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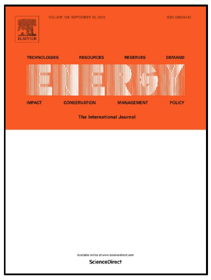

Review of Policies and Measures for Sustainable and Energy Efficient Urban Transport

Tomislav Letnik, Maršenka Marksel, Giuseppe Luppino, Andrea Bardi, Stane Božičnik

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Tomislav Letnik
University of Maribor, FGPA, Smetanova 17, 2000 Maribor, Slovenia
e-mail: tomislav.letnik@um.si

Maršenka Marksel
University of Maribor, FGPA, Smetanova 17, 2000 Maribor, Slovenia
e-mail: marsenka.marksel@um.si

Giuseppe Luppino
Institute for Transport and Logistics – ITL, Viale Aldo Moro 38, 40127 Bologna, Italy
e-mail: giuseppe.luppino@regione.emilia-romagna.it

Andrea Bardi
Institute for Transport and Logistics – ITL, Viale Aldo Moro 38, 40127 Bologna, Italy
e-mail: andrea.bardi@fondazioneitl.org

Stane Božičnik, Ph.D.
University of Maribor, FGPA, Smetanova 17, 2000 Maribor, Slovenia
e-mail: stane.bozicnik@um.si

Abstract

Sustainable and energy efficient transport of passengers and goods has become a major concern of policy makers worldwide. This paper examines the existence of policies and measures for sustainable urban freight transport in European cities. The methodology for comprehensive mapping and benchmarking of strategic policy documents and measures has been developed and applied to a panel of 129 European cities. The desktop analysis shows an extremely heterogeneous situation of logistics and mobility planning policies and planning documents adopted in Europe. Cities are mainly opting for soft measures with high impact on savings. They are trying to achieve efficiency with adequate regulation system and measures supporting the introduction of new services. Only few measures directly promoting energy savings were identified while on the other hand, various measures with indirect impact on energy consumption were recognized.

Keywords: urban transport, city logistics, sustainability, energy efficiency, policy measures

1 INTRODUCTION

Despite of its important role in modern society, transport has many shortcomings resulting in congestion, pollution, CO2 emissions, noise and accidents. Transport is also the largest energy-consuming sector in the EU-28 [1–3], whereby road transport consumes 83% of total energy consumption in transport and accounts for 93% of CO_2 emissions [4,5]. Road transport vehicles are predominantly using fossil fuels, which emit large quantity of greenhouse and other polluting gases into the atmosphere and therefore significantly contribute to climate change and global warming [6–8]. Without appropriate regulatory measures, energy use and greenhouse gas (GHG) emissions from the land transport sector is expected to grow. Compared with 2009, 50% growth is expected by 2030 and more than 80% by 2050 [9]. To reach sustainable low-carbon economy by 2050, Europe needs to cut emissions from transport by at least 60% compared to 1990 [10,11]. Transport is considered also as one of the most important factors for achieving the goal of the Paris agreement, which aim is to limit global temperature rise in this century well below 2 °C, comparing to the pre-industrial levels [12,13].

Pietzcker et al. [14] studied alternative scenarios on transport decarbonisation in energy-economic models. They found out that in the first half of the century, transport is expected to leg behind mitigation efforts of other sectors for 10-30 years. Even in the most stringent policy scenario, more than 85% of transport final energy will still come from the fossil fuels. Deep emission reductions in transport sector (by 90% and more) is expected in the long run (until the end of the century) and only in the case when the most stringent policy scenarios would have been implemented. The preconditions of the scenarios to meet the expected results are: implementation of the advanced vehicle technologies in combination with carbon-free primary energy sources and inclusion of the road transport into the EU ETS (European Emissions Trading Scheme) [5]. Carbon pricing should be complemented with region-specific and integrated transport policies aiming at changing mobility demand and promoting the use of innovation in alternative transport options and the use of alternative fuels [15–17].

European transport policy aims to foster decarbonisation of transport through gradual implementation of various measures to be achieved by 2050 [18]: no more conventionally-fuelled cars in cities, 40% share of sustainable low carbon fuels in aviation; at least 40% emissions decrease in shipping, 50% shift of intercity passenger and freight journeys from road to rail and waterborne transport on medium distances. Given that 25% of emissions of transport in the EU originates in urban areas, towns and cities play the key role in mitigating the negative effects of transport [19]. Manny cities are currently implementing "Sustainable Urban Mobility Plans" (SUMPs) [20], which are mainly dedicated to mobility of passengers [22]. In most cases freight transport has not been considered or has been addressed only partially. In the absence of clear guidelines for addressing urban freight issues, cities have adopted diverse strategic documents and measures. Consequently, we are today lacking the understanding about the structure of the implemented urban freight policy measures in the European cities and their efficiency. In particular this holds good also for the field of sustainable energy use and mitigation of CO_2 emissions caused by the city logistic operations. To overcome this problem EC has set a very ambitious goal of CO_2-free city logistics by 2030 and initiated the concept of "Sustainable Urban Logistics Plans" (SULPs) [21] aiming to comprehensively address also urban freight issues.

In order to understand the need for comprehensive planning of sustainable and energy efficient freight transport system in cities, the first part of the article deals with literature review of existing urban transport problems and policies for mitigation of highlighted problems. The second part of the article presents a comprehensive overview (and benchmark) of the transport policy documents implemented in European cities aiming at development of sustainable and energy efficient urban freight transport system.

2 REVIEW OF SUSTAINABLE URBAN FREIGHT TRANSPORT PROBLEMS, POLICIES AND INITIATIVES

Urban freight delivery is a very complex process faced with numerous issues that need to be solved in order to perform efficient services for customers [23]. Deliveries are, on one hand subject to various characteristics of urban areas and on the other, to dynamically changing expectations of customers [24]. To cope with this complexity and with problems of increasing traffic volume, energy consumption, emissions and congestion, various transport policy measures are adopted in cities around the world. The main aim of the literature review is therefore to present overview of the main problems of the urban freight deliveries and related policy measures and methods dedicated to solving these problems. Literature review is based on scientific refereed journals, refereed conference proceedings and scientific reports.

2.1 Review of urban freight problems

Firstly, we deal with the most outstanding problems of urban freight deliveries, studied by scholars in recent years and tackled from different perspectives and on different levels. We decided to utilize our own classification based on problems, which are most often considered in the literature lately.

The overview of the most outstanding problems and the literature dealing with these problems is presented in the Table 1.

Table 1: Literature review of main urban freight problems

Topic	Papers
Increasing demand for urban freight deliveries	Olsson and Woxenius 2014 [25]; Tozzi et al. 2014 [26]; Tadić et al. 2015 [27]; Morganti et al. 2014 [28];
Low utilisation rates of urban delivery vehicles	Domínguez et al. 2012 [29]; Bozzo et al. 2014 [30]; MDS Transmodal 2012 [31]; Iwan 2014 [32];
Energy use, transport emissions and noise of delivery vehicles	Arvidsson 2013 [33]; Tozzi et al. 2014 [26]; Bektas et al. 2015 [34]; Dablanc 2009 [35];
Increasing congestion in dense urban areas	Lindholm 2013 [36]; Tozzi et al. 2014 [26];
Inadequate road transport infrastructure	Stefanelli et al. 2015 [37]; Rose et al. 2016 [38];
Lack of logistics transhipment facilities and double parking	Russo and Comi 2012 [39]; Silva and Alho 2015 [40]; Lopez et al 2016 [41];
High delivery cost for last mile delivery operations	Roca-Riu and Estrada 2012 [42];

Urban freight problems are strongly related to existing trends and expectation of customers. Studies show that the need for just in time deliveries and the trend of e-commerce results in high fragmentation of urban freight delivery demand and supply [25–28,31]. Cities are consequently facing more frequent deliveries and higher number of urban freight transport trips. Empirical studies reveal that freight vehicles today produce already 10 to 15% of total urban vehicle-kilometres [36]. Cities are also facing the problem of low vehicle utilisation rates [31,32]. Average load factor is decreasing and is today only at the level of 30-40%. In addition to that, more than 20% of vehicle-kilometres are driven empty [29,30]. These trends contribute to negative impacts on urban environment. About 25% of CO_2 emissions, 30% of nitrate oxides and 50% of particulates that are emitted by transport are, in large cities, generated by trucks and vans [35]. Commercial vehicles are also contributing to over 20% of energy consumption and urban traffic congestion [26,34].

Likewise, scholars report about problems related to inadequate transport and logistics infrastructure in cities. In general, there is a problem with accessibility for customers located in the city centres due to narrow streets and physical barriers [38]. The other problem is related to logistics facilities in dense urban areas needed for transhipment and parking operations for the last mile deliveries. This kind of facilities are often missing, which forces the delivery vehicles to double park or circulate around the city until they find the most appropriate place for parking. In European cities this occurs in 70-80% of deliveries [41]. This is energy and time consuming and contributes significantly to the reduction of the available road capacity and to the increase of urban traffic congestion [39,40]. It also increases costs and energy consumption of last mile delivery. Studies revealed that, although last mile delivery represents only a small part of the total travelled distance, it generates almost 30% of the total transportation costs [42].

2.2 Review of the most commonly studied logistics policies and measures

To solve main problems of urban freight deliveries depicted in previous section, a great number of transport policy measures have been adopted and tested in urban areas around the world. Scholars have tried to provide unified taxonomy for classification of policy measure types but so far this has not yet reached the point of synthesis or general agreement [43]. Stathopoulos et al. [44] suggested the following classification: market-based measures, regulatory measures, land use planning measures, infrastructural measures, management measures and measures related to new technologies. Feng Shi et all [45] proposed the following classification: congestion charges, parking charges, public transit priority systems, vehicle quota systems and travel credit systems. A comprehensive overview of efficient and sustainable strategies for last-mile deliveries was given also by Browne et al. [46] and Giuliano et al. [43] identifying strategies like: labelling or other certification schemes; traffic and parking regulations; land use planning and zoning; city logistics and consolidation schemes; off-hours deliveries and intelligent transport systems. Urban freight policy issues have also been addressed by: Nuzzolo and Comi [47], Benjelloun et all. [48] and Browne et all [49].

