A review on transportation last-mile network design and urban freight vehicles

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Abstract

Last mile logistics also referred as city logistics or urban logistics, concerns to the optimization of urban freight transportation systems. This relatively recent concept responds to the need for feasible and sustainable last mile logistics solutions that contribute to reductions on not only costs but on congestion and environmental effects, particularly in dense cities. Decisions on a supply level involve network design, which includes urban facilities location. In this context facilities are called urban or city distribution centers, micro distribution centers, satellites platforms or just satellites. On other hand, vehicle fleet related decisions need to be also customized to this particular urban distribution context, specifically dealing with multi-mode selection, fleet size, smaller vehicle capacities (i.e. city-freighters), power technology, vehicle autonomy, and inclusive, vehicle design, etc. Literature suggests there is still an opportunity in terms of optimization modeling and methodologies to address these issues. This work revises the drivers motivating the topic, the last mile distribution network elements, and establishes an explicit connection between urban network design and the actual development and use of more environmental and suitable vehicles for urban freight.

Keywords

Last-mile logistics, urban logistics, urban delivery, urban distribution centers, electric vehicles, systematic review, distribution networks.

1 Introduction

Last Mile (LM) logistics also referred as city logistics or urban logistics, concerns to the optimization of urban freight transportation systems. LM logistics is currently regarded as one of the most expensive, least efficient and most polluting sections of the entire supply chain (Gevaers et al, 2014). According to Joerss et al (2016), the LM market is growing at a rate from 7 to 10% in mature markets. The increased urbanization and the awareness of freight transportation impacts have stressed the importance of City Logistics (CL) as a comprehensive approach aimed at mitigating the negative effects of distribution activities without penalizing social, cultural, and economic issues (De Marco et al, 2014).

Several terms have been coined to refer to LM distribution logistics. The LM term is often used when dealing with the distribution or delivery process inside a city. For example, Traditionally, LM delivery has referred to the distributor / retailer delivering to the customer's home instead of using a package carrier (Chopra & Meindl, 2016). LM distribution also refers as the last part of the supply chain, and is important cause involve the final transaction between company and costumers, so last-mile logistic is the last stretch of a (business-to-customer) B2C parcel. It takes place from the order penetration point to the final consignee's preferred destination point, for reception of goods. On other hand, the "City Logistik" concept, developed in Germany and also applied by a number of Swiss cities, corresponds to "spontaneous" groupings of carriers cooperating for consolidation and distribution activities with very light government involvement. City Logistics (CL), defined by Crainic et al (2009), is the process for totally optimizing the logistics and transport activities by private companies in urban areas while considering the traffic environment, traffic congestion and energy consumption within the framework of a free market economy. To Taniguchi (2016), it is based on the systems approach that involves a number of technical processes including modeling, evaluation and the application of information technologies.

According to Saenz (2016) there are three characteristic aspects that condition the urban distribution: Infrastructure influence, distribution strategy and vehicle characteristics. Logistics Service Providers (LSP) can act in the last two and perceive the effects (either benefits or barriers) of the first one. As part of the LM distribution strategy, a key factor is the Urban Distribution Center (UDC). An UDC is a logistic facility strategically located for the LM collection and distribution of goods, which is situated close to or inside an urban area. Large freight transport service providers use them for operational purposes, functioning as a junction between urban and interurban parts of the transport chain (Foltynski 2014). In these spots, large trucks deliver the merchandise which is separated in small trucks for the final delivery. It is expected that with these UDCs is possible to increase the load factor, decrease traffic problems and decrease pollution.

To achieve the last goals, the "green" focus in logistics has also recently received increasing and close attention from governments and business organizations. There are many varieties of problems concerning green transportation, such as the promotion of alternative fuels, electronic vehicles, green intelligent transportation systems, and other eco-friendly infrastructures (Lin 2014).

At a strategic level, designing LM logistics systems implies decision making processes on several elements of the network design such as: scope of the system, agents involved in the supply chain, facilities settlement, fleet dimensioning, among others. When the problem is a redesign of an existing system, the last two elements are usually the most susceptible to be changed. In addition, they are usually considered as known parameters when other tactical or operational problems are to be solved (e.g. routing, inventory management, etc.).

Therefore, it is perceived the need to address this research in urban distribution centers and how their capacity and location are defined; and fleet dimensioning; specifically, how fleet size and vehicle capacity are defined, together with the power technology selection (i.e. fuel, electric, hybrid, etc.).

This study makes a systematic review on last mile distribution logistics, from the perspective of the LSP, with emphasis on the decisions of logistics networks design related to urban facilities and green fleets.

1.1 Research Questions

To understand the distinguishing characteristics of LM distribution logistics approaches from the conventional ones, three research questions (RQ) are addressed: RQ1: What are the drivers that motivate the development of the city logistics solutions? And from a logistics service provider, RQ2: What are the considerations to take into account when designing a LM distribution network, including variables and solution methodologies, and RQ3: How decisions on urban facilities and green fleet composition are related in LM distribution? To answer these questions, this study characterizes recent literature in LM logistics and CL, with focus on the distinctive and novel criteria and conditions of design of an urban distribution network.

2 Systematic review methodology

In order to make a systematic review of the literature, two methodologies were considered: Tranfield et al (2003) and Keathley et al (2016). They were adapted to the one presented in Figure 1, and is similar to the one followed by Lagorio et al (2016). This review shares with this work not only the systematic review process but the topic. It is a review on urban logistics. However, following Tranfield among others systematic reviews' authors, they answered different questions, focused on the evolution of the literature and to identify the most relevant papers in the field.

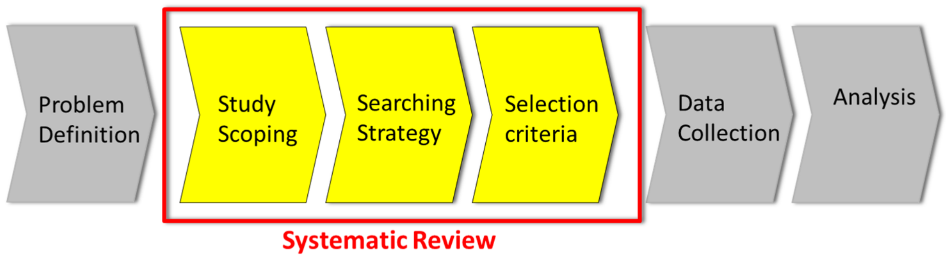

Figure 1. Research methodology

2.1 Scoping Study

For this research, first it was decided to make a selection of journals before going to the papers. Table 1 summarizes the criteria for selecting the journal's list. The following keywords were used: Logistics, Supply Chain, Distribution, Transportation, Urban, and Electric Vehicle. We selected Scimago Journal Rank (SJR) as the main ranking source because it gives us the Q and H index of the Journals.

Even we have keywords that are related with our subject this does not mean that all the titles they are given to us were what we were searching. Just entering each one of the six keywords Scimago gives us a total of 485 titles of Journals. The next step was making a filter because at the end we will just keep the relevant journals. In this point is where we start building the first matrix. A first filter was to exclude titles themes really far from our subject such as medicine, maritime transportation, air transportation, water issues, land issues, and forestry. So our matrix starts with 311 titles of Journals.

Ranking:	At first: SJR (Scimago Journal Rank) At the end: JCR (Journal Citation Index)
Keywords:	Logistics, Supply Chain, Distribution, Transportation, Urban, Electric Vehicle
Type of document:	Journal (no proceedings)
Language:	English
Classification:	Q1- Q3 in Scopus
Index H:	H > 3
Pertinence:	After analyzing the scope and papers.
Exclusion:	Topics: civil engineering, electronic engineering, energy, legal issues, architecture, medicine, water, air, forestry, etc.

