Impacts of vehicle technology shift and downsizing in urban logistics: application if Lisbon, Portugal
Sandra Melo\textsuperscript{a}, Ricardo Coimbra\textsuperscript{b}, Rui Couchinho\textsuperscript{c}, Patricia Baptista\textsuperscript{a}

\textsuperscript{a} LAETA, IDMEC, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1 - 1049-001 Lisboa – Portugal, sandra.melo@tecnico.ulisboa.pt and patricia.baptista@tecnico.ulisboa.pt
\textsuperscript{b} FEUP, Faculdade de Engenharia da Universidade do Porto, Rua Dr Roberto Frias s/n 4200-465 Porto - Portugal ricardo.coimbra@trenmo.com
\textsuperscript{c} Instituto Superior Técnico - Universidade de Lisboa, Departamento de Engenharia Civil, Arquitetura e Georrecursos, CESUR - Centro de Sistemas Urbanos e Regionais, IST - CESUR / Av. Rovisco Pais / 1049-001 Lisboa / PORTUGAL, rui.couchinho@tecnico.ulisboa.pt

Extended abstract

Objectives and motivation
The increasing urbanization, population growth and changes on demand patterns, has led to increasing urban freight movements. Despite the relevant role of urban goods distribution and supply requirements to urban populations in the sustainable development of cities, it also generates negative impacts on the economic power, accessibility, quality of life and on the attractiveness of urban areas. Under such context, society is becoming more demanding in terms of sustainability, putting public administrators’ and private operators into a difficult challenge, which cannot be delayed anymore. Urban logistics stakeholders are expected to maintain and promote the cities sustainability, mobility and quality of life, while ensuring that urban goods distribution systems efficiently serve their city’s needs. As a result, there is the need to promote urban goods distribution new solutions that are environmentally friendly and, at the same are efficient enough to satisfy both society’s and distribution companies’ needs. Research has identified new solutions that potentially reply to both requisites, from operational and strategic levels of intervention. At the strategic level of intervention, the use of technologies to pursue the concept of analytic cities (such as real-time traffic management) is increasingly popular. At the operational level, solutions resulting from the intervention within the distribution fleet (by a technology shift or by a vehicle downsizing) are also being disseminated as best practices on urban logistics.

Despite its trendy promotion, research does not present yet, at the best knowledge of authors of this paper, an overall quantitative analysis of the effects of those solutions. Such analysis should identify the system efficiency, economic, social and environmental effects of the initiative, considering the affected stakeholders group.

This research paper addresses that gap, by analyzing the effects of a combination of technology shift and vehicle downsizing, by considering the change to small electric vehicles and to cargo-bikes, applied to the city of Lisbon (Portugal). Results are then compared with others from related studies and data is presented on the effect of the replacement rate on the viability of the measure, the maximum geographical range of small vehicles to deliver goods and the effects of the initiative on other users of the road infrastructure.

General description
In order to assess the impact of this set of innovative urban logistics solution, authors built a model using microscopic traffic commercial simulation with AIMSUN (Advanced Interactive Microscopic Simulator for Urban and Non-Urban Networks). AIMSUN allows to model the traffic conditions in the selected area, identifying the road network critical areas and analyzing the most relevant journeys made by goods vehicles seeking to supply shops and services in the Lisbon downtown. The data provided by the Lisbon Municipality, reveals that commercial vehicles access the area of study, through eight major points, as is presented in Figure 1.

Figure 1 – Traffic counts in Lisbon downtown, Source: TIS, June 2012

Additionaly to the conventional commercial vehicles, vans and trucks, two further vehicle categories were included: small electric vehicles and cargo bikes. Specific vehicle parameter adaptations (vehicle dimensions, speed and acceleration profiles) were made to include SEV and cargo-bikes within the vehicle typologies. Their on-road dynamic performance was based on real world measurements of these vehicle types performing urban logistics activities.
The application of this combination of technology shift and vehicle downzizing was tested by promoting an increasing penetration of small electric vehicles and of cargo-bikes to values of 5% and 10%. These scenarios assume that the demand is not affected and keeps the same pattern, which means that the replacement rate of vans and trucks by small electric vehicles and cargo bikes is not necessarily 1:1. For these scenarios, the efficiency of the system will be evaluated through traffic variables such as flow, speed, travel time, delay time and fuel consumption. The energy and environmental impacts were assessed through energy consumption and emissions outcomes in a life-cycle perspective. A cost analysis is also performed by including operational, maintenance costs and the acquisition costs differential.

**Results and conclusions**

The preliminary results of this work show that the best geographical context for the vehicle downsizing should be the street/block level, since a considerable adoption of these alternatives would lead to a general increase in delay times on the traffic network. This is justified by the intrinsic characteristics of small electric vehicles that impose lower speeds on other road users. Those negative impacts on the general mobility are worst as the number of small vehicles increase. Moreover, when the replacement rate is higher than 1:1, results reveal that conventional vehicles perform better and lead to better traffic conditions, lower fleet costs and lower operational costs. When considering cargo bikes instead of small electric vehicles, the first appear present a better performance on the system, due to their higher circulation flexibility and consequently, being more easily surpassed. Further work will be performed to assess the optimal penetration rate of these vehicles for the purposes of urban logistics for this specific case study.

In summary, small electric vehicles and cargo bikes appear as an innovative urban logistics solution, justifying the need for a deep and critic analysis on its system efficiency, economic, energy and environmental impacts. Results from the quantitative analysis do not present them as the best practice in urban logistics, although in specific conditions, they do present results leading to a sustainable transport system.

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**Keywords**: urban logistics; vehicle downsizing; small electric vehicles; cargo bikes.