For the purpose of this overview, we have adopted the methodology of Stathopoulos et al. [44] and added additional type of measure specifically focused on energy. Improvement of energy efficiency is of vital importance from environmental as well as from economic point of view [50–52].

Papers considering above mentioned types of policy measures are listed in the Table 2.

Table 2: Literature review of main types of policy measures

Type of measure	Papers
Energy measures	Taniguchi 2014 [53]; Johansen et al. 2014 [54]; Stefanelli et al. 2015 [37]; MDS Transmodal Limited 2012 [31]; Macario 2011 [55]; Byers et al. 2015 [56]; ERTRAC and ALICE 2014 [57]; Mellios et al. 2011 [58];
Market-based measures	Taniguchi et al. 2010 [59]; Bozicnik and Mulej [60]; Bozicnik [61]; Danielis 2015 [62]; Björklund and Abrahamsson 2015 [63]; MDS Transmodal Limited 2012 [31]; Elspeth and Ballantyne 2013 [64]; Stathopoulos et al. 2012 [44]; CIVITAS 2015 [65]; Stefanelli et al. 2015 [37]; Taniguchi 2014 [53]; Leonardi et al. 2014 [66]; Dablanc et al. 2013 [67]; Quak and Bruening 2012 [68];
Regulatory measures	Quak and De Koster 2006 [69]; Leonardi et al. 2014 [66]; Oliveira et al. 2014 [70]; Alho et al. 2014 [71]; Taniguchi 2014 [53]; Filippi et al. 2010 [72]; Taniguchi et al. 2014 [73]; Manuzuri et al [74], Woxenius [75];
Land use planning measures	Taniguchi et al. 2014 [73]; Morganti et al. 2014 [28]; Macario 2011 [55]; Taniguchi 2014 [53]; Leonardi et al. 2014 [66]
Infrastructure measures	MDS Transmodal Limited 2012 [31]; Macario 2011 [55]; Morganti et al. 2014 [28]; Quak and Bruening 2012 [68]; Simoni et al. 2017 [76]; Lindsey at al. 2014 [77];
Management measures (supporting services)	Lopez et al. 2016 [41]; Björklund and Abrahamsson 2015 [63]; Leonardi et al. 2014 [66]; McLeod and Cherrett 2011 [78]; Letnik et al. 2018 [79]; Taniguchi 2014 [53]; Quak and Bruening 2012 [68]; Simoni et al. 2017 [76];
New technologies	Dablanc et al. 2013 [67]; Taniguchi et al. 2016 [80]; Leonardi et al. 2014 [66]; Taniguchi 2014 [53]; Stefanelli et al. 2015 [37]; Taniguchi et al. 2010 [59]; Filippi et al. 2010 [72]; Bubel and Szymczyk 2016 [81];

Energy policy measures are intended to directly or indirectly promote environmentally friendly, sustainable and energy efficient urban freight distribution. The following measures are most often mentioned in the literature: anti-idling and eco-driving [37,53,54] (training for energy efficient driving), modal shift [31,55,56] (rail, underground, inland waterways) and certification programmes [37,57,58] (labelling – fleet operators).

Market based policy measures are using price mechanism to force transport operators and customers to change their behaviour [65]. The following measures are most often mentioned in the literature: road pricing [59,62] (road user charging, parking charges), taxation [31,63] (tax discount for environmentally friendly vehicles), tradable permits [37,44,60,61,64,65] (total amount of acceptable emissions), incentives and subsidies [53,66–68] (electric vehicles promotion, reduction of tax, funding schemes).

Regulatory policy measures are setting restrictions to control the activities of transport operators with the aim of limiting negative impact of delivery vehicles in urban areas.

Following measures are most often mentioned in the literature: time access restrictions [66,69,70] (daytime delivery bans, silent night-time deliveries), parking regulations [53,71,72] (vehicle parking reservation systems, delivery space booking system, timeshare of parking space, peak-hour clearways), load factor restrictions [74,75] (access allowed to vehicles with high enough load factor) and environmental restrictions [73] (emission standards, engine related restrictions).

Land use planning policy measures are in place to change existing land use patterns and reserve private space in urban areas for public needs. Following measures are most often mentioned in the literature: location of logistics facilities [73] (on street - kerbside and off-street loading bays), delivery areas (cargo handling space), integration of logistics plans into land use planning concepts, collection points [28,55] (locker stations), urban consolidation centres [53,66] (UCC).

Infrastructure policy measures are in general dealing with investment into transport/logistics infrastructure and are, in many cases, part of the overall land use planning policy. The following measures are most often mentioned in the literature: investment in transport infrastructure [31,55] (maintenance of existing and/or building of new roads/lines dedicated to delivery vehicles, investment in electric charging stations) and investment in logistics facilities [28,68,76,77] (loading bays, urban consolidation centres, freight lockers).

Management policy measures are dedicated to organizational and business aspects for managing infrastructure and services for more efficient urban freight deliveries. The following measures are most often mentioned in the literature: management of urban loading bays [41,78,79], freight traffic flow management (priority network for heavy goods vehicles), management aspects of consolidation schemes [63,66,76] (managing urban consolidation centres), new business models [53,68] (canvas, collaboration schemes).

Policy measures related to new technologies are referring to any kind of ITS (intelligent transport system) and ICT (information communication systems) systems that allow freight vehicles to opt for alternative or more optimal routes for last mile delivery. The following measures are most often mentioned in the literature: new vehicle technologies [66,67,80] (electric/hybrid engines and batteries, new vehicle concepts), dynamic vehicle routing [37,53,66,80] (freight routing optimisation) and ITS information systems [59,72,81] (variable message signs, regulating multi-use lanes, optimize the use of street space, traffic control).

2.3 Review of collaborative initiatives and mechanisms

City authorities are faced with the problem of implementing transport policy measures caused by different acceptance levels of large number of different stakeholders and actors. The distinction between stakeholders and actors is important according to Ballantyne et all [82]. Those who directly affect issues in urban freight (policy makers, decision makers and local authorities) are actors, those who have a direct interest in urban freight (companies, individuals, interest groups, etc.) are stakeholders. Traditionally receivers, carriers and forwarders have been considered as the most relevant stakeholders [44,83,84], but they have often not been included in the policy making process. Banister and Hickman [85] emphasize the importance of involvement of non-public decision makers in a fully participatory transport planning process in cities. Involvement of all relevant stakeholders and actors is recognised as a precondition for successful implementation of measures and for diminishing potential conflicts among them. Literature review on collaboration mechanisms is presented in Table 3.

Table 3: Literature review of stakeholders and actors collaboration tools and mechanisms

Topic	Papers
Collaboration mechanisms	Taylor and Hallsworth 2000 [86]; Hensher and Brewer 2001 [87]; Buldeo Rai et al. 2017 [88];
Freight quality partnership	Roche-Cerasi 2012 [89]; Lindholm 2014 [90]; Quak et al. 2016 [91]; Eidhammer et al. 2016 [92]; Jedliński 2016 [93]; Marcucci et al. 2017 [94];
Living Lab	Quak et al. 2016 [91]; Nesterova and Quak 2016 [95]; Gatta et al 2017 [96];

Several methods have been deployed for involving different stakeholders in the process of specific measure implementation. Multi-actor multi criteria analysis (MAMCA) for example, explicitly includes stakeholders' perspectives in transport measures evaluation with reference to stakeholder objectives. MAMCA is a stepwise methodology in which stakeholders and their key objectives are identified and weighted [88]. Also "learning through action" approach has been implemented [87]. This approach emphasizes learning through a collaborative process between different stakeholders and actors, where the outcome is both a normative development as well as strategy development towards intended change. There are also some practical experiences of collaboration in the European Courier, Express and Parcel sector (CEP). Confronted with growing complexity of the "last and first-mile" issue and faced with a competitive environment, the traditional actors of the CEP sector in Europe are evolving in similar way and their strategies, tools, and organizations are becoming very much alike [86].

In recent years Freight Quality Partnership (FQPs) has emerged as the most promising approach for including stakeholders in discussions of problems and identification of solutions [90,94]. Freight Quality Partnerships are collaborative networks of freight partners. The objective of FQP is to optimize freight transport by working together on logistics operation issues, exchanging information and experiences and developing a common freight strategy [92,93]. Implementation process includes identification of target groups and their different needs, development of a communication platform and deployment of dedicated, specific city measures (e.g. use of priority lanes) [89]. FQP has been recently enhanced with the concept of living lab [91] aiming at constantly revising and continuously improving logistics performance to meet stakeholders' needs. Final aim is to obtain long lasting impact and to cope with the complexities of the urban freight system, resulting in optimal solutions which "per se" include also optimised concept of energy use.

2.4 Review of models and modelling techniques for urban freight and energy policies

Effectiveness of policies and initiatives presented in previous sections is difficult to predict, therefore modelling and simulation tools had to be developed and used to support decision making process of urban planners and policy makers [97]. Literature dealing with urban freight is not huge, but is very complex, therefore only some basic elements and the most recent advancements are presented in this section. In addition, the advancement of some energy models was analysed, because energy aspects are currently only partially addressed under the framework of the urban freight models.

Table 4: Literature review on urban freight transport and energy models

Topic	Papers
Freight transport models	Taniguchi et al. 2001 [98]; Gonzalez-Feliu 2008 [99]; Crainic et al. 2009 [100]; Tamagawa et al. 2010 [101]; Taniguchi et al. 2012 [102]; Anand et al. 2012 [103]; Gonzalez-Feliu and Routhier 2012 [104]; Tawasszy et al. 2012 [105]; Taniguchi et al. 2014 [73]; Teo et al. 2014 [106]; Behnke and Kirschstein 2017 [107]; Comi et al. 2017 [108]; Le Pira et al. 2017 [97]
Energy models	Jebaraj and Iniyan 2006 [109]; Wagner and Wegener 2007 [110]; Bhattacharyya Govinda and Timilsina 2009 [111]; Keirstead et al. 2012 [112]; Suganthi and Samuel 2012 [113];; Cui et al. 2017 [51]; Gereboni et al. 2017 [114]**;** Debnath and Mourshed 2018 [115]

In general, only few papers are dealing with urban freight modelling issues [73,98,100–104,107,108]. Freight aspects of urban traffic modelling have been neglected for decades, namely in focus of modelling efforts were predominantly passenger traffic flows. Freight transport models have been originally built, based on aggregated four stage model (generation and attraction, distribution, modal split and assignment), which was originally developed for modelling of passenger transport [98]. Necessity to deal with increasing traffic problems in cities through implementation of urban freight policies and the need to evaluate the effects of implemented policies has resulted in increased interest of urban freight models in the late 1990s.