Table 1. Excluding Criteria

The second filter step was to exclude proceedings, publication older than year 2000, an H index equal or bigger than 3, and journals in last quartile (Q4). At this point, another areas not related with our subject were also excluded, as are civil engineering, aerospace engineering, chemistry, architecture, math, education, psychology, history, geography and tourism.

After applying these criteria we reduced the number of journals to 41. In order to give more validity to the selected journals list we made a second check searching the titles we kept up to now in another ranking source: the Journal Citation Report. From this ranking source we added 8 Journals. So from our 485 starting Journals we decided to work with a list of 49 journals.

2.2 Searching Strategy

In order to search the papers we used two databases, EBSCO and ScienceDirect. To start searching for the papers we ordered the Journals by highest H index. The strategy used is based on the Boolean search presented in table 2.

Databases:	**ScienceDirect, EBSCO**
Search:	Boolean Phrase
Type of document:	Original articles and reviews
Language:	English
Date:	>2000
Pertinence:	After analyzing the scope and papers.
Additional inclusions:	Snowballing.
	Proceedings and specific conferences

Table 2. Searching strategy

2.3 Criteria Selection

In the 49 journals chosen in the previous section, we found 172 related articles. After reading title and abstract, if necessary, we kept 53 articles. From them we got complete access to 33. Then, as part of a snowballing process, we decided to make an exception in the exclusion criteria, and we considered articles from, for example, Transportation Research Procedia and Procedia Social and Behavioral Sciences from the last 5 years, since they include recent advances in conferences completely related to our topic. With this inclusion, 23 articles were added to the corpus for a total of 56 articles. These articles went through a searching process showed in Figure 2, until no more new articles were added. For each of them, a summary data sheet was filled.

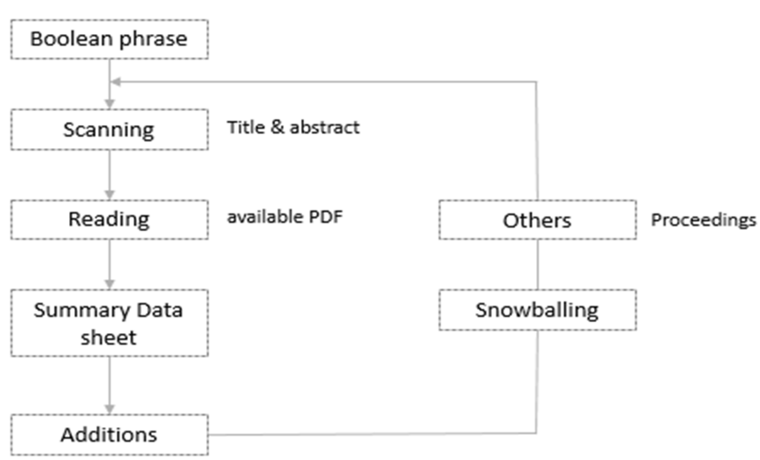

Figure 2. Searching process

3 Descriptive analysis of the corpus

To describe the corpus, we decided to describe the papers through the following: a) publication year, b) frequency of paper per journal, c) keywords, and d) places where the research is done, and where the researchers are from.

In Figure 3 we have the articles distribution by year. Even there are some fluctuations in the period, we can appreciate the increment of contributions regarding LMD, and this confirms an increasing trend. Of course, there is a peak in the last years because of the inclusion of proceedings; however there is also an increase in the number of selected papers in the last year. Papers from 2017 are not included in Figure 3.

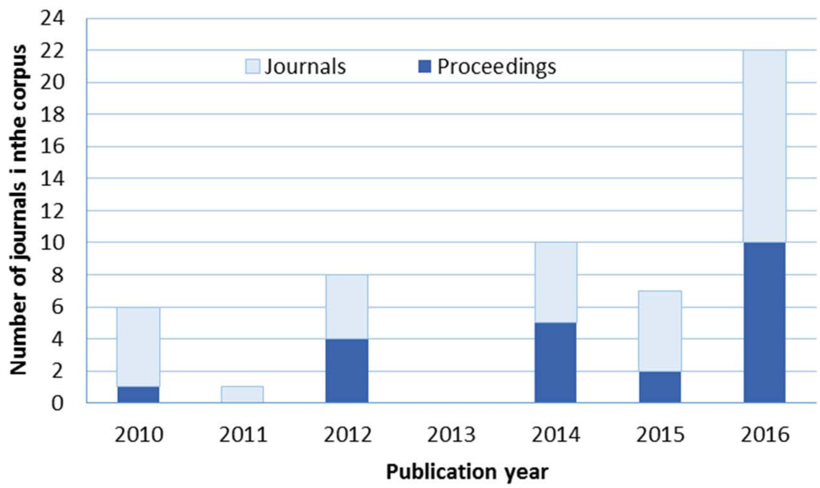

Figure 3. Articles frequency per year

Figure 4 shows the journal's names where the articles were published. We observe again the great contribution from proceedings, and from the series of Transportation Research journals. On other hand, when reading the articles, we extracted our own keywords to identify them. Figure 5 shows these keywords and their frequency. In this case, papers could be classified in more than one keyword.

