLR has been used to perform a comprehensive study of City Logistics main topics, trends and gaps. In particular in this paper we focused on papers published in refereed journals in the field of logistics, transportation and economics in the period 1999-2014. The starting year has been selected accordingly to the fact that the “city logistics” term has been used for the first time in 1999 (see Taniguchi et al., 1999).

The guidelines provided by Kitchenham & Breton (2013) have been used as a basis to develop the SLR protocol for our research described in the following paragraph.

2.1. Outline of the systematic literature review

Our research went through three main stages: selection, coding and analysis of the papers. In an SLR, the selection process is very critical for the quality of the results and was conducted according to the following three steps: 1) automated search; 2) selection based on title and abstract; 3) selection based on full text. These steps are further explained in the following paragraphs.

STEP 1: Automated search

Major publishers’ database and library services such as Elsevier (i.e., Sciedirect), Emerald, Springer, Wiley, and Scopus were used. Keywords combinations including terms such as “city logistics”, “urban logistics”, “last mile delivery”, “urban freight” and “urban freight delivery” were used.

We have adopted the following inclusion criteria:

- Language: English
- Document Types: Article
- Sources: Journals in AIDI and AiIG classification list (the complete classification lists are available upon demand contacting the authors).

These criteria led to a first set of 104 papers (Fig. 1).

STEP 2: Selection based on title and abstract

Perusing titles and abstracts, we excluded three papers since they resulted out of topic, being related to trail freight transport, transit transport and logistics of big events.

STEP 3: Selection based on full text

This third step led from 101 to 91 papers, after a thorough scrutiny that led to reject 10 papers because they addressed too specific topics such as energy, RFID, CO2 calculation, supply chain disruption and operations, GRASP and megacities.

3. Main findings from the collected corpus

The distribution over the years of the publications in the resulting corpus underlines the current relevance of the subject (Fig. 2). Analyzing the collected corpus, we identified some recurrent topics and methodologies adopted, as described in the following sub-sections.

3.1. Main topics addressed

Among the most common and recurrent macro-topics, we highlight the following:

1. Limited Traffic Zone (LTZ): an LTZ is an urban area subject to traffic restrictions. We do not only refer to traffic spatial limitations, but also to the entire set of rules governing the access to the area (time windows, limitations about weight, width and type of fuel).
2. **Loading/unloading areas**: papers related to loading / unloading area refer to their ideal location to serve the largest number of commercial activities, their management system and rules for their use and booking.

3. **Urban Consolidation Centers (UCC), Urban Distribution Centers (UDC) and Transit Point (TP)**: infrastructures that allow the consolidation of goods before the last mile delivery. This is meant to ensure that vehicles traveling the last mile for the final delivery can maximize their load factor. These facilities are usually classified into three main types: urban consolidation centre (UCC), urban distribution centre (UDC) and transit point (TP) depending on how long goods remain in the warehouse and what kind of actions are performed on freight (i.e., consolidation, tranship).

4. **Road Pricing**: all measures which provide for payment of a toll for the use of a particular infrastructure (i.e., access to LTZ, use of a bridge or of a bypass road).

5. **Multi-use Lanes**: sharing lanes by transit and trucks.

6. **Night delivery/off-hours delivery**: shifting delivery of goods from standard time window (9.00-18.00) to another period of the day (early morning or night), it is possible to decrease emissions thanks to the reduction of traffic congestion peaks.

7. **Information and communications technology (ICT) and intelligent transportation systems (ITS)**: articles regarding the design and implementation of ICT solutions in city logistics projects. In some cases, ICT solutions are applied to the whole freight transportation system, whereas in other cases ICT solutions have a specific application (e.g., truck and parcels traceability, on-line reservation of loading-unloading bays). ITS are advanced applications which aim to provide innovative services relating to different modes of transport and traffic management, and to enable various users to be better informed and make safer, more coordinated, and smarter use of transport networks.

8. **Delivery by bike**: use of cargo-bike for freight distribution in city centres.

9. **Other innovative solutions** (freight tram, water transport, Delivery and Servicing Plan (DSP), share-a-ride, drones): we chose to consider innovative solutions that are not yet widespread in a separated class. This class includes new types of distribution modes (by tram, by canals and by drones) and completely new solutions (a very specific planning of delivery service or a sort of car-sharing for goods).

10. **Pick-up points and parcel lockers**: pick-up points are prearranged places where people can go to collect their on-line pre-ordered parcels. Parcel lockers are units that are installed alongside neighbourhood delivery and collection box units or in conjunction with Post Office Boxes in a retail facility that is used for parcel delivery.

11. **Vehicle Routing Problems (VRP)**: articles related to the optimization of paths of individual vehicles or fleet of vehicles in order
to reduce routes, waiting time, emission of pollutants and consequently the traffic congestion.

12. **Green vehicles**: all vehicles that had sustainable power (electrical, Liquefied Petroleum Gas, Compressed Natural Gas).

13. **Emission/Pollution**: many articles focused on how to reduce pollutants levels (i.e., CO2, NOx, PMx) and pollution from vehicles (environmental, acoustic).

14. **Stakeholders involvement**: all articles related to stakeholders engagement and management in city logistics projects.

15. **Performance assessment/comparison of solutions**: this topic includes all methods to calculate the impact of city logistics solutions on transportation system. Sometimes, the topic is just related to the assessment of environmental impacts, sometimes economic impacts, and solutions are often treated separately (i.e., UDC, road pricing, LTZ).