Taniguchi, which is considered as the father and initiator of urban freight modelling [116], noticed that three general types of models are required to predict the effects of urban freight policies [98]: demand models, supply models and impact models. The most recent advancement of urban freight modelling is showing the trend towards emission related models, which can be classified into the following categories [73]: network models (evaluating impacts of policies for reducing greenhouse gas emissions from road freight vehicles); fleet models (predicting aggregate emissions from the overall fleet); routing models (developing routes that minimise the travelled distance) and life cycle analysis models (estimating energy consumption and emissions of freight vehicles over their life). The most recent development in urban freight modelling is associated with the use of alternative transport modes, such as [117–119]: electric trucks, vans, freight bikes and rail. These alternative transport solutions increase the sustainability and liveability of urban areas, which is also becoming the main goal of urban planners and policy makers.

Taniguchi et al [102] also studied emerging techniques for enhancing the practical application of urban freight models. Topics addressed: advanced heuristic and meta heuristic optimisation techniques (stochastic programming and applied parallel tabu search) for dynamic vehicle routing and scheduling problems; multi-objective optimisation techniques (genetic algorithms, evolutionary algorithms, particle swarm optimization, simulated annealing, tabu search and ant colony optimisation) for optimisation of decision making problems; and intelligent agent systems (agent based systems) for optimization of collaborative distribution systems in urban areas. La Pira [97] additionally recognized that dynamic multi agent-based simulation approach and game theory simulation techniques as the most effective to mediate interactions among stakeholders as a consensus building process for definition of the urban freight delivery policies.

On the other side energy modelling has a long tradition and dates back in 1950s. Development of energy models went through different phases in relation to the energy supply and demand on one hand and the technological development and development of new modelling techniques on the other [111]. Many review studies and surveys on energy models exist [109,111–113,120] but we decided to analyse two of them, which are from the authors' perspective the most relevant from the policy making point of view.

The first one is the "review of urban energy system models" provided by Keirstead et al. [112]. Their research is important because it is focused on models relevant for urban environments. They reviewed 219 scientific papers and identified five main focus groups: technology design, building design, urban climate, systems design, and policy assessment. The policy assessment models are the most aggregated ones and are applied to evaluate energy performance of the whole city to shape up policy decisions. Regression models are often used to understand impacts of consumer preferences, economic effects and general urban evolution. Simulation and optimization techniques are also used, primarily to assess the potential impacts of the policy change. In addition to that, they also highlighted the sixth field, which is land use and transportation modelling (LUT). They claim that "transportation has direct relevance to the use of energy in cities but has been overlooked by the literature to date". According to Wagner [110], operational land use transport model systems are loosely integrated with transport air quality and energy assessment models that translate the predicted transport flows into pollutant and fuel consumption estimates. LUT models are mainly build on activity-based principles and probability-based approaches.

The second study is a "comprehensive review of energy models" produced by Jebaraj and Iniyan [109]. Energy models were studied and grouped into following categories: energy planning models, energy supply-demand models, forecasting models, renewable energy models, emission reduction models and optimisation models. Energy planning models (EPMs), which are applied to forecast energy demand and supply, are considered as the most important for policy making process and for energy sector development. From the modelling techniques point of view, we need to mention also the study of Debnath and Mourshed [115] that identified end evaluated 50 different forecasting method for the use in EPMs. They found out that artificial neural network is the most widely used and efficient method, which is applied in 40% of all analysed EPMs. Moreover, they found out that computational intelligence methods demonstrate better performance than statistical ones. For comprehensive review of advanced energy related optimisation method, please see Cui et al. [51].

Finally, Gereboni et al. [114] studied the possibilities of linking energy and transport models to support policy making. Some tests have been performed and proved that linking of models is already possible, provided statistics and data are available. In general, transport models are to be considered as basis for generating inputs to energy models and not vice versa.

3 REVIEW OF URBAN FREIGHT TRANSPORT POLICIES AND MEASURES IMPLEMENTED IN STRATEGIC DOCUMENTS OF EUROPEAN CITIES

The main aim of this section is to identify, in the first step, existence of relevant transport policy documents of the European Cities. In the second step, maturity level of the transport policy measures of the selected European cities is analysed, with specific focus on analysis of integration of urban freight measures into strategic city mobility planning documents.

According to our knowledge no methodology for identification of logistics planning documents and classification of them according to their maturity level exists in literature. The new methodology for analysis and transparent presentation of logistics planning documents of the vast variety of European cities is therefore developed and introduced.

3.1 Panel of cities

European cities included in the analysis have been selected according to their size and other relevant characteristics. The main idea was to examine a diverse sample of cities (continental cities, cities with navigable rivers and coastal cities). In addition the focus was not only on city centres but on wider territory aspect of Functional Urban Areas (FUAs) consisting of the city core and its commuting zone [121]. In view of all these aspects, 129 cities (shown in the *Figure 1* below) have been selected for the analysis.

After selection of suitable cities, the main aim was to identify information sources related to relevant strategic city transport policy documents. This step was very difficult because documents containing this kind of information are very versatile and fragmented. To map and analyse measures, two types of sources have been selected: as the primary source of information the institutional websites of the selected cities were chosen, and different thematic websites dedicated to Sustainable Urban Mobility Plans (SUMPs), urban logistics and Sustainable Urban Logistics Plans (SULPs), as a secondary source.

Figure 1. Location of cities considered in the panel

As it can be seen from the Figure 1. selected cities are spread all over the EU.

3.2 Identification of strategic documents

The identified strategic documents of European cities were classified into five main categories:

- SUMPs without city logistics measures;
- Mobility plan documents with city logistics measures;
- SUMPs with city logistics measures;
- Logistics plans;
- SULPs.

SULP is the most comprehensive document specifically devoted to logistics issues in urban areas [122]. From this point of view, cities having this document implemented are considered as logistically most advanced. Logistics plans are similar to SULP, for they are in the whole extend devoted to logistics issues and the only difference to SULP is that they have been implemented before SULP methodology was available. The logistics plans structure is therefore not standardised, as in the case of SULP, and they are therefore considered as slightly less relevant. SUMPs are in general tackling all mobility issues and in that respect freight transport is often omitted or is only partially mentioned. SUMPs with city logistics measures are therefore next on the scale of relevant documents implemented in European cities. Mobility plan documents introduced before SUMP methodology exist and are therefore a bit less relevant than SUMPs. Finally, we tried to identify SUMPs implemented but not containing any logistics issues. This option is on the bottom of our evaluation scale because SUMPs should, in general, deal also with logistics. If the SUMPs are not dealing with logistics that means logistics issues are not recognised as relevant revealing that the cities stick to old, uncomplete, planning patterns.

The results of the analysis of documents, identified in the panel of cities, are presented in the *Figure 2* below.

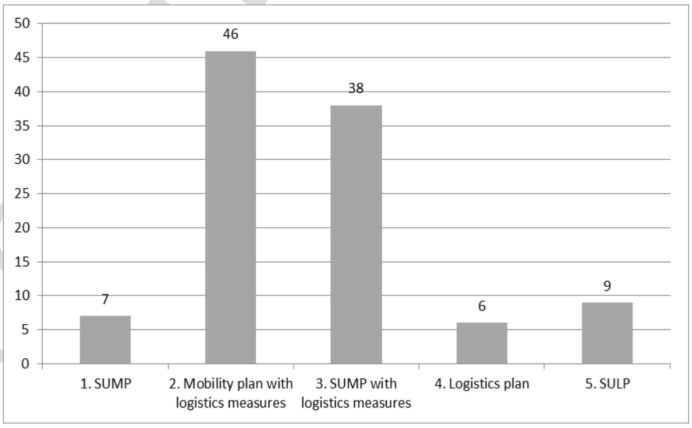

Figure 2. Frequency of planning documents by category in the chosen panel of cities

From the panel of 129 cities, 29 of them (22,5%) do not have documents consistent with any of the defined categories. This does not mean that those cities are not facing mobility issues or do not have mobility plans. It means that they do not have documents, which could be categorized as SULP, SUMP, logistics plan or mobility plan and that there are no specific logistics measures integrated into the adopted city transport/logistics policy.

Among the remaining 100 cities, seven cities have SUMPs without city logistics measures, 46 cities have mobility plan with city logistics measures, 38 cities have SUMPs with logistics measures, four cities have logistics plans and nine cities have SULPs.

In the following table (Table 5), existence of relevant transport policy documents in the selected panel of cities is presented more in details.