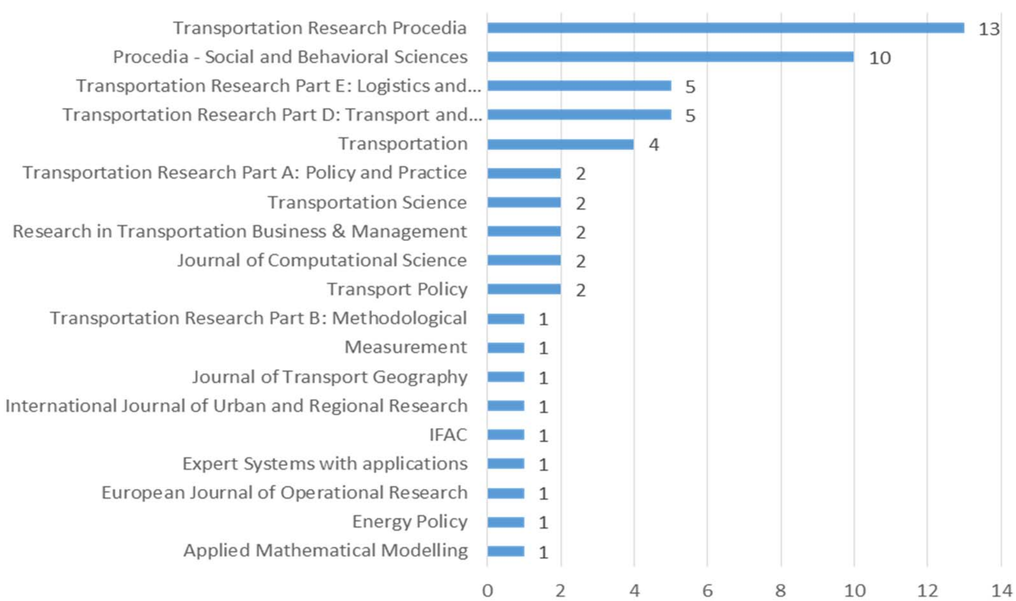

Figure 4. Papers per journal

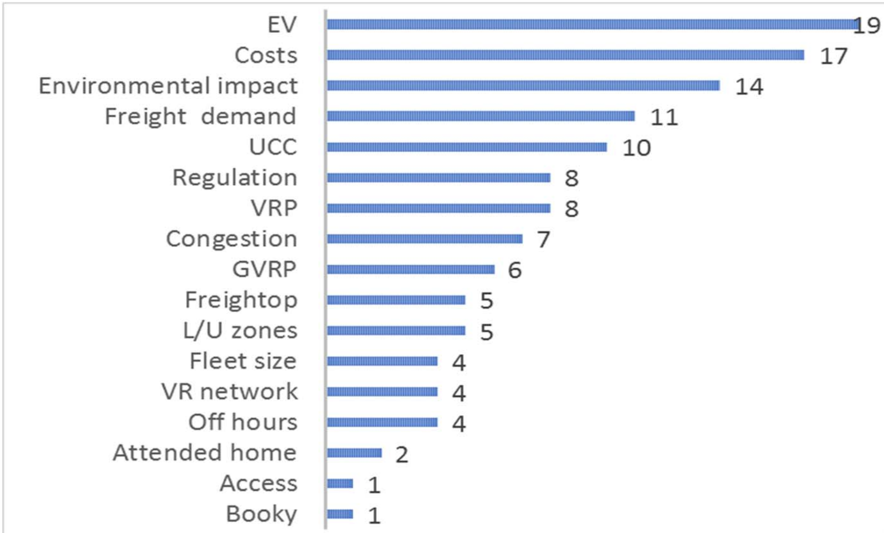

Figure 5. Number of papers addressing each keyword

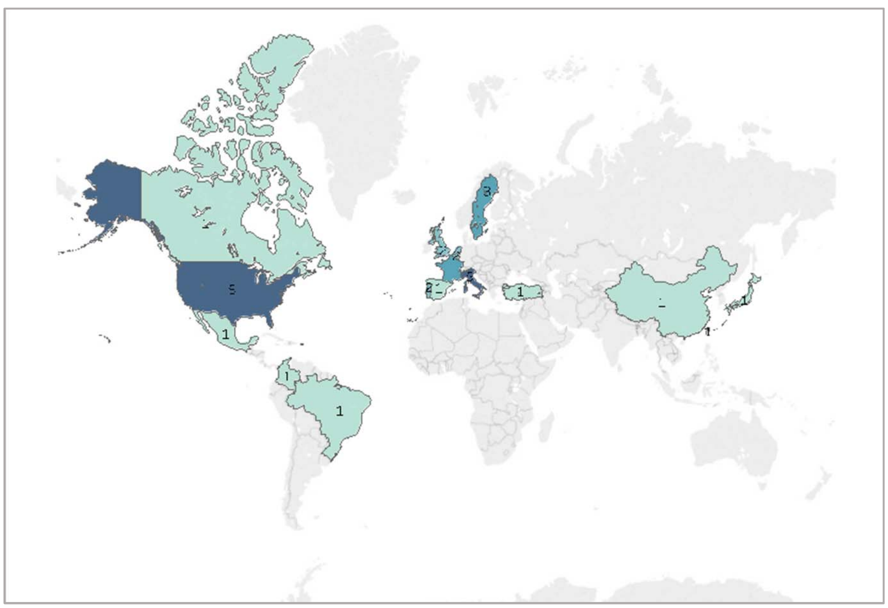

Figure 6. Countries talking about LMD

In Figure 6 we can see the countries where LML has been study. We can see that in Europe is where more projects have been implemented. In North America, this theme is more recent than in Europe, but currently there are many projects in the main cities. Meanwhile Latin-American is starting taking care about this subject, especially in some megacities, where congestion and pollution are the main concerns. In Asia, the problem before it become a big problem, for example the bicycle have been a delivery system since centuries before, but now the EV are trend in all the world. In Figure 7, the map shows the cities where the authors work. We can see a natural similarity with Figure 6. We can also find that some papers written by groups of authors from different universities and nationalities.

Figure 7. Cities where the authors work

4 Last mile logistics' drivers

To answer the first RQ1, we conclude from introduction and justification sections of the corpus, the main ideas that seem driving the interest for working on last mile distribution logistics. They are grouped in four: 1) the urban density increasing, 2) the e-commerce market boom, 3) the sustainability awareness, and 4) the pursuit for better cities. These drivers are developed below:

4.1 Urban density increasing

The global population is increasingly concentrating in cities (Foltynski, 2014). Cities are continuously confronted by a variety of challenges caused by the urban transport that is why we must face the challenge of reducing traffic congestion and pollution emissions. Cities are growing at a rapid pace, paired with an increase in residential and business needs, with around 80% of the population living in cities, with the majority in medium-sized cities. This has produced an increase in the movement of goods into the city from external producers.

Approximately 75% of the energy and 75% of CO2 is consumed in cities. Therefore, they play a key role in achieving the EU objective of 20% energy saving by 2020 and developing a low carbon economy by 2050. In Europe, around 75% of the population lives in urban areas and this is predicted to increase to about 80% by 2020. Talking about world´s population, 70% will be living in cities by 2050 (Foltynski, 2014). These Urban population growth and rapid urbanization have generated an increasing freight transportation demand within cities. These cause environmental and mobility problems linked to air pollution and traffic congestion (Browne, 2012, Benjelloun & Crainic, 2008).

Furthermore, megacities, which are cities with a population of over ten million, are increasing on number and size. Whereas in 1950 the only megacities were Tokyo and New York, currently there are 28; it is expected to have 41 in 2030 (Kin, 2017). In emerging markets is a new phenomenon; the size of these cities combined with the high growth rates provides substantial sustainability challenges. Urban freight transport contributes to these challenges (Kin, 2017). Nanostores are an essential part of the economy ecosystem in emerging markets. Nanostores do not only offer products, to the mass market at the right price-point but they also provide income to small business owners. Understanding the operational characteristics and the supply chain requirements of the nanostores is an essential step in effectively reaching over 5 billion consumers in emerging markets.

4.2 E-commerce market boom

E-commerce is all electronically mediated information exchanges between an organization and its external stakeholders. E-commerce in general is a developing process from information and communication to transaction, integration and automation (Enarsson, 2002). E-commerce has become more popular in business using Internet. Sales in physical stores grew only 0.9% globally, while online sales grew 14.8% between 2007 and 2012 (Visser, 2014). This growth of Internet shopping Business to Consumer (B2C) affects urban delivery systems (Taniguchi 2016). E-commerce (B2C) is creating a surge in home deliveries that is increasing the social and environmental costs of goods distribution systems.

The characteristics of the e-commerce service are: small packages, high frequencies, decreases shopping trips by customer, failed deliveries, low utilization of vehicles, attended home deliveries. One of the major challenges here is the delivery cost. According to Kämäräin (2001), the cost differences generated when comparing deliveries with and without windows time are of 42%, while Boyer (2009) shows that the distance traveled in routes increases to 2.15 times when going from scenarios without time windows to others with windows of one hour.

4.3 Sustainability awareness

More than a half of the papers are concerned on sustainability issues. They look for improving not only the logistic process but to take care on the effects on the environment. The potential benefits are both economic and environmental (De Marco 2014). As an example, we can mention Rao et al (2015) that integrate the economic, environmental, and social dimensions of sustainable development.

In the modern society, reduction of the CO_2 emission is a major challenge. Annual European Union greenhouse gas inventory states that total CO_2 emission due to road transportation increased 123 million ton between 1990 and 2012 for 28 member countries of EU (Afsar, 2016). In addition, global transport emissions have risen annually by nearly two billion tons of CO_2 equivalent since 2000, with freight transport generating between 20% and 60% of local transport-based pollution (International Energy Agency, World Energy Outlook 2013).

According to this agency, cities are where 69% of Europe's CO2 are emitted and urban transport accounts for 70% of the pollutants and 40% of the greenhouse gas emissions from European road transport (Green Paper: Towards a new culture for urban mobility, 2007).

Using electrical vehicles (EVs) seems to be the option to CO_2 emissions and reduce noise pollution. EVs and other low carbon vehicles are expected to have an important role- in meeting CO_2 reduction targets. EVs are an energy-efficient alternative for the traffic in the cities caused by the urban freight transport; also they help to reduce emissions and noise. According to Foltynski (2014), the advantages of EVs are more pronounced when switching to more efficient ways for the last-mile delivery of goods in city centers.

A wider CL vision suggests a more integrated logistics system, where shippers, carriers, and movements are coordinated, and the freight of different customers and carriers is consolidated into the same green vehicles (De Marco et al, 2014).

