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Designing Light Electric Vehicles for urban freight transport

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Executive Summary

The number of light commercial vehicles (LCV) in cities is growing, which puts increasing pressure on the livability of cities. Freight vehicles are large contributors to polluting air and CO2 emissions and generate problems in terms of safety, noise and loss of public space. Small electric freight vehicles and cargo bikes can offer a solution, as they take less space, can maneuver easily and do not emit local pollution. There is an increasing interest in these vehicle, called light electric freight vehicles (LEFV's), among logistic service providers in European cities. However, various technical and operational challenges impede large scale implementation. Within the two-year LEVV-LOGIC project, (2016-2018) the use of LEFV's for city logistics is explored. The project combines expertise on logistics, vehicle design, charging infrastructure and business modelling to find the optimal concept in which LEFV's can be a financial competitive alternative for conventional freight vehicles. This contribution to EVS30 will present the project's first year results, showing the guideline for and the applied design of LEFV for future urban city logistics.

1 Introduction

The number of light commercial vehicles[1] (LCV) registrations in Europe has increased from 1.3 million in 2009 to 1.7 million in 2015 [1]. In 2015, LCV accounted for approximately 11% in the total light duty vehicle market, compared to 8.5% in 2009. The London Assembly Transport Committee reported an increase of 11% in kilometres driven by LCV, while lorry traffic remained the same [2]. The increase of LCV in urban traffic is a result of the rising e-commerce market, the growth of inner city construction work, the increase of self-employed workers, and trends in the food, catering and hospitality market. The average shipment size in city logistics becomes smaller and deliveries are more time-critical [3]. As a result, the maximum capacity of freight vehicles is rarely needed [4].

The delivery of goods and services are in essence required for the functioning of cities, but the vehicles put increasing pressure on the city in terms of pollution, congestion, accessibility and loss of public space [5]. One of the opportunities for improvement may be found in the use of Light Electric Freight Vehicles (LEFV) in cities. The vehicles are smaller in size, can manoeuvre easily and are free from polluting emissions.

[1] Gross vehicle weight below 3.5 metric ton. Also known as delivery vans.

In recent years, various companies across European cities have started to offer city logistics with LEFV's. However, logistic operators with LEFV only play a marginal role, while the number of LCV in city logistics continues to grow. Producers of LEFV's see limited growth in demand. There is no large-scale production of LEFV’s yet as the optimal vehicle specifications (per freight segment) has not been defined yet.

2 LEVV-LOGIC project

Within the LEVV-LOGIC project, the Amsterdam University of Applied Sciences (AUAS) and the Rotterdam University of Applied Sciences (RUAS) work together with approximately 30 public and private organizations to explore how LEFV can be a financially competitive alternative for conventional freight vehicles. The research runs from 2016 to 2018 and has started by exploring the potential of LEFV for specific freight flows based on the characteristics of the logistics demand and according delivery profiles (e.g. freight conditions, customer services, delivery frequency, network density). Next, the optimal design of the vehicles is explored. At the EVS30 conference we will present the project’s first year results.

The LEVV-LOGIC project defines light electric freight vehicles as electrically powered or electrically assisted vehicles that are in size smaller than a