Table 5: Category of strategic documents available in selected European cities

COUNTRY	CITY	1	2	3	4	5
AUSTRIA	Vienna			●		
	Linz					
	Graz			●		
	Salzburg			●		
	Innsbruck					
BELGIUM	Bruges		●			
	Ghent		●			
	Antwerp		●			
	Liege		●			
	Brussels		●		●	
	Namur		●			
	Charleroi					
BULGARIA	Sofia					
	Pleven					
	Ruse					
	Varna		●			
	Burgas			●		
	Stara Zagora					
	Balchik					●
CROATIA	Zagreb		●			
	Dubrovnik	●				
CZECH REPUBLIC	Prague	●				
	Brno	●				
	Ostrava			●		
DENMARK	Aalborg		●			
	Aarhus					
	Odense					
	Copenhagen		●			
ESTONIA	Tallinn		●			
	Tartu		●			
FINLAND	Helsinki		●			
	Turku					
	Tampere					
FRANCE	Toulouse			●		
	Marseille			●		
	Lyon			●		
	Strasbourg			●		
	Lille			●		
	Paris			●		
	Nantes			●		
GERMANY	Bremen			●		
	Berlin		●		●	
	Hannover		●			
	Dresden			●		
	Frankfurt		●			
	Munich		●			
GREECE	Thessaloniki	●				
	Athens					
	Serres					●
HUNGARY	Székesfehérvár					
	Pécs					
	Győr					
ITALY	Palermo		●			
	Catania		●			
	Bari		●			
	Naples			●		
	Rome		●			
	Ancona					
	Florence					
	Ravenna			●		
	Genoa		●			
	Turin			●		
	Milan			●		
	Lucca					●
IRELAND	Dublin		●			
	Cork		●			
LATVIA	Riga		●			
LITHUANIA	Klaipėda					
	Kaunas					
	Vilnius					
THE NETHERLANDS	s'Hertogenbosch					●
	Utrecht			●	●	
	Rotterdam		●			
	Amsterdam		●			
NORWAY	Trondheim					●
	Oslo					
POLAND	Kraków		●			
	Wrocław			●		
	Warsaw		●			
	Szczecin	●				
PORTUGAL	Lisbon			●		
	Coimbra	●				
	Porto					
	Almada					●
ROMANIA	Târgu Mureş					
	Timişoara			●		
	Bucureşti	●				
	Constanţa			●		
	Iaşi					
	Ploieşti					
	Alba Julia					●
	Bistriţa					
SLOVAKIA	Bratislava					
	Košice			●		
	Žilina			●		
SLOVENIA	Ljubljana			●		
SPAIN	A Coruña			●		
	Bilbao					
	San Sebastián			●		
	Burgos					●
	Zaragoza			●		
	Barcelona			●		
	Huelva			●		
	Córdoba			●		
	Valencia			●		
	Murcia			●		
	Málaga			●		
	Sevilla		●			
	Madrid			●		
	Terrassa			●		
SWEDEN	Malmö			●	●	
	Göteborg		●			
	Stockholm		●		●	
SWITZERLAND	Basel					
	Zurich		●			
	Geneva		●			
UNITED KINGDOM	Belfast		●			
	Dundee					●
	Edinburgh		●			
	Glasgow		●			
	Bradford		●			
	Leeds		●			
	Liverpool		●			
	Cambridge		●			
	Norwich		●			
	Gloucester		●			
	Cardiff		●			
	Bristol		●			
	London		●		●	

LEGEND:
Document category

1. SUMP
2. Mobility plan with log. measures
3. SUMP with logistics measures
4. Logistics plan
5. SULP

With specific reference to SULPs, it is important to mention that all the 9 cities having SULP in place, were involved in the ENCLOSE EU project devoted to the development of SULPs in the cities participating in the project. Therefore, SULP concept can be considered as a specific project concept.
On the other hand, the SUMP concept is quite present in the panel: 45 cities have developed SUMPs, of which 38 also include logistics. It is worthwhile to report that about 15.6% of the cities with adopted SUMPs have not included logistics into the document.

3.3 Identification of measures and their inclusion in transport planning documents of the selected cities

In the next phase, the panel of cities was reduced to 30 cities with well-developed and adopted logistics planning documents and measures. In these cities in total 158 measures were identified. These measures were reviewed in detail. Out of 158 measures 58 measures of the best practice character and enough available data were selected. The selected measures were grouped into 10 measure types that has been used for detailed analysis. The main criteria for final selection of measures was application suitability of the measure not only to the city centre but also to the City FUA level.

The following measures have been identified:

- Off street loading bays
- Cargo bikes
- Clean fuels and vehicles
- Spatial planning for logistics
- Freight routes
- Delivery and servicing plans
- Mobile depots
- Of peak deliveries
- By boat logistics
- Urban distribution centres

Selected measures are described and analysed more in details to identify their main goals, problems and obstacles for development/implementation and benefits of implementation.

3.3.1 Off-street loading bays

The measure focuses on developing loading and unloading areas located off-street. The objective is to make public spaces less congested and more liveable [78]. This measure can be result of: private agreements among businesses, the initiative of a single business, part of a regulatory intervention of city transport planning, etc. [31].

The implementation of this measure results in reduced congestion, improved quality of public infrastructure use and more efficient loading and unloading activities in dense urban areas [123]. City of Paris, for example, decided to impose off-street loading bays (spaces dedicated to freight activities) to stores of at least 500 square metres, offices of 2,500 square metres and hotels with 150 rooms or more [108,124]. In Rome simulation of ICT based management of loading bays resulted in reduction of the total delivery time of 66% [108].

3.3.2 Cargo Bikes

Cargo bikes can be used for light deliveries (up to 250 kg) and on short distances. They are ideal for deliveries in city centres or limited parts of urban areas [125,126]. Implementation requires presence of a cycling infrastructure, logistics facility from which bicycles can run their last mile delivery and it is often associated with measures, such as urban distribution centres or mobile depots [76].

Cargo bikes bring environmental friendliness and noise reduction. For example, in Turin (Italy) an emissions reduction of 250 grams of CO2 per km [127] was estimated. In London pilot project total distance travelled decreased by 14% and the CO2 emissions per delivered parcel fell by 55% [128]. There are some cost benefits for businesses due to lower purchase prices and maintenance costs for bikes compared to other transport means such as vans. Cargo bikes can have access to city areas where, due to regulations, vans do not have access [129].

3.3.3 Clean fuels / vehicles mobility scheme

The main objective of this measure is to foster sustainable and low carbon delivery services in urban areas. This measure can be applied as a selection criteria for access to urban areas and regulatory incentive for clean vehicles [130]. Secondly, this type of measure can be included in a local or wider regional system of subsidies as stimulating instrument for procurement of clean vehicles [131].

Reductions of emissions and pollution are the main benefit of this measure [80,132]. In case of Los Angeles port, emissions from trucks were reduced by 80% in 2012 based on progressive ban for trucks with higher emission levels accessing port area [133]. In the City of London, replacing diesel vans with electric vans and tricycles operating from a micro-consolidation centre resulted in decrease of 20% for total distance travelled and reduction of 54% for the CO2 emissions per parcel delivered [134].

3.3.4 Spatial planning for logistics

This measure focuses on identification and reservation of the most optimal land locations for logistics purposes. Conversion of land-use purposes of specific areas into areas suitable for logistics facilities is one specific type of this measure [135]. Different types of reserved land use can answer to different logistics purposes. For example, a small area could host an urban distribution centre; reserved areas along canals or in the proximity of railways could increase accessibility to multimodal transport solutions [136].

Strategic allocation of logistics areas should improve logistics efficiency. A rational and systematic allocation of logistics areas enables development of economies of scale in the logistics activities and mitigates logistics sprawl [137]. The measure also fosters multimodal transport and brings environmental benefits. The city of Brussels and city of Paris are identifying and reserving land for logistics purposes with the aim of improving freight delivery network in the city and on the regional level [135].

3.3.5 Freight routes

This measure focuses on regulating freight vehicles' routes. The measure is part of authorities' traffic regulatory actions aiming to limit traffic conflicts between cars and freight vehicles. The main objective is improvement of the efficiency of freight deliveries by providing the most optimal routes to transport nodes and industrial areas. This results in increased average speed of commercial vehicles and reduced congestion. This measure can be further developed by means of IT applications for real time routing of vehicles in a wider smart city context [138].

The city of Amsterdam has developed the Voorkeursnet Goederenvervoer: a selective network of preferential routes that freight carriers can use in a flexible and safe manner to reach their destinations [139]. Introduction of Intelligent Freight Routing Optimisation in Vienna resulted with up to 60% reduction in time, up to 15% reduction in distance, up to 20% reduction in fuel and emissions and up to 30% reduction of costs for deliveries in urban areas [140].

3.3.6 Delivery and Servicing Plans

Delivery and Servicing Plans (DSPs) are key strategy documents outlining how a public or private sector organisation deals with its need to generate freight transport efficiently, safely and in a sustainable way [141]. Within the same company, goods deliveries are often managed independently by different sectors. This reduces the efficiency of inbound logistics activities. The main purpose of this measure is to optimise fleets and freight demand and reduce the number of unnecessary trips. This measure focuses on the reduction of: energy use (CO_2 and other emissions); congestions and on the improvement of residents' quality of life [141]. The same measure applies also to different companies located in the same specific city area.

The city of London has developed a document explaining in detail Delivery and Servicing Plans (DSPs) to companies [142], which is informing suppliers of the exact delivery location; implementing delivery booking systems; moving deliveries out of peak hours; reducing delivery frequencies; centralising the ordering system; consolidate the number of suppliers; and take advantage of consolidation centres.

3.3.7 Mobile Depots

Mobile depots are mobile warehouses serving specific city areas. A trailer is loaded at a depot outside the city and it is transported to a central parking area within the city centre. Environmentally friendly transport vehicles, such as cargo bikes, trolleys or on-foot deliveries are done for the last mile deliveries. Last mile delivery can be performed by sub-contractors of the logistics operator owning the depot. In the evening the trailer is moved back to the logistics operator's main depot (e.g. together with the cargo bikes or trolleys) [143].

The measure significantly reduces pollution e.g. the Brussels pilot reports a reduction of CO_2 by 24% and of PM_{10} by 22% [54]. Similar results are in Turin (IT) pilot project of TNT and Pony Zero [127].

3.3.8 Off-peak deliveries

This measure focuses on shifting delivery schedules out of peak hours or during the night. It focuses on supply chains that do not necessarily need daytime deliveries, such as retail and wholesale companies, food, groceries and similar products. The measure is focussed on the benefit for transport operators deriving from the fact that delivering at night is faster (e.g. less congestion, more space for unloading, less fines). Deliveries at night can be attended or un-attended and can require a change in receivers' staff working hours [144].

The City of Barcelona (ES) promoted a pilot project to deliver at night to supermarkets with a truck equipped with the PIEK technology to reduce noise (carpeted floor, low-noise pneumatic technology and low-noise rubber wheels). The pilot proved that journey times were reduced by 50%, fuel consumption up to 57% and emissions up to 53% [89].

3.3.9 By boat logistics

It is a solution for urban delivery chains, focusing on the use of waterways (where available) as energy-efficient alternative of transport in the urban areas. The main aim of the measure is to optimize the multimodal transport network and to reduce the energy use, pollution and congestion on the roads in the cities [145]. Deliveries to the urban areas are performed through integrated multimodal system, which often includes inland waterways (canal network) and road transport. The measure can focus on different supply chains, such as beverage and foods or low added-value chains, like waste or construction materials.

The measure was implemented in Paris for deliveries of food and beverages to Franprix supermarket stores through the river Seine. Following phases of the transport service are implemented: the first transportation operation by truck from the warehouse to the Port of Bonneuil-sur-Marne, where special containers are loaded on the vessel; after more than 20 km the goods are unloaded in the central area of Paris and delivered by truck to shops located in a radius of 4 km from the river side.