4.4 Pursuit for better cities

Logistics service providers' main activity consists in undertaking freight distribution to customers (Ehmke & Mattfeld, 2012). They are expected to offer high quality and reasonably priced delivery services in urban areas, which present several peculiarities like traffic congestion and restricted traffic areas (Benjelloun & Crainic, 2008).

"Freight vehicles compete for the street and parking space capacity and contribute significantly to congestion and environmental nuisances, such as emissions and noise (OECD, 2003, Patier, 2002, Figliozzi, 2007). These nuisances impact the life of people living or working in cities, and the productivity of the firms located in urban zones and of the associated supply chains. They also contribute to the belief that "cities are not safe" that pushes numerous citizens to move out of the city limits".

Travelers suffered travel delay of 4.8 billion hours, using extra 1.9 billion gallons of fuel (Jaller et al, 2015). Urban areas are experiencing rapid development and expansion. Economic activities are increasing demanding more consumer goods and services. Private and commercial vehicle demand has also increased.

The reduction of freight vehicle trips during peak hours has been a common policy goal. Policies have been implemented to shift logistics operations to nighttime hours. The purpose of these policies has been to mitigate congestion and environmental impacts. Off-peak policies can be environmentally improving or damaging, depending on traffic speeds and meteorology (Sathaye, 2010). As an example, Holguin & Sánchez (2016) show that switching deliveries to off-hours (7 PM to 6 AM) can reduce emissions and can also reduce CO_2 emissions by 200 million tons/year. Currently there are already many congestion problems in the city, but in the future deliveries are expected to increase (Marcurri and Danielis 2008).

5 Last mile distribution logistics Network

To answer RQ2, we first identify the components to be considered in the design of logistics; then, we identify the main considerations and variables when facing the challenge of designing (or redesigning) a LM distribution logistics network, and present the lists of papers that deal with each topic.

5.1 Distribution Network

The main elements that integrate a distribution network are the distribution channels, the facilities, the fleet and the transport network.

5.1.1 Distribution channels

A Last-mile distribution system involves linear movement of merchandise from the source of merchandise to customer homes. There are three basic forms for these movements' push, pull and hybrid (Lim 2015).

Changing the distribution network design affects different costs in the supply chain, such as inventories, transportation, facilities and handling, and the information (Chopra, 2016). In a direct store delivery, the flow of cash information and products is handled by a manufacturer's distribution person, usually the delivery person. In the wholesaler and distributor channels, manufacturer has no visibility to the nanostores.

Push-Centric System: N-Tier Direct to home, send to customers' homes by someone other than the customer. Is when the retailers are responsible to fulfill the orders and ensure products are 'pushed' or delivered to the customers' doorsteps. The trade-offs in decision-making of distribution channel selection are centered on level of inventory, transportation cost and level of responsiveness achievable. The nearest the picking spot is from the consumer segment, the more responsive the channel would be but at the expense of lower level of inventory aggregation; translating to higher inventory level and cost.

Pull-Centric System: Customer Self-Help, fetched from the source of merchandise by the customer. This is when the customers perform 'self-help' service to make purchase and collect their products from the fulfillment point (order fulfillment), and perform the "last-mile delivery". Here the customers perform the last-mile themselves. This comes at the expense of customer satisfaction. The study by Kämäräinen et al. (2001) affirms that customer satisfaction is typically lower compared to attend home delivery (AHD) as customer should travel to and from the store.

Hybrid-Centric System: N-Tier to Customer Self-Help Location, sent to some intermediate site from which the customer fetches the merchandise. The hybrid system attempts to locate the middle ground and leverage on the attractiveness of both a wholly push- or pull-centric distribution structure. For instance, it permits the use of more economic transportation such as full truck load vehicles for delivery of large quantity of goods to the DC, DC sorts the orders, and have the goods delivered using smaller vehicles to the designated shared recommended pick up point for customers to collect.

This classification can be seen as a new version of classical Chopra's classification of distribution network in a supply chain (Chopra & Meindl, 2016). The push-centric system by Lin is to the Chopra's network called Distributor storage with last-mile delivery. It worth noting that this scheme, also referred as "traditional channel" is the most used in developing countries, where there is a strong presence of small shops attended directly by their owner. These shops are called nanostores (Blanco & Fransoo, 2013). For example, it represents about 61 percent of the market share in all Latin America (Nielsen, 2009).

5.1.2 Facilities

Concerning to facilities in the distribution network one major finding of this study is to recognize that it is not enough to only consider the main facilities as manufacturer, warehouse, distribution centers, retailers and customers as Chopra (2016) used to classify distribution networks. New elements need to be added such as urban consolidation centers (UCC) or urban distribution centers (UDC), satellites, pick-up or collection points, and load / unload zones.

The UDC concept as physical facility is close to those of intermodal logistic platforms and freight villages, which receive large trucks and smaller vehicles dedicated to local transportation, and offer storage, sorting, and consolidation (de-consolidation) activities, as well as a number of related services, e.g. legal counsel, accounting, brokerage, and so on. Table 3 summarizes the main concepts related to city facilities. Some of them are equivalent in meaning. There are two-tier facilities: the UDCs and the platforms satellites. Urban-trucks move freight to satellites, and city-freighters are vehicles of relatively small capacity that can travel along any street in the city toper form the required distribution activities, both are supposed to be environmental friendly.

Table 3. Main concepts on urban logistics and urban facilities

LMD / LML / LMD	Last mile delivery/Last mile distribution / Last mile logistics. It refers to the distributor / retailer delivering the Chopra product to the customer's home instead of using a package carrier.	Chopra
UL / CL	Urban Logistics /City Logistics is based on the systems approach that involves a number of technical processes including modeling, evaluation and the application of information technologies.	Taniguchi, 2016
UCC / UDC /TP	Infrastructures that allow the consolidation of goods before the last mile delivery. These facilities are usually classified into three main types, namely, urban consolidation centers, urban distribution centers and transit points, depending on how long goods remain in the warehouse and what type of actions are performed regarding freight (i.e. consolidation, transshipment).	Lagorio, 2016
Load and Unload zone	The ideal location to serve the largest number of commercial activities, their management system and rules for use and booking.	Lagorio, 2016
CLC	City Logistics Center: Logistics facility that is situated in relatively close proximity to the geographic area that it serves, be that a city center, an entire town or a specific site (e.g. shopping mall), from which consolidated deliveries are performed within that vicinity.	Crainic, 2009
Pickup centers	Pick-up points are prearranged places where people go to collect their on-line ordered parcels. Parcel lockers are last generation automatic dispensers that allow the delivery and retrieval of goods and documents around the clock	Lagorio, 2016

Kunse et al (2016) identifies logistics location decisions as a strong positive influence on logistics operations, as well as transport technology on the economic performance of logistics operators and on environmental quality. The success factors for UDCs according to Taniguchi (2016) are the location which should be near to the city or even inside, the subsidy collection, the collaboration with shipper and freight between the same company or different, the financial viable situation which envelope the costs, the service of the UDC, the access permit cost, delay in delivery time, and the distance from the parking bay from the shop.

5.1.3 Fleet

The interest in modern EVs comes from the characteristics that differ from conventional petrol or diesel vehicles. Their ecological impact can be positive when renewable energy such as wind or solar energy is used (Lebeau et al, 2012).

The advantages of EVs are even more pronounced when switching to more efficient ways for the last-mile delivery of goods in city centers (Foltynski, 2014). Table 4 summarizes the definitions of the new vehicles used in city deliveries, and Table 5 describes a classification by Foltynski (2014) of the different types of electrical vehicles. Related with this, Kunse et al (2016) used the concept Treibstoff costs to include cost of gasoline (including other combustibles) and other forms of propulsion energy (as e.g. gas, electricity) including taxes.