16. **Comparison among different solutions**: many papers deal with the purpose of comparing different city logistics solutions in order to evaluate the optimal one that best fits the context.

17. **E-commerce**: all articles concerning on-line goods purchasing and the related delivery processes. These papers were considered of interests since we considered the typical e-commerce customer living in an urban centre.

3.2. **Main methodologies**

Beyond the topic addressed, each paper has been also classified in terms of the research methodology(ies) adopted. We considered the following main methodologies:

- **Case study/Interview**: an implementation of a research method involving an up-close, in-depth, and detailed examination of a subject of study, as well as its related contextual conditions, through use of interviews and direct observations.
- **Quantitative modelling**: research methods that seek to understand the behaviour of a phenomenon by using (complex) mathematical and statistical models and measurement.
- **Questionnaire/Survey**: methods to collect big amounts of data by administering questionnaires and performing structured surveys.
- **Experimental/Piloting**: a pilot project or pilot experiment is a small scale preliminary study conducted in order to evaluate feasibility, time, cost, adverse events, and effect size (statistical variability) in an attempt to improve upon the study design prior to performance of a full-scale research project.
- **Literature/Systematic review**: a systematic review is a literature review focused on a research question that tries to identify, appraise, select and synthesize all high quality research evidence relevant to that question.
- **Other (i.e., frameworks, ontologies)**.

The result of this classification is shown in (Fig. 3).

![Fig. 3 Percentage of different types of research methods in selected papers](image)

Along with the methodology, it is important to consider the type of data used in the research; we distinguish between qualitative (or unstructured) and quantitative (or structured) data. Quantitative data are data that can be quantified and verified, and that are amenable to statistical manipulation (i.e., data on emissions of pollutants, traffic flows, flows of goods, km covered by a vehicle, orders from a store or from e-commerce customers). Qualitative data represent information that have aspects that are unable to be measured, or are found to be approximations (i.e., opinions of stakeholders, social sustainability). The result of the classification of data used is reported in (Fig. 4).

![Fig. 4 Percentage of different types of data in selected papers](image)
Quantitative data defines whereas qualitative data describes: using the two types of data together we can have a more complete definition of the phenomenon studied.

4. Discussion

To answer RQ1, we can observe that there are three topics that are discussed more often in our sample (Fig. 5):

- **VRP solutions**: VRP problems were already well known when the concept of city logistics born; therefore, many studies started from the optimization of the transportation along a research stream that was already consolidate.

- **Stakeholder involvement**: studying city logistics issues is not possible without considering the whole transport system in which every actor and stakeholder has conflicting interests (pedestrians, drivers, couriers, and transporters).

- **Solutions performance assessment/comparison**: one of the main critical aspects of city logistics projects is evaluating their effectiveness. There are many factors to take into account from an environmental, economic and social point of view. We have seen in previous paragraphs the complexity to derive data and consequently it is equally complex to identify impacts and KPIs of one or more solutions.

To answer RQ2, we can observe that the attention and research effort devoted to the different topics is changed throughout years (Fig. 6). At the beginning of the research about city logistics, only some topics were taken into account: UCC, reserved lanes, ICT (especially on-board GPS instruments), VRP solutions, emissions, stakeholder involvements, solutions performances and comparisons.

In a second phase, there was a growing interest in some topics like LTZ, UCC, VRP problems (more complex if compared to those considered in the first phase, encompassing in this phase also time windows and stakeholders behaviors) and stakeholders involvement. Nowadays, we can observe that the focus on some topics has diminished (road pricing, reserved lanes) and many new topics were born, such as bike delivery, pick-up points deployment, e-commerce delivery and other innovative solutions.

Finally, we can observe that there is a growing interest in comparing different solutions and in assessing solutions performance, due to the effort on creating solutions more and more efficient that can perfectly fit real problems.

Finally, about RQ3, we can state that one of the emerging evidences is that, while there are new emerging topics, there is not a widespread of new research methodologies and instruments.

Another gap is that there are not papers that made a comparison among innovative solutions or between a traditional solution and an innovative solution.

We can also observe that very few papers propose composite solutions (combinations of different innovative and/or traditional solution).

5. Conclusions

In this article, we tried to answer three questions related to city logistics research streams, aiming to identify the most studied topics throughout years.

We also identified some trends and gaps in the scientific literature regarding city logistics using systematic literature review as methodology, identifying a corpus of papers of greatest interest.

We have defined a research protocol that includes articles in English published in journals included in the AIDI and AiIG journal classification lists.

![Fig.5 Number of papers for each topic](image-url)
We can state that, besides the discussed gaps, there are also some open issues: for instance, performance assessment and comparison of cities and solutions. Nobody has so far discussed a comparison method that can identify impact and performance of each city logistics solutions that can also be reliable and repeatable for each case.

Moreover, many other things can still be discovered in the field of space sharing between transport of passengers and goods, a definitive solution for transport generated by the e-commerce has to be found (i.e., pick-up points, returns management), new generation of low emission vehicles raise more and more interests (i.e., Electrical Automated Guided Vehicles, cargo-bike).

There are also new innovative solutions potentials that have not been yet completely investigated as the internet of things and the use of big data in the transportations field.

References


Due to the limited number of pages available, the complete list of papers resulting from the systematic literature review has been omitted here, but is available upon request to the authors.