In this pilot project savings of about 450,000 vehicle-kilometres are reported, which corresponds to reduction of 37% of the energy used (CO_2 emissions) for the transport between the regional depot and the shops in the city centre [146].

3.3.10 Urban Distribution/Consolidation Centres

Urban Distribution/Consolidation Centres (UDC/UCC) are logistics facilities located in proximity of the receivers in the urban areas aiming at reduction of congestion and pollution. A range of other value-added logistics and retail services can be provided by UDC/UCC too. Input of goods to UDC/UCC is done in large shipment volumes. Goods are consolidated at the logistics facilities of UDC and transported to their final destinations by environmentally friendly vehicles (e.g. small clean-fuelled vehicles, bikes etc.)

The city of London has developed an UCC specifically dedicated to the construction sector (London Construction Consolidation Centre). It is a distribution centre and delivery service area for construction materials for four major building projects in the city. The benefits are: reduction of energy used for transport 70-80% (CO_2 emissions); reduction of 70% of the number of vehicles travelling to the construction sites [147,148].

3.3.11 Inclusion of measures in transport planning documents of the selected cities

Table 6 below presents overview of the number (frequency) of adopted low carbon urban logistics measures in the European cities. On one hand, number of measures adopted in each individual city (frequency), and on the other, number of adoptions of individual measure in the panel of selected cities (presented as a weight) is presented.

Table 6: Adopted low carbon urban logistics measures by the European cities

COUNTRY	**CITY**	Off-street loading bays	Cargo bikes	Clean fuels and vehicles	Spatial planning for logistics	Freight routes	Delivery and servicing plans	Mobile depots	Of peak deliveries	By boat logistics	Urban Distribution Centres	Coordination of freight rules	**FREQ.**
AUSTRIA	Vienna	●	●	●									3
BELGIUM	Ghent		●										1
BELGIUM	Brussels				●	●	●	●	●				**5**
BULGARIA	Burgas			●						●			2
BULGARIA	Balchik									●			1
CROATIA	Zagreb						●						1
CZECH R.	Brno										●		1
DENMARK	Aalborg	●		●			●						2
FINLAND	Helsinki					●							1
FRANCE	Paris	●	●		●					●	●		**5**
FRANCE	Lyon		●	●									2
FRANCE	Toulouse					●					●	●	3
GERMANY	Berlin			●									1
GERMANY	Bremen			●									1
GRECE	Serres					●	●		●		●		**4**
HUNGARY	Pécs											●	1
ITALY	Turin		●	●				●					3
ITALY	Lucca		●								●		2
NETHERLANDS	Amsterdam					●				●			2
NETHERLANDS	Utrecht			●						●			2
NETHERLANDS	s'Hertogenbosch										●		1
NORWAY	Trondheim			●			●						2
POLAND	Kraków	●									●		2
PORTUGAL	Almada										●		1
ROMANIA	Alba Giulia								●		●		2
SPAIN	Barcelona	●							●		●		3
SPAIN	Burgos									●	●	●	3
SWEDEN	Malmö					●							1
UK	London						●				●		2
UK	Dundee										●		1
UK	Norwich										●		1
WEIGHT		5	**7**	**9**	2	**6**	**6**	2	4	**6**	**14**	3	

As can be seen from the Table 6, Brussels and Paris are the most advanced among all of the analysed cities with 5 different measures adopted in the strategic transport policy documents. The majority of cities, 14 out of 30, have planned to implement Urban Consolidation Centres. Among the most popular measures are also clean fuels and vehicles (planned in 9 cities) and cargo bikes (planned in 7 cities).

3.4 Benchmark of selected measures

The main characteristic of measure also defines its applicability. For better understanding the measures (in the Table 7 below, measures are in the sequel qualitatively benchmarked (number of measures belonging to specific category is counted) with reference to:

- category of measure,
- territorial level of applicability,
- the investment and operational costs and
- savings.

Measures can be, based on their main purpose, categorised to the following groups: regulation, technology, infrastructure, service, industrial/economic, urban planning and energy. Regulation measures are mainly imposed by the city authorities to regulate or modify users' behaviour. Technology measures are strictly related to technological development, which is implemented to improve efficiency of urban freight delivery processes. Service oriented measures are focused to improvement of logistics-oriented services in urban areas and are mainly dedicated to logistics operators. Industrial or economic measures are to be understood as incentives for business entities, which are indirectly providing solutions or tools for efficient urban deliveries. Urban planning measures are oriented towards positioning of logistics infrastructure and facilities in urban areas. Energy measures are primarily dedicated to energy savings and achievement of energy efficiency.

From the spatial point of view, measures can be focused to the strict city centre (e.g. pedestrian – low emission zones), to the specific part of the city (e.g. industrial or residential area) or to the entire Functional urban area (e.g. eco norms for freight delivery vehicles in urban areas).

Successful implementation of measures is in many cases related to the volume of investment needed for their implementation. The lower the need for investment, the bigger is the possibility for implementation of the measure. The so-called soft measures (e.g. communication measures, organizational measures …) are often preferred by the policy makers than hard or investment-oriented measures (e.g. building new street, new logistics terminal).

Crucial criteria for the measure implementation are savings. The bigger the savings, the bigger is the possibility and the need for measure implementation. Savings can be measured in time (e.g. shorter delivery time), costs (e.g. savings in delivery costs for transport operator), CO2 emissions (e.g. savings of emissions imposed from delivery vehicles) and energy (e.g. savings of energy needed for delivery).

Table 7: Overview and benchmark of selected logistics measures

ASSESSMENT PARAMETERS	Off-street loading bays	Cargo bikes	Clean fuels and vehicles	Spatial planning for logistics	Freight routes	Delivery and servicing plans	Mobile depots	Of peak deliveries	By boat logistics	Urban Distribution Centres	**NUM.**
Category											
Regulation	●	●	●		●					●	**5**
Technology					●						1
Infrastructures	●		●	●						●	4
Services		●				●	●	●	●	●	**6**
Industrial/econ			●			●					2
Urban planning	●			●							2
Energy			●								1
Scale of application											
Specific area	●	●				●	●	●	●	●	7
City centre	●	●	●			●	●	●	●	●	**8**
City/FUA	●		●	●	●	●					5
Investment											
Low		●		●	●	●	●	●			**6**
Medium	●								●	●	3
High			●								1
Savings											
Low											0
Medium	●	●	●	●			●	●	●		**7**
High					●	●				●	3

Majority of measures under consideration in the upper part of the Table 7 are categorised as regulatory or service measures. The reason behind is that the city authorities, with the aim to regulate and optimise the urban freight, predominantly impose these measures. It should be noted that only one measure out of all selected, is predominantly focused on energy issues. Clean vehicles and fuels are the only measures dealing directly with energy policy issues in urban areas. At the same time, several other measures have indirect impact on energy use. The benefits are achieved due to optimisation of transport flows (e.g. fuel savings), the introduction of clean vehicles for logistics operations (e.g. electric mobility) or modal shift (e.g. use of transport means with lower energy impact).

Table 7 below, in the part dealing with the "scale of application" of the selected measures, reveals that the analysed measures are less frequently applied outside of the city centres and more frequently in the city centres and/or in the specific areas within the city. It may be concluded that the problems are much more severe in the city centres, which in Europe are very often old, historical centres with specific logistics problems.

The part of the Table 7 assessing the volume of needed investments by implementation of individual selected measure (presented results are based on experts' opinions) reveals that 6 out of 10 analysed measures demonstrate low investment needs.

Very interesting results are shown in the lower part of the Table 7, where savings of the implemented measures are assessed. Majority of the measures under consideration (6 out of 10) belong to the category of low investments needs but on the other side, the expected savings are on the medium to high level. It may be concluded that cities are focusing on soft measures (low costs, low investments), which are expected to bring optimal (medium/high) results.

4 CONCLUSIONS

A comprehensive literature review of urban freight related problems, policies, initiatives and models has been conducted to present the state of the art in planning processes of European cities and inclusion of energy related aspects.

The analysis revealed that cities are mainly dealing with the problems of: increasing transport demand, low utilisation rates, high energy use, increasing transport emissions and noise of delivery vehicles, increasing congestion in dense urban areas, inadequate road transport infrastructure, lack of logistics transhipment facilities, double parking and high delivery cost for last mile delivery operations. All these problems negatively influence not only business processes but also environmental and energy aspects of urban areas. To cope with this problem, cities are implementing the following types of measures: market-based measures, regulatory measures, land use planning measures, infrastructure measures, management measures and measures related to new technologies. Cities are also deploying new approaches and initiatives to include various stakeholders in the policy making process through implementation of different collaboration mechanisms, such as freight quality partnerships and living labs. All this measures and concepts are consequently positively influencing also the energy consumption.

In the second part the article, overview and benchmark of sustainable transport policy documents and plans implemented in 129 European cities is presented. Regardless of the differences among cities, some similarities in types of implemented measures were identified. The following main types of measures were recognised: off-street loading bays, cargo bikes, clean fuels and vehicles, spatial planning for logistics, freight routes, delivery and servicing plans, mobile depots, off-peak deliveries, by boat logistics and urban distribution centres. Although only clean fuels and vehicles can be categorised as a primary energy-based measure, other measures are also considerably contributing to energy efficiency and energy savings. What is also interesting, urban distribution/consolidation centre is present in almost half of the analysed cities and perceived the most effective measure to be implemented in cities. The analysis also reflects rational behaviour of the city councils, because the cities are focusing mainly on soft measures (low costs, low investments), which are expected to bring optimal (medium/high) results.

Presented case studies of different European cities in the last part of the article have shown that well selected measures and/or their optimal combination can substantially decrease the energy consumption and CO2 footprint. Single measures can bring on average about 20-30% savings while their optimal combination could result even in about 60-70% saving. We can conclude that with optimal combination of measures, cities can contribute to gradual realisation of the EU Commission's aim of CO2 free city. Standardisation of approaches in the cities, as well as on the functional urban areas level, is needed and recommended.

Energy aspects are currently only partially addressed under the framework of urban freight models. Linking of energy and transport models is already possible, provided statistics and data are available. In general, transport models are to be considered as basis for generating inputs to energy models and not vice versa.