Table 4. Types of vehicles

EV	Electrical vehicles present an opportunity to reduce greenhouse gas emissions; due to they don't use combustible. Their emissions depend on the electrical energy production's emissions.	Afsar, 2016
Hybrid	They contaminated less than regular combustible vehicles, because these vehicles use combustible but in majority from a hybrid source.	Lebeau, 2012
Tricycle	Three wheel vehicles with human propulsion source.	Zhang, 2016
Bike	Two wheels, human propulsion source. Use of cargo-bike for freight distribution.	Lagorio, 2016
Scooter	Two wheels vehicle that work with battery, or a small motor.	Wang, 2008
Drones	Programmed vehicles without humans. Recently used to deliver goods in cities or places of difficult access.	

Table 5. Types of Electric Vehicles (Foltynski 2014)

EV or BEV	Electric vehicle or Battery electric vehicle; are powered only by one or more electric motors. They receive electricity by plugging into the grid and stroking it in batteries.
PHEV	Plug-in hybrid electric vehicle; use batteries to power an electric motor, plug into electric grid to charge, and use a petroleum-based or alternative fuel to power an ICE or other propulsion source.
HEV	Hybrid electric vehicle, combine an ICE or other propulsion source with batteries, regenerative braking, and an electric motor to provide high fuel economy. They rely on petroleum-based or alternative fuel for power and are not plugged in to charge.
ICE	Internal combustion engines; generate mechanical power by burning a liquid fuel or gaseous fuel. They are the dominant power source used by on-road vehicles today.
EVSE	Electric vehicle supply equipment; delivers electrical energy from an electricity source to charge an EV or PHEV batteries. It communicates with EV and PHEV to ensure that an appropriate and safe flow of electricity is supplied.

Finally, the last element is the transport network. It refers to the road, water, and pipeline infrastructure. It is an element highly strategic driven by the administrative actors, and it is considered out of the scope of this study. When City logistics is seen as a strategic problem, the identification of its stakeholders becomes relevant. Examples can be found in Crainic & Benjelloun, 2009, Vidal et al, 2015, Bebrends, 2016, and Kunze (2016). The last one makes the "widest" classification of stakeholders to model with systems thinking the interdependence of their decisions on CL. The business part includes producers, resellers and LSP, for individuals it includes customers and citizens, and the administrator includes City Authorities and Lawmakers.

5.2 Considerations and variables from the corpus

In this section, we present the analysis from the corpus in four stages: the main focus (or dimension) of the articles, the solution methods used, the objective pursued, and other considerations that should be taking into account. In each stage, we identify subcategories if needed, and present a list of the papers that deal each topic.

Since this study is focused on facilities and fleets in a LM distribution network, Table 6 shows these dimensions, and a sub classification for each one. It can be observed that a third dimension showed up, the demand management. It is related to decisions when facing access or time restrictions, most of them looking for sustainable goals.

Related with vehicles, we found many papers talking about routing; even this topic was out of the scope we wanted to consider. The distinguishing characteristics for urban distribution are the importance of time-dependent routes, length of arcs and variable speeds.

In addition, some papers treat heterogeneous fleets, considering a combination of traditional fleets (i.e. internal combustion engines) with green vehicles (electric or hybrid ones). Loading and unloading areas showed up frequently. One article studies the use of tricycles in urban distribution in China, showing this is an efficient transport and how they are beginning to be recognized as a viable mode to LMD.

Table 6. Dimensions

Dimension	*Topic*	*List of papers*
Urban Locations	UCC	101 148 355 357 365 366 511 1812
	Load / Unload zones	355 365 369 391 527
Vehicles	EV fleet dimensión	441 3511 3516 3612
	EV heterogeneous fleet	31 182 357 1130 1131 1812 3516
	Trcycles	372
	VRP load factor	183 491 524 1131 1812
	VRP time dependent	367 391 441 491 1131
	VRP network design	116 358 359 521
Demand	Off-hours	54 149 35 356
	Access restrinction	31

Table 7. Solution methods

Step	*Method*	*List of papers*
Modelling	MIP	31 182 366 1131 1812 491 524
	Frameworks	352 357 451 501 1130 1811 3612
Tools	Survey	142 361 431 501 1130 1811
	City data	51 54 101 116 142 149 182 352 355 356 357 365 366 369 372 461 511 521 525 526 527 529 1130 3511 3515 3516 3610 5210
	Telemetrics	358 359 367 369 391 451 461 471 521 3514 3516 3518
Solution	(meta) Heuristics	116 183 366 491 524 1131 1812 3518 441 391 116
	Statistics	358 359 501 526 527 3516
	Analitical methods	1130 441 367 491 358
Validation	Cases	51 54 101 116 142 149 182 352 355 356 357 358 365 366 369 372 461 511 521 525 526 527 529 1130 3511 3515 3516 3610 5210 1130
	Benchmarking	441 511 524 1812
	Simulation	352 529 1131 3513 3515 3516 3518

Concerning to solution methods, we found many conceptual frameworks that try to describe or model the situation, as well as many applications in cities whose results are handled as cases because it is recognized that each city has its own characteristics, without pretending that the results can be "extrapolated" to any other city. We also see the consistency of tools with validation methods (cases versus city data). Metaheuristics are often used when the problems is focused on solving routing problems. Other analytical methods are used, such as discrete choice analysis, enumeration techniques, continuous approximation of combinatorial problems, data analytics, etc.

On other hand, when analyzing the objectives pursued by the corpus, cost still appears as the main one. Objective costs refer to any type of cost involved in the LMD, such as infrastructure cost, driver costs, truck costs, travel costs, energy cost, time of delivery, stop time, etc. However, objectives on reducing emissions are almost as frequent as costs reduction. Few papers focus on efficiencies and the quality of life issue is handled as congestion, as well as the delays in the deliveries.

Table 8. Objectives

Objective	*List of papers*
Costs	31 148 182 357 358 359 368 372 431 441 451 461 525 1811 1812 3516 3611
Emission	54 148 149 182 355 357 368 491 526 1811 1812 3514 3611 3612
Congestion	54 116 149 358 359 526 1131
Operational performance	511 471 3511

Finally, some considerations are pointed out, and they are classified as endogenous or exogenous to a logistic service provider. The concept of consolidation is when a company put together the delivery from different areas. The collaboration is when different companies share a UDC and information related to the deliveries to reduce their costs. These two concepts are central when thinking on urban distribution networks. The idea of getting benefits comes from the possibility that, through cooperation and collaboration, the share of the distribution network elements will allow increase efficiency and decrease costs and environmental effects.

The concept of sustainability refers to the presence of the three pillars of sustainability: the social, economic and environmental ones. On other side, policy and regulation issues remind us the importance of considering their effects on LM performance and how they become barriers or motivators for a urban and sustainable solutions.

Detours appear also as an option, and it refers to the option of deviate from the most efficient route, either by congestion, by access restrictions or conditions of the road. At last, logistics performance refers typically to efficiency measures.

Table 9. Final considerations

Considerations	*For a LPS:*	*List of papers*
Consolidation	Endogenous	51 3511
Collaboration	Endogenous & Exogenous	182 368 451
Sustainability	Endogenous & Exogenous	54 148 149 182 355 357 368 491 526 1811 1812 3514 3611 3612
Policy / regulation	Exogenous	356 451 461 511 521 524 3516 3517
Detours	Endogenous & Exogenous	431
Load/Unload zones	Endogenous & Exogenous	355 365 369 391 527
Logistics performance	Endogenous	511 471 3511

Other related reviews are Boloukan et al (2016), Lagorio (2016), Visser et al (2014), Behrends (2016).

5.3 Urban facilities and green vehicles

In order to answer the RQ3, compatibility between urban logistics and green vehicles has been observed. Though, the limited range of BEVs is often considered the most important barrier, it is estimated that more than 80% of freight trips in European cities are shorter than 80 km, which is compatible with those limited ranges of BEVs. Ranges in Europe are assessed based on the NEDC which assumes a more energy efficient driving cycle than in real conditions (Pelkmans and Debal, 2006). On other hand, UCCs are identified as a suitable logistics concept in which BEVs can achieve city-center deliveries (ELCIDIS, 2002); and BEVs behavior also depends on a home base at which they can be recharged during their inactive period.

Green Vehicles and EVs are expensive compared with regular combustible vehicles, and they have less capacity for the merchandise. We need to have in mind that less capacity means we need more vehicles, and this could generate more costs in number of trucks and drivers.

Rao et al (2015) identifies three sustainability criteria when solving the problem of locating facilities in the city. He considers the economic criteria, the environmental criteria and the social criteria. The economic criteria refer to the price of acquiring land, upside delivery flexibility, transportation conditions (connectivity), service level, and human resource condition. Next, the environmental criteria are about the environmental protection level, impact on ecological landscape, natural conditions. Last, the social criteria refer to the public facilities condition, security, comply with environmental regulations, impact on nearby residents, and impact on traffic congestion.

On other hand, Quak et al (2016) review the feasibility of using EV in UFT from a carrier's perspective, including their attitudes towards EFV. They identify five critical elements for the EFV business case. The first element is the technology which involves fewer maintenance efforts, lack of MTT service and repairing, limited availability of heavy EFV. This has four charging methods; the in-house charging, the public charging points, the inductive charging, and battery charging. Some possible extra costs are the high vehicle battery repair, vehicle replacement, charging infrastructure, grid upgrade, and landlord permission. As a benefit is involve low main cost.

As a second element we have the operations, this is the adoption of considerations from logistics view. It involves possible extra costs in the transshipment costs of goods from ICE to EFV. The third element is the economics. The small businesses have problems due to lack of funding, especially for them the production of batteries can also be a limitation. A price of an EFV depending on the ton size compared with a conventional van is showed in Table 10.

Table 1. Relative costs of BEVs

EFV	PRICE
Less than 3.5 tons	2 times
Between 3.5 – 7.5 tons	2 – 4 times
More than 7.5 tons	4 – 5 times

Some possible extra cost for this element are the higher purchase price, higher vehicle repair, vehicle replacement, heating/cooling equipment, training of drivers/additional hiring, additional procurement costs. While a potential benefit could be the lower operational costs and the lower main cost (20-30%).

The next element is the policy and procurement this refers to favorable taxation schemes, no congestion charge for EFVs, no parking fee or no road tax. In other side the supportive policies such as entering low emission zones, use of bus lanes, parking at non-loading areas, wider time access restrictions, and possibilities to enter pedestrian zones can result in operational advantages. It also involves decrease in stress for the drivers, better performance and fewer mistakes.

The last element is the drivers' attitude. It is about having happy and stress-free drivers, with positive attitude toward customers.

5.3.1 Green fleets and routing problems

VRP problems involving green fleets are identified as fleet size and mix pollution-routing problem. These problems consider the effect of speed zones, the fact that a shortest path is not always the fastest, least polluting path in CL, and that the faster driving is cheaper and less polluting in the CL context.

It is also found that highest costs are attained when all customers are in the city center, that it is preferable to locate depots outside the city center, and that costs can decrease by up to 17% when using heterogeneous fleet instead of a homogeneous one, while depot capacity utilization levels tend to be higher than the vehicle capacity utilization levels.

6 Final remarks

Coming from the analysis we have done, papers are showing and demonstrating the importance of the comparison of different solutions. The case studies methodology is giving useful information and good data to analysis. The main drawback is that conclusions are totally linked to the special situation and it becomes quite hard to compare different approaches. We also noticed that no distinction is made in the corpus on the type of products to be delivered, whether they are of mass consumption or not, nor on the density of the urban zone. It is generally assumed to be denser than national wide logistics networks but it is not explicitly said. However, the products may or may not be mass consumption. For example, home deliveries may include from supermarket items to infrequent parcels.

6.1 New strategies

Some new strategies to improve the last mile distribution had been recently studied. Those concepts had been developed and now are reaching interests in order to answer the challenges related with the LMD problem.

The first is the collaboration, not only sharing responsibility, but also sharing resources and more importantly, the information. This a known concept that is already recognized as important to LMD but not really appreciated in the literature read.

There is also a new concept that should be explored: Crowdsourcing. This is a "type of participatory online activity in which a person, institution, non-profit organization, or company, proposes to a group of individuals, through an open and flexible call, the free and voluntary accomplishment of a task the accomplishment of the task, of variable complexity and modularity, and in which the multitude must participate by contributing their work, money, knowledge, and / or experience, always implies a mutual benefit. The user will receive the satisfaction of a concrete necessity, whether it is economic, social recognition, self-esteem or personal development, while the crowdsource will obtain and use the user's contribution, whose form will depend on the type of activity performed" (Estellés & González, 2006). We have not found scientific literature concerning the logistics problems implied when using this type of distribution strategy.

Another strategy is to use frequent points in the city, such as gas stations and convenience stores as satellite or collection points. This strategy has not been discussed in the scientific literature but is observed in practice and in some white papers.

The last strategy proposed is the co-modality which involves the range of services offered by modes of transport that include the use of public transport as well as trains, buses or taxis to transport goods as well as to transport passengers. This one is exposed by Taniguchi (2016), but not found in the corpus. We did not found either the use of autonomous vehicles in LMD.

6.2 Recommendations for future research

It appears that in order to keep working and go further in this field, the analysis of two major components of this urban logistic ecosystem, people and technology will be relevant. These decisions will totally change the analyzing point of view by moving from a technology-centered approach to an approach focused on reaction and interactions between those majors. So, it can be a relevant point to use a systemic approach showing the interactions with the components instead of an only focus on the components.

To end, it's worth proposing other interesting topics that appeared not to be well developed in the corpus, such as: a) Fleet composition, considering heterogeneous fleet including motor and non-motorized vehicles; b) Schemes of acquisition of city facilities altogether, such as rental, tertiary, garages, loading zones booking, etc; and c) Implications of logistics decisions in human resource management. The fact that more vehicles with less capacity means more drivers, and the consequent questions, such as: where are vehicles running? What will be the work-basis for a driver? And, what is the best scheme of vehicle' ownership?

6.3 Limitations

The limited access to complete articles is identified as the main limitation of this study. At least 20 articles were excluded for this cause. Therefore, conclusions and findings are the result of the analysis done exclusively from the corpus described above. However, we think this is a good sample that gives confidence on the generality of the analysis presented in this work.

7 References

7.1 Methodologies sources

Gomez Bastar S., Metodología de la Investigación, *Red Tercer Milenio*, 2012.

Jordan C.H. & Zanna M.P., How to read a Journal Article in Social Psychology, *The Self in Social Psychology*, pp. 461-470, 1999.

Keathley-Herring H., Van Aken E., Gonzalez-Aleu F., Deschamps F., Letens G., and Cardenas Orlandini P., Assessing the maturity of a research área: bibliometric review and proposed framework, 2016.

Tranfield D., Denyer D. and Smart P., Towards a Methodology for developing evidence-informed management knowledge by means of science review, *British Journal of Management*, pp. 207-222, 2003.

7.2 Papers in the corpus

(31) Franceschetti A., Honhon D., Laporte G., Van Woensel T. and Fransoo J.C., Strategic fleet planning for city logistics, *Transportation Research Part B: Methodological,* Vol. 95. pp. 19-40, 2017.

(51) Holguín-Veras J. & Sánchez-Díaz I., Freight Demand Management and the Potential of Receiver-Led Consolidation programs, *Transportation Research Part A: Policy and Practice,* Vol. 84. pp. 109-130, 2016.

(54) Sathaye N., Harley, R. and Madanat S., Unintended environmental impacts of nighttime freight logistics activities, *Transportation Research Part A: Policy and Practice,* Vol. 44. pp. 642-659, 2010.

(101) Cidell J., Distribution Centers among the Rooftops: The Global Logistics Network Meets the Suburban Spatial Imaginary, *International Journal of Urban and Regional Research,* Vol. 31. pp. 832-851, 2011.