5 REFERENCES

[1] EUROSTAT. Consum Energy 2017. http://ec.europa.eu/eurostat/statistics-explained/index.php/Consumption_of_energy#Publications.

[2] Bel G, Joseph S. Climate change mitigation and the role of technological change: Impact on selected headline targets of Europe's 2020 climate and energy package. Renew Sustain Energy Rev 2017:0–1. doi:10.1016/j.rser.2017.10.090.

[3] Ruzzenenti F, Basosi R. Modelling the rebound effect with network theory: An insight into the European freight transport sector. Energy 2017;118:272–83. doi:10.1016/J.ENERGY.2016.12.011.

[4] Huggins D. Panorama of transport. Eurostat, European Commision; 2009.

[5] Heinrichs H, Jochem P, Fichtner W. Including road transport in the EU ETS (European Emissions Trading System): A model-based analysis of the German electricity and transport sector. Energy 2014;69:708–20. doi:10.1016/J.ENERGY.2014.03.061.

[6] Geng Z, Dong J, Han Y, Zhu Q. Energy and environment efficiency analysis based on an improved environment DEA cross-model: Case study of complex chemical processes. Appl Energy 2017;205:465–76. doi:10.1016/J.APENERGY.2017.07.132.

[7] Han Y, Zeng Q, Geng Z, Zhu Q. Energy management and optimization modeling based on a novel fuzzy extreme learning machine: Case study of complex petrochemical industries. Energy Convers Manag 2018;165:163–71. doi:10.1016/J.ENCONMAN.2018.03.049.

[8] Whyte K, Daly HE, Ó Gallachóir BP. Modelling HGV freight transport energy demand in Ireland and the impacts of the property construction bubble. Energy 2013;50:245–51. doi:10.1016/J.ENERGY.2012.12.030.

[9] International Association of Public Transport. Climate action and public transport- Analysis of planned actions. 2014.

[10] EU Transport Policy. Transp Environ 2017. https://www.transportenvironment.org/what-we-do/eu-transport-policy.

[11] Olabi AG. Energy quadrilemma and the future of renewable energy. Energy 2016;108:1–6. doi:10.1016/j.energy.2016.07.145.

[12] UNFCCC. Adoption of the Paris agreement (1/CP.21). United nations framework convention on climate change. Paris: 2015.

[13] Pan X, Wang H, Wang L, Chen W. Decarbonization of China's transportation sector: in light of national mitigation toward the Paris Agreement goals. Energy 2018. doi:10.1016/J.ENERGY.2018.04.144.

[14] Pietzcker RC, Longden T, Chen W, Fu S, Kriegler E, Kyle P, et al. Long-term transport energy demand and climate policy: Alternative visions on transport decarbonization in energy-economy models. Energy 2014;64:95–108. doi:10.1016/J.ENERGY.2013.08.059.

[15] Calvillo CF, Sánchez-Miralles A, Villar J, Martín F. Impact of EV penetration in the

interconnected urban environment of a smart city. Energy 2017;141:2218–33. doi:10.1016/J.ENERGY.2017.12.006.

[16] Li W, Dai Y, Ma L, Hao H, Lu H, Albinson R, et al. Oil-saving pathways until 2030 for road freight transportation in China based on a cost-optimization model. Energy 2015;86:369–84. doi:10.1016/J.ENERGY.2015.04.033.

[17] Brown T, Schlachtberger D, Kies A, Schramm S, Greiner M. Synergies of sector coupling and transmission reinforcement in a cost-optimised, highly renewable European energy system. Energy 2018;160:720–39. doi:10.1016/J.ENERGY.2018.06.222.

[18] European Commission. White Paper - Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system. vol. COM(2011). 2011.

[19] European Commission. The EU explained: Transport. 2014. doi:10.2775/13082.

[20] ELTIS. Guidelines - Developing and implementing a Sustainable Urban Mobility Plan. 2014.

[21] Wefering F, Rupprecht S, Bührmann S, Böhler-Baedeker S. Guidelines. Developing and Implementing a Sustainable Urban Logistics Plan. 2014.

[22] European Commission. A Concept for Sustainable Urban Mobility Plans. 2013.

[23] Hatzopoulou M, Miller EJ. Transport policy evaluation in metropolitan areas: The role of modelling in decision-making. Transp Res Part A Policy Pract 2009;43:323–38. doi:10.1016/j.tra.2008.11.001.

[24] Ducret R, Lemarié B, Roset A. Cluster Analysis and Spatial Modeling for Urban Freight. Identifying Homogeneous Urban Zones Based on Urban Form and Logistics Characteristics. Transp Res Procedia 2016;12:301–13. doi:10.1016/j.trpro.2016.02.067.

[25] Olsson J, Woxenius J. Localisation of freight consolidation centres serving small road hauliers in a wider urban area: barriers for more efficient freight deliveries in Gothenburg. J Transp Geogr 2014;34:25–33. doi:10.1016/j.jtrangeo.2013.10.016.

[26] Tozzi M, Corazza MV, Musso A. Urban goods movements in a sensitive context: The case of Parma. Res Transp Bus Manag 2014;11:134–41. doi:10.1016/j.rtbm.2014.03.003.

[27] Tadić S, Zečević S, Krstić M. City Logistics – Status and Trends. Int J Traffic Transp Eng 2015;5:319–43. doi:http://dx.doi.org/10.7708/ijtte.2015.5(3).09.

[28] Morganti E, Dablanc L, Fortin F. Final deliveries for online shopping: The deployment of pickup point networks in urban and suburban areas. Res Transp Bus Manag 2014;11. doi:10.1016/j.rtbm.2014.03.002.

[29] Domínguez A, Holguín-Veras J, Ibeas Á, dell'Olio L. Receivers' Response to New Urban Freight Policies. Procedia - Soc Behav Sci 2012;54:886–96. doi:10.1016/j.sbspro.2012.09.804.

[30] Bozzo R, Conca A, Marangon F. Decision Support System for City Logistics: Literature Review, and Guidelines for an Ex-ante Model. Transp Res Procedia 2014;3:518–27. doi:10.1016/j.trpro.2014.10.033.

[31] MDS Transmodal Limited. Study on Urban Freight Transport. DG MOVE 2012.

[32] Iwan S. Adaptative Approach to Implementing Good Practices to Support Environmentally Friendly Urban Freight Transport Management. Procedia - Soc Behav Sci 2014;151:70–86. doi:10.1016/j.sbspro.2014.10.009.

[33] Arvidsson N. The milk run revisited: A load factor paradox with economic and environmental implications for urban freight transport. Transp Res Part A Policy Pract 2013;51:56–62. doi:10.1016/j.tra.2013.04.001.

[34] Bektas T, Crainic TG, Woensel T Van. From Managing Urban Freight to Smart City Logistics Networks. 2015.

[35] Dablanc L. Freight Transport for Development Toolkit: Urban Freight. World 2009:50.

[36] Lindholm M. Urban freight transport from a local authority perspective – a literature review. Eur Transp \ Trasp Eur 2013:1–37.

[37] Stefanelli T, Di Bartolo C, Galli G, Pastori E, Quack H, Uccelli I. Smart choices for cities - Making urban freight logistics more sustainable. 2015.

[38] Rose WJ, Mollenkopf DA, Autry CW, Bell JE. Exploring urban institutional pressures on logistics service providers. Int J Phys Distrib Logist Manag 2016;46:153–76. doi:10.1108/IJPDLM-03-2015-0068.

[39] Russo F, Comi A. City Characteristics and Urban Goods Movements: A Way to Environmental Transportation System in a Sustainable City. Procedia - Soc Behav Sci 2012;39:61–73. doi:10.1016/j.sbspro.2012.03.091.

[40] Silva J de A e, Alho A. Using Structural Equations Modelling to explore perceived urban freight deliveries parking issues. Urbe 2015 2015:1–20.

[41] Lopez C, Gonzalez-Feliu J, Chiabaut N, Leclerq L. Assessing the impacts of goods deliveries' double line parking on the overall traffic under realistic conditions. 6th Int. Conf. Inf. Syst. Logist. Supply Chain, Bordeaux, France: 2016, p. 1–7.

[42] Roca-Riu M, Estrada M. An Evaluation of Urban Consolidation Centers Through Logistics Systems Analysis in Circumstances Where Companies have Equal Market Shares. Procedia - Soc Behav Sci 2012;39:796–806. doi:10.1016/j.sbspro.2012.03.148.

[43] Giuliano Genevieve , O'Brien Thomas DL and HK. Synthesis of Freight Research in Urban Transportation Planning. 2013.

[44] Stathopoulos A, Valeri E, Marcucci E. Stakeholder reactions to urban freight policy innovation. J Transp Geogr 2012;22:34–45. doi:10.1016/j.jtrangeo.2011.11.017.

[45] Shi F, Xu GM, Liu B, Huang H. Optimization method of alternate traffic restriction scheme based on elastic demand and mode choice behavior. Transp Res Part C Emerg Technol 2014;39:36–52. doi:10.1016/j.trc.2013.11.015.

[46] Browne M, Piotrowska M, Woodburn A, Allen J. Literature Review WM9: Part I - Urban Freight Transport 2007:49.

[47] Nuzzolo A, Comi A. A system of models to forecast the effects of demographic changes on urban shop restocking. Res Transp Bus Manag 2014;11:142–51. doi:10.1016/j.rtbm.2014.03.001.

[48] Benjelloun A, Crainic TG, Bigras Y. Towards a taxonomy of City Logistics projects. Procedia - Soc Behav Sci 2010;2:6217–28. doi:10.1016/j.sbspro.2010.04.032.

[49] Browne M, Allen J, Nemoto T, Patier D, Visser J. Reducing Social and Environmental Impacts of Urban Freight Transport: A Review of Some Major Cities. Procedia - Soc Behav Sci 2012;39:19–33. doi:10.1016/j.sbspro.2012.03.088.

[50] Geng Z, Qin L, Han Y, Zhu Q. Energy saving and prediction modeling of petrochemical industries: A novel ELM based on FAHP. Energy 2017;122:350–62. doi:10.1016/J.ENERGY.2017.01.091.

[51] Cui Y, Geng Z, Zhu Q, Han Y. Review: Multi-objective optimization methods and application in energy saving. Energy 2017;125:681–704. doi:10.1016/J.ENERGY.2017.02.174.

[52] Olabi A. Developments in sustainable energy and environmental protection. Energy 2012;39:2–5. doi:10.1016/j.energy.2011.12.037.

[53] Taniguchi E. Concepts of City Logistics for Sustainable and Liveable Cities. Procedia - Soc Behav Sci 2014;151:310–7. doi:10.1016/j.sbspro.2014.10.029.

[54] Johansen BG, Andersen J, Eidhammer O, Verlinde S, Filipe LN, da Rocha J, et al. Demonstration Assessments - Straightsol project. 2014.

[55] Macario R. Managing Urban Mobility Systems. vol. 53. 2011. doi:10.1017/CBO9781107415324.004.

[56] Byers EA, Gasparatos A, Serrenho AC. A framework for the exergy analysis of future transport pathways: Application for the United Kingdom transport system 2010–2050. Energy 2015;88:849–62. doi:10.1016/J.ENERGY.2015.07.021.

[57] ERTRAC, ALICE. Urban Freight research roadmap. 2014.

[58] Mellios G, Hausberger S, Keller M, Samaras C, Ntziachristos L, Hausberger S, et al. Parameterisation of fuel consumption and CO2 emissions of passenger cars and light commercial vehicles for modelling purposes. 2011. doi:10.2788/58009.

[59] Taniguchi E, Thompson RG, Yamada T. Incorporating risks in City Logistics. Procedia - Soc Behav Sci 2010;2:5899–910. doi:10.1016/j.sbspro.2010.04.005.

[60] Bozicnik S, Mulej M. Corporate social responsibility and requisite holism-supported by tradable permits. Syst Res Behav Sci 2009;27:n/a-n/a. doi:10.1002/sres.989.

[61] Božičnik S. Model for Road Traffic CO2 Emissions Control by Means of Tradable Permits. Sustain. Transp., Berlin, Heidelberg: Springer Berlin Heidelberg; 2012, p. 317–46. doi:10.1007/978-3-642-23550-4_14.

[62] Danielis R, Valeri E, Rotaris L. Performance evaluation methods for urban freight distribution chains : a survey of the literature. Urbe 2015 2015:1–21.

[63] Björklund M, Abrahamsson M. Critical components , similarities and differences in business models for urban consolidation. Urbe 2015 2015:1–13.

[64] Elspeth E, Ballantyne F. The benefit of integrating freight logistics into urban transport demand management measures and policies 2013.

[65] CIVITAS. Smart shoices for cities - Making urban freight logistics more sustainable. 2015.

[66] Leonardi J, Browne M, Allen J, Bohne S, Ruesch M. ScienceDirect Best Practice Factory for Freight Transport in Europe: Demonstrating How “Good” Urban Freight Cases are Improving Business Profit and Public Sectors Benefits. Procedia - Soc Behav Sci 2014;125:84–98. doi:10.1016/j.sbspro.2014.01.1458.

[67] Dablanc L, Giuliano G, O’Brien T, Holliday K. Best Practices in Urban Freight Management: Lessons from an International Survey. TRB, Transp Res Rec 2013:22.

[68] Quak H, Bruening M. Innovative solutions for city logistics: demonstration and viability results. Eur Transp Conf 2012 2012:1–17.

[69] Quak H, De Koster R. The Impacts of Time Access Restrictions and Vehicle Weight Restrictions on Food Retailers and the Environment. Eur J Transp Infrastruct Res 2006;6:131–50.

[70] Oliveira LK de, Oliveira BRP e, Correia V de A. Simulation of an Urban Logistic Space for the Distribution of Goods in Belo Horizonte, Brazil. Procedia - Soc Behav Sci 2014;125:496–505. doi:10.1016/j.sbspro.2014.01.1491.

[71] Alho A, Silva J de A e, Sousa JP de. A State-of-the-Art Modeling Framework to Improve Congestion by Changing the Configuration/Enforcement of Urban Logistics Loading/Unloading Bays. Procedia - Soc Behav Sci 2014;111:360–9. doi:10.1016/j.sbspro.2014.01.069.

[72] Filippi F, Nuzzolo A, Comi A, Site PD. Ex-ante assessment of urban freight transport policies. Procedia - Soc Behav Sci 2010;2:6332–42. doi:10.1016/j.sbspro.2010.04.042.

[73] Taniguchi E, Thompson RG, Yamada T. Recent Trends and Innovations in Modelling City Logistics. Procedia - Soc Behav Sci 2014;125:4–14. doi:10.1016/j.sbspro.2014.01.1451.

[74] Muñuzuri J, Larrañeta J, Onieva L, Cortés P. Solutions applicable by local administrations for urban logistics improvement. Cities 2005;22:15–28. doi:10.1016/j.cities.2004.10.003.

[75] Woxenius J. Directness as a key performance indicator for freight transport chains. RETREC 2012;36:63–72. doi:10.1016/j.retrec.2012.03.007.

[76] Simoni MD, Bujanovic P, Boyles SD, Kutanoglu E. Urban consolidation solutions for parcel delivery considering location, fleet and route choice. Case Stud Transp Policy 2017:0–1. doi:10.1016/j.cstp.2017.11.002.

[77] Lindsey C, Mahmassani HS, Mullarkey M, Nash T, Rothberg S. Regional logistics hubs, freight activity and industrial space demand: Econometric analysis. Res Transp Bus Manag 2014;11:98–104. doi:10.1016/j.rtbm.2014.06.002.

[78] McLeod F, Cherrett T. Loading bay booking and control for urban freight. Int J Logist Res Appl 2011;14:385–97. doi:10.1080/13675567.2011.641525.

[79] Letnik T, Farina A, Mencinger M, Lupi M, Bozicnik S. Dynamic Management of Loading Bays for Energy Efficient Urban Freight Deliveries. Energy 2018.

[80] Taniguchi E, Thompson RG, Yamada T. New Opportunities and Challenges for City Logistics. Transp Res Procedia 2016;12:5–13. doi:10.1016/j.trpro.2016.02.004.

[81] Bubel D, Szymczyk K. The SmartFreight project as a superior way to cope with congestion and environmental negative externalities in urban areas. Transp Res Procedia 2016;16:25–34. doi:10.1016/j.trpro.2016.11.004.

[82] Ballantyne EEF, Lindholm M, Whiteing A. A comparative study of urban freight transport planning: addressing stakeholder needs. J Transp Geogr 2013;32. doi:10.1016/j.jtrangeo.2013.08.013.

[83] Lindholm ME. Enabling sustainable development of urban freight from a local authority perspective. 2012.

[84] Russo F, Comi A. A classification of city logistics measures and connected impacts. Procedia - Soc Behav Sci 2010;2:6355–65. doi:10.1016/j.sbspro.2010.04.044.

[85] Banister D, Hickman R. Transport futures : Thinking the unthinkable. Transp Policy 2013;29:283–93. doi:10.1016/j.tranpol.2012.07.005.

[86] Taylor M, Hallsworth A. Power relations and market transformation in the transport sector: The example of the courier services industry. J Transp Geogr 2000;8:237–47. doi:10.1016/S0966-6923(00)00014-4.

[87] Hensher DA, Brewer AM. Developing a freight strategy: The use of a collaborative learning process to secure stakeholder input. Transp Policy 2001;8:1–10. doi:10.1016/S0967-070X(00)00031-7.

[88] Buldeo Rai H, van Lier T, Meers D, Macharis C. Improving urban freight transport sustainability: Policy assessment framework and case study. Res Transp Econ 2017. doi:10.1016/j.retrec.2017.08.005.

[89] Roche-Cerasi I. State of the Art report - Urban logistics practices. Trondheim, Norway: 2012.

[90] Lindholm M. Successes and Failings of an Urban Freight Quality Partnership – The Story of the Gothenburg Local Freight Network. Procedia - Soc Behav Sci 2014;125:125–35. doi:10.1016/j.sbspro.2014.01.1461.

[91] Quak H, Lindholm M, Tavasszy L, Browne M. From Freight Partnerships to City Logistics Living Labs - Giving Meaning to the Elusive Concept of Living Labs. Transp Res Procedia 2016;12:461–73. doi:10.1016/j.trpro.2016.02.080.

[92] Eidhammer O, Andersen J, Johansen BG. Private public collaboration on logistics in Norwegian cities. Transp Res Procedia 2016;16:81–8. doi:10.1016/j.trpro.2016.11.009.

[93] Jedliński M. The Idea of “FQP Projectability Semicircle” in Determining the Freight Quality Partnership Implementation Potential of the City. Transp Res Procedia 2016;16:191–201. doi:10.1016/J.TRPRO.2016.11.019.

[94] Marcucci E, Gatta V, Marciani M, Cossu P. Measuring the effects of an urban freight policy package defined via a collaborative governance model. Res Transp Econ 2017;65:3–9. doi:10.1016/j.retrec.2017.09.001.

[95] Nesterova N, Quak H. A city logistics living lab: a methodological approach. Transp Res Procedia 2016;16:403–17. doi:10.1016/j.trpro.2016.11.038.

[96] Gatta V, Marcucci E, Le Pira M. Smart urban freight planning process: integrating desk, living lab and modelling approaches in decision-making. Eur Transp Res Rev 2017;9. doi:10.1007/s12544-017-0245-9.

[97] Le Pira M, Marcucci E, Gatta V, Inturri G, Ignaccolo M, Pluchino A. Integrating discrete choice models and agent-based models for ex-ante evaluation of stakeholder policy

acceptability in urban freight transport. Res Transp Econ 2017;64:13–25. doi:10.1016/j.retrec.2017.08.002.

[98] Taniguchi, Eiichi; Thompson, Russell G.; Yamada, Tadashi; van Duin R. City Logistics - Network Modelling and Intelligent Transport Systems. Emerald, Inc.; 2001.

[99] Gonzalez-Feliu J. Models and Methods for the City Logistics: The Two-Echelon Capacitated Vehicle Routing Problem. Politecnico di Torino, 2008.

[100] Crainic TG, Ricciardi N, Storchi G. Models for Evaluating and Planning City Logistics Systems. Transp Sci 2009;43:432–54. doi:10.1287/trsc.1090.0279.

[101] Tamagawa D, Taniguchi E, Yamada T. Evaluating city logistics measures using a multi-agent model. Procedia - Soc Behav Sci 2010;2:6002–12. doi:10.1016/j.sbspro.2010.04.014.

[102] Taniguchi E, Thompson RG, Yamada T. Emerging Techniques for Enhancing the Practical Application of City Logistics Models. Procedia - Soc Behav Sci 2012;39:3–18. doi:10.1016/j.sbspro.2012.03.087.

[103] Anand N, Quak H, van Duin R, Tavasszy L. City Logistics Modeling Efforts: Trends and Gaps - A Review. Procedia - Soc Behav Sci 2012;39:101–15. doi:10.1016/j.sbspro.2012.03.094.

[104] Gonzalez-Feliu J, Routhier J-L. Modeling Urban Goods Movement: How to be Oriented with so Many Approaches? Procedia - Soc Behav Sci 2012;39:89–100. doi:10.1016/J.SBSPRO.2012.03.093.

[105] Tavasszy LA, Ruijgrok K, Davydenko I. Incorporating Logistics in Freight Transport Demand Models: State-of-the-Art and Research Opportunities. Transp Rev 2012;32:203–19. doi:10.1080/01441647.2011.644640.

[106] Teo JSE, Taniguchi E, Qureshi AG. Evaluation of Load Factor Control and Urban Freight Road Pricing Joint Schemes with Multi-agent Systems Learning Models. Procedia - Soc Behav Sci 2014;125:62–74. doi:10.1016/j.sbspro.2014.01.1456.

[107] Behnke M, Kirschstein T. The impact of path selection on GHG emissions in city logistics. Transp Res Part E Logist Transp Rev 2017;106:320–36. doi:10.1016/J.TRE.2017.08.011.

[108] Comi A, Buttarazzi B, Schiraldi MM, Innarella R, Varisco M, Rosati L. DynaLOAD: A simulation framework for planning, managing and controlling urban delivery bays. Transp. Res. Procedia, vol. 22, Elsevier; 2017, p. 335–44. doi:10.1016/j.trpro.2017.03.049.

[109] Jebaraj S, Iniyan S. A review of energy models. Renew Sustain Energy Rev 2006;10:281–311. doi:10.1016/j.rser.2004.09.004.

[110] Wagner P, Wegener M. Urban Land Use, Transport and Environment Models. DisP - Plan Rev 2007;43:45–56. doi:10.1080/02513625.2007.10556988.

[111] Bhattacharyya Govinda SC, Timilsina R. Energy Demand Models for Policy Formulation A Comparative Study of Energy Demand Models. 2009.

[112] Keirstead J, Jennings M, Sivakumar A. A review of urban energy system models: Approaches, challenges and opportunities. Renew Sustain Energy Rev 2012;16:3847–66. doi:10.1016/J.RSER.2012.02.047.

[113] Suganthi L, Samuel AA. Energy models for demand forecasting—A review. Renew Sustain Energy Rev 2012;16:1223–40. doi:10.1016/J.RSER.2011.08.014.

[114] Gerboni R, Grosso D, Carpignano A, Dalla Chiara B. Linking energy and transport models to support policy making. Energy Policy 2017;111:336–45. doi:10.1016/J.ENPOL.2017.09.045.

[115] Debnath KB, Mourshed M. Forecasting methods in energy planning models. Renew Sustain Energy Rev 2018;88:297–325. doi:10.1016/J.RSER.2018.02.002.

[116] Taniguchi E, Yamada T, Kakimoto Y. Models for Evaluating City Logistics Measures. Proc East Asia Soc Transp Stud 2001:16.

[117] Feng W, Figliozzi MA. 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 - Soc Behav Sci 2012;39:702–11. doi:10.1016/j.sbspro.2012.03.141.

[118] Josh Sanburn. Deliver a fix for traffic jams, 10 big ideas in transportation. Time 2013;March:40.

[119] Maes J, Vanelslander T. The Use of Bicycle Messengers in the Logistics Chain, Concepts Further Revised. Procedia - Soc Behav Sci 2012;39:409–23. doi:10.1016/j.sbspro.2012.03.118.

[120] Beaujean JM, Charpentier JP, Nakicenovic N. Global and International Energy Models: A Survey. Annu Rev Energy 1977;2:153–70. doi:10.1146/annurev.eg.02.110177.001101.

[121] OECD. Redefining "Urban": A New Way to Measure Metropolitan Areas. 2012. doi:10.1787/9789264174108-en.

[122] Foltyński M. Management tool for streamlining city logistics. Transp Res Procedia 2016;16:89–103. doi:10.1016/j.trpro.2016.11.010.

[123] Nourinejad M, Wenneman A, Habib KN, Roorda MJ. Truck parking in urban areas: Application of choice modelling within traffic microsimulation. Transp Res Part A Policy Pract 2014;64:54–64. doi:10.1016/j.tra.2014.03.006.

[124] Kohr B. Delivering the goods. Pharm Manuf Pack Sourcer 2013:24–5. doi:10.1108/eb056701.

[125] Wrighton S, Reiter K. CycleLogistics - Moving Europe Forward! Transp Res Procedia 2016;12:950–8. doi:10.1016/j.trpro.2016.02.046.

[126] Nocerino R, Colorni A, Lia F, Luè A. E-bikes and E-scooters for Smart Logistics: Environmental and Economic Sustainability in Pro-E-bike Italian Pilots. Transp Res Procedia 2016;14:2362–71. doi:10.1016/j.trpro.2016.05.267.

[127] TNT. Il "Mobile Depot" di TNT Sabarca a Torino. TNT PEOPLE Netw 2016. https://www.tnt.com/express/it_it/site/home/Chi-e-TNT/Media-Relation/Comunicati-stampa/Mobile-Depot.html.

[128] Schliwa G, Armitage R, Aziz S, Evans J, Rhoades J. Sustainable city logistics — Making cargo cycles viable for urban freight transport. Res Transp Bus Manag 2015;15:50–7. doi:10.1016/J.RTBM.2015.02.001.

[129] Leonardi J, Browne M, Allen J. Before-after assessment of a logistics trial with clean urban freight vehicles: A case study in London. Procedia -Social Behav Sci 2012;39:146–57. doi:10.1016/j.sbspro.2012.03.097.

[130] Cruz C, Montenon A. Implementation and Impacts of Low Emission Zones on Freight Activities in Europe: Local Schemes Versus National Schemes. Transp Res Procedia 2016;12:544–56. doi:10.1016/j.trpro.2016.02.010.

[131] Browne M, Allen J, Leonardi J. Evaluating the use of an urban consolidation centre and electric vehicles in central London. IATSS Res 2011;35:1–6. doi:10.1016/j.iatssr.2011.06.002.

[132] Al-Alawi BM, Bradley TH. Review of hybrid, plug-in hybrid, and electric vehicle market modeling Studies. Renew Sustain Energy Rev 2013;21:190–203. doi:10.1016/j.rser.2012.12.048.

[133] The Port of Los Angeles. Clean Truck Program Terminal Access n.d. https://www.portoflosangeles.org/ctp/idx_ctp.asp (accessed December 14, 2017).

[134] Melo S, Baptista P, Costa Á. Comparing the Use of Small Sized Electric Vehicles with Diesel Vans on City Logistics. Procedia - Soc Behav Sci 2014;111:350–9. doi:10.1016/j.sbspro.2014.01.068.

[135] Diziain D, Ripert C, Dablanc L. How can we Bring Logistics Back into Cities? The Case of Paris Metropolitan Area. Procedia - Soc Behav Sci 2012;39:267–81. doi:10.1016/j.sbspro.2012.03.107.

[136] Raimbault N, Andriankaja D, Paffoni E. Understanding the Diversity of Logistics Facilities

in the Paris Region. Procedia - Soc Behav Sci 2012;39:543–55. doi:10.1016/j.sbspro.2012.03.129.

[137] Dablanc L, Rakotonarivo D. The impacts of logistics sprawl: How does the location of parcel transport terminals affect the energy efficiency of goods' movements in Paris and what can we do about it? Procedia - Soc Behav Sci 2010;2:6087–96. doi:10.1016/j.sbspro.2010.04.021.

[138] Dalla G, Cheah L, Courcoubetis C. A game of supply chains and an Urban Consolidation Center. Urbe 2015 2015:1–15.

[139] Regterschot E, van 't Hull C, Algra H, Korteweg A. Voorkeursnet Goederenvervoer Amsterdam. 2009.

[140] Puchinger J, Schrampf J. ILOS - Intelligent Freight Logistics in Urban Areas: Freight Routing Optimisation in Vienna. 2013.

[141] Trailblazer. Delivery & Servicing Plans Toolkit. 2013.

[142] Leonardi J, Browne M, Allen J, Zunder T, Aditjandra PT. Increase urban freight efficiency with delivery and servicing plan. Res Transp Bus Manag 2014;12:73–9. doi:10.1016/j.rtbm.2014.10.001.

[143] Verlinde S, Macharis C, Milan L, Kin B. Does a Mobile Depot Make Urban Deliveries Faster, More Sustainable and More Economically Viable: Results of a Pilot Test in Brussels. Transp Res Procedia 2014;4:361–73. doi:10.1016/j.trpro.2014.11.027.

[144] Holguín-Veras J, Wang X (Cara), Sánchez-Díaz I, Campbell S, Hodge SD, Jaller M, et al. Fostering unassisted off-hour deliveries: The role of incentives. Transp Res Part A Policy Pract 2017;102:172–87. doi:10.1016/j.tra.2017.04.005.

[145] van Rooijen T, Quak H. City Logistics in the European CIVITAS Initiative. Procedia - Soc Behav Sci 2014;125:312–25. doi:10.1016/j.sbspro.2014.01.1476.

[146] Fine M, Rizet C. Supermarket stores deliveries using waterways in Paris - BESTFACT report. 2013.

[147] Transport for London. The Directory of London Construction Consolidation Centres. 2016.

[148] Transport for London. London Construction Consolidation Centre 2008.

Highlights

- Literature review of urban freight transport problems, policies, measures and models.
- Methodology for mapping and benchmarking strategic policy documents.
- Review of strategic policy documents for a panel of 129 European cities.
- Best practice examples of measures contributing to energy saving.