(116) Bachmann R. & Langevin A., A vehicle routing cost evaluation algorithm for the strategic analysis of radial distribution networks, *Transportation Research Part E: Logistics and Transportation Review*, Vol. 45. pp. 50-60, 2009.

(114) Zhang G., Smilowitz K. and Erera A., Dynamic planning for urban drayage operations, *Transportation Research Part E: Logistics and Transportation Review,* pp. 764-777, 2011.

(119) Jula H., Dessouky M., Ioannou P., and Chassiakos A., Container movement by trucks in the metropolitan networks: modeling and optimization, *Transportation Research Part E: Logistics and Transportation Review*, pp. 235-259, 2005.

(141) Igl J. & Kellner F., Exploring greenhouse gas reduction opportunities for retailers in Fast moving consumer goods distribution networks, *Transportation Research Part D: Transport and Environment*, pp. 55-69, 2017.

(142) Lebeau K., Van Mierlo J., Lebeau P., Mairesse O. and Macharis C., The market potential for plug-in hybrid and battery electric vehicles in Flanders: A choice-based conjoint analysis, *Transportation Research Part D: Transport and Environment,* Vol. 17. pp. 592-597, 2012.

(148) Rao C., Goh M., Zhao Y. and Zheng J., Location selection of city logistics centers under sustainability, *Transportation Research Part D: Transport and Environment,* pp. 29-44, 2015.

(149) Holguín-Veras J., Encarnación T., González-Calderón C.A., Winebrake J., Wang C., Kyle S., Herazo-Padilla N., Kalahasthi L., Adarme W., Cantillo V., Yoshizaki H. and Garrido R., Direct impacts of off-hour deliveries on urban freight emissions. *Transportation Research Part D: Transport and Environment*, 2016.

(182) Muñoz-Villamizar A., Montoya-Torres J.R. and Faulin J., Impact of the use of electric vehicles in collaborative urban transport networks: A case study, *Transportation*, Vol. 50. pp. 40-54, 2017.

(183) Teng L. & Zhang Z., Green vehicle routing problem with load factor. *Transportation*. Vol 3. pp. 75-82, 2016.

(1130) Nuzzolo A. & Comi A., Urban freight demand forecasting: A mixed quantity/delivery/vehicle-based model, *Transportation Research Part E: Logistics and Transportation Review*, pp. 84-98, 2014.

(1131) Xiao Y. & Konak A., The heterogeneous green vehicle routing and scheduling problem with time-varying traffic congestion, *Transportation Research Part E: Logistics and Transportation Review,* Vol. 81. pp. 146-166, 2016.

(1811) Lebeau P., Macharis C. and Van Mierlo J., Exploring the choice of battery electric vehicles in city logistics: A conjoint-based choice analysis, *Transportation*, pp. 245-258, 2016.

(1812) Koç Ç., Bektaş T., Jabali O. and Laporte G., The impact of depot location, fleet composition and routing on emissions in city logistics. *Transportation*, pp. 81-102, 2016.

(223) Thomas F., Urban Freight Economics: A New Rail Paradigm For Large Lots, *Transportation Journal*, pp. 5-15, 2001.

(352) Kijewska K. & Iwan S., Analysis of the Functioning of Urban Deliveries in the City Centre and its Environmental Impact Based on Szczecin Example, *Transportation Research Procedia,* Vol. 12. pp. 739-749, 2016.

(353) Nesterovaa N. & Quaka H., A city logistics living lab: a methodological approach, *Transportation Research Procedia,* pp. 403-417, 2016.

(354) Roca-Riu M., Estrada M. and Fernández E., An evaluation of urban consolidation centers through continuous analysis with non-equal market share companies, *Transportation Research Procedia,* pp. 370-382, 2016.

(355) De Oliveira L.K., Fonseca de Oliveira G. and De Abreu Vieira R., Identifying Solutions for Car Vehicle Deliveries in Urban Areas, A Case Study in Belo Horizonte (Brazil). *Transportation Research Procedia,* Vol. 16. pp. 425-432, 2016.

(356) Holguín-Veras J., Sánchez-Díaz I. and Browne M., Sustainable urban freight systems and freight demand management. *Transportation Research Procedia,* Vol. 12, pp. 40-52, 2015.

(357) Janjevic M., Lebeau P., Ballé Ndiaye A., Macharis C., Van Mierlo J. and Nsamzinshuti A., Strategic scenarios for sustainable urban distribution in the Brussels capital region using urban consolidation centres, *Transportation Research Procedia* Vol. 12. pp. 598-612, 2016.

(358) GroB P., Geisinger M., Ehmke J.F. and Mattfeld D.C., Interval travel times for more reliable routing in city logistics, *Transportation Research Procedia*, Vol. 12, pp. 239-251, 2016.

(359) GroB P., Ulmer M.W., Ehmke J.F. and Mattfeld D.C., Exploiting travel time information for reliable routing in city logistics, *Transportation Research Procedia*, Vol. 10, pp. 652-661, 2015.

(361) Gevaers R., Van de Voorde E. and Vanelslander T., Cost Modelling and Simulation of Last-mile Characteristics in an Innovative B2C Supply Chain Environment with Implications on Urban Areas and Cities, *Procedia - Social and Behavioral Sciences*, Vol. 125. pp. 398-411, 2014.

(363) Ehrler V. & Hebes P., Electromobility for City Logistics–The Solution to Urban Transport Collapse? An Analysis Beyond Theory, *Procedia - Social and Behavioral Sciences*, Vol 48. pp. 786-795, 2012.

(365) Dezi G., Dondi G. and Sangiorgi C., Urban freight transport in Bologna: Planning commercial vehicle loading/unloading zones, *Procedia - Social and Behavioral Sciences,* Vol. 2. pp. 5990-6001, 2010.

(366) Guyona O., Absia N., Feillet D. and Garaixa T., A modeling approach for locating logistics platforms for fast parcels delivery in urban areas, Procedia - *Social and Behavioral Sciences*, Vol. 39. pp. 360-368, 2012.

(367) Ehmke J.F. & Mattfeld D.C., Vehicle routing for attended home delivery in city logistics, *Procedia - Social and Behavioral Sciences*, Vol. 39, pp. 62-632, 2012.

(368) Feng W. & Figliozzi M.A., Conventional vs electric commercial vehicle fleets: a case study of economic and technological factors affecting the competitiveness of electric commercial vehicles in the USA. *Procedia - Social and Behavioral Sciences*, Vol. 38, pp. 702-711, 2012.

(369) Patier D., Bertrand D., Chalon R. and Deslandres V., A new concept for urban logistics delivery area booking. *Procedia - Social and Behavioral Sciences,* pp. 99-110, 2014.

(372) Zacharias J. & Zhang B., Local distribution and collection for environmental and social sustainability - tricycles in central Beijing, *Journal of Transport Geography*, Vol 49, pp. 9-15, 2015.

(391) Ehmke J.F., Steinert A. and Mattfeld D.C, Advanced routing for city logistics service providers based on time-dependent travel times, *Journal of Computational Science*, Vol. 39. pp. 193-205, 2010.

(431) Vidal Vieira J.G. & Fransoo J., How logistics performance of freight operators is affecting by urban distribution issues, *Transport Policy,* Vol 44, pp. 37-47, 2015.

(441) Vaz Penna P.H., Afsar H.M., Prins C. and Prodhon C., A Hybrid iterative local search algorithm for the electric fleet size and mix vehicle routing problem with time windows and recharging stations, *IFAC,* Vol. 49, no. 12. pp. 955-960, 2016.

(451) Awasthi A., Adetiloye T. and Crainic T.G., Collaboration partner selection for city logistics planning under municipal freight regulations, *Applied Mathematical Modelling*, Vol. 40, pp. 510-525, 2016.

(461) Andress D., Das S., Joseck F. and Nguyen T.D., Status of advanced light-duty transportation technologies in the US, *Energy Policy*, Vol. 41, pp. 348-364, 2012.

(471) Speranza M.G., Trends in transportation and logistics, *European Journal of Operational Research*, In press, 2016.

(481) Lin C., Choy K.L., Ho G.T.S., Chung S.H. and Lam H.Y., Survey of green vehicle routing problem: past and future trends. *Expert Systems with applications*, Vol. 41, pp. 1118-1138, 2014.

(491) Naderipour M. & Alinaghian M., Measurement, evaluation and minimization of CO2, Nox, and CO emissions in the open time dependent VRP, *Measurement* . Vol. 90, pp. 443-452, 2016.

(3511) De Marco A., Cagliano A.C., Mangano G. and Perfetti F., Factor influencing logistics service providers efficiency' in urban distribution systems, *Transportation Research Procedia*, pp. 499-507, 2014.

(3513) Boloukian R. & Jürgen Siegmann J., Urban Logistics: a key for the airport-centric development - a review on development approaches and the role of urban logistics in comprehensive airport-centric planning. *Transportation Research Procedia*, Vol. 12, pp. 800-811, 2016.

(3514) Kauf S., City logistics - a strategic element of sustainable urban development, *Transportation Research Procedia,* Vol. 16. pp. 158-164, 2016.

(3515) Moen O., The five-step model - procurement to increase transport efficiency for an urban distribution of goods, *Transportation Research Procedia,* Vol. 12. pp. 861-873, 2016.

(3516) Quak H., Nesterova N., Van Rooijen T. and Dong Y., Zero emission city logistics: current practices in freight electromobility and feasibility in the near future. *Transportation Research Procedia*, Vol. 14. pp. 1506-1515, 2016.

(3517) Papoutsis K. & Nathanail E., Facilitating the selection of city logistics measures through a concrete measures package: A generic approach. *Transportation Research Procedia*, Vol. 12. pp. 679-691, 2016.

(3518) Crainic T.G., Nguyen P.K. and Toulouse M., Synchronized multi-trip multi-traffic pickup & delivery in city logistics, *Transportation Research Procedia,* Vol. 12, pp. 26-39, 2016.

(3611) Taniguchi E., Thompson R.G. and Yamada T., Recent trends and innovations in modelling city logistics, *Procedia - Social and Behavioral Sciences*, Vol. 125, pp. 4-14, 2014.

(3612) Van Rooijen T. & Quak H., City logistics in the European CIVITAS Initiative, *Procedia - Social and Behavioral Sciences,* Vol. 125, pp. 312-325, 2014.

(501) Schliwa G., Armitage R., Aziz S., Evans J. and Rhoades J., Sustainable city logistics Making cargo cycles viable for urban freight transport, *Research in Transportation Business & Management*, Vol. 15, pp. 50-57, 2015.

(511) Morganti E. & Gonzalez-Feliu J., City logistics for perishable products: The case of the Parma's Food Hub, *Case Studies on Transport Policy*, Vol. 3, pp. 120-128, 2015.

(521) Noyan N., Balcik B. and Atakan S., A Stochastic Optimization Model for Designing Last Mile Relief Networks, *Transportation Science*, Vol. 50, pp. 1090-1113, 2016.

(523) Muñuzuri J. & Cortés P., Recent advances and future trends in city logistics, *Journal of Computational Science,* Vol. 3, pp. 191-192, 2012.

(524) Schneider M., Stenger A. and Goeke D., The Electric Vehicle-Routing Problem with Time Windows and Recharging Stations, *Transportation Science*, Vol. 48, pp. 500-520, 2014.

(525) Sheu J., A novel dynamic resource allocation model for demand-responsive city logistics distribution operations, *Transportation Research Part E*, Vol. 42, pp. 445-472, 2006.

(526) Velázquez-Martínez J.C., Fransoo J.C., Blanco E. and Valenzuela-Ocaña K., A new statistical method of assigning vehicles to delivery areas for CO2 emissions reduction, *Transportation Research Part D*, Vol. 46, pp. 133-144, 2016.

(527) Alho A. & Abreu Silva J., Analyzing the relation between land-use/urban freight operations and the need for dedicated infrastructure/enforcement — Application to the city of Lisbon, *Research in Transportation Business & Management*, Vol. 11, pp. 85-97, 2014.

(528) Lin C., Lin D. and Young M.M., Price planning for time-definite less-than-truckload freight services, *Transportation Research Part E,* pp. 525-537, 2009.

(529) Taylor G., DuCote W. and Whicker G., Regional fleet design in truckload trucking, *Transportation Research Part E,* Vol. 49, pp. 167-190, 2006.

(5210) Wang Y., Locating battery exchange stations to serve tourism transport: A note, *Transportation Research Part D,* Vol. 13, pp. 193-197, 2008.

7.3 Other references

Arolas E., González E. and Ladrón-de-Guevara F., Towards an integrated crowdsourcing definition. *Journal of Information Science*, 2012.

Chopra S. & Meindl P., Designing the distribution network in a Supply Chain. *Supply Chain Management: Strategy, Planning, and Operation*, 2016.

Falsini D., Fumarola A. and Schiraldi M.M., Sustainable Transportation Systems: dynamic routing optimization for a last-mile distribution fleet, *International Conference on Sustainable Development: the Role of Industrial Engineering,* pp. 15-19, 2009.

Foltynski, M.: (2014). Electric fleets in urban logistics. 1st International Conference Green Cities 2014 – Green Logistics for Greener Cities (48-59). *Procedia – Social and Behavioral Science.*

Harrington, T.S., Singh Srai, J., Kumar, M. Wohlrab, J. Identifying criteria for urbansystem 'last-mile' solutions – amulti-stakeholder perspective. *Production Planning & Control* pp. 456-476, 2016

Kin B., Verlinde S. and Macharis C., Sustainable urban freight transport in megacities in emerging markets. *Sustainable Cities and Society*. 2017.

Kunze O., Wulfhorst G. and Minner S., Applying system thinking to city logistics: A qualitative approach to model interdependencies of decisions by various stakeholders and their impact on city logistics, 2015.

Lagorio A., Research in urban logistics: a systematic literature review, *International Journal of Physical Distribution & Logistics Management,* pp. 908 -931, 2016.

Tadić S. & Zečević S., A Framework for Structuring City Logistics Initiatives. *International Journal for Traffic & Transport Engineering*, 2016.

Visser J., Toshinori N. and Browne, M., Home Delivery and the Impacts on Urban Freight Transport: A review, *Procedia Social and Behavioral Sciences*, 2014.

Oliveira, L.K., Ramos, N.T., Novaes, A.G.N. The sixth international conference on City Logistics. Assessing model for adoption of new logistical services: An application for small orders of goods distribution in Brazil. *Procedia – Social and Behavioral Science*. pp. 6286-6296. 2010

Green Paper: Towards a new culture for urban mobility. COM, 2007. Brussels 25.9.2007

Crainic T.G. & Benjelloun A., Trends, challenges and perspectives in city logistics. Simulating the impact of new australian bi-modal urban freight terminals. 2009.

Gevaers R., Van de Voorde E. and Vanelslander T., Characteristics of innovations in last mile logistics – using best practices, case studies and making the link with Green and sustainable logistics. *University of Antwerp. Belgium*, 2009.

Li C., Loscher K., Nagi A.B., Sheerazi H.A., Blair K., Fonseca S. and Millison W., Going the last mile: Best practices of urban freight movement, *Columbia University.*

Danielis R., Maggi E., Rotaris L. and Valeri E., Urban supply chains and transportation policies, *Working Papers SIET*, 2012.

Ennarsson L., Distribution and re-distribution in e-commerce, 2002.

Joerss M., Schröder J., Neuhaus F., Klink C., Mann F., Parcel Delivery: The Future of Last Mile, *Travel Transport Logistics*, 2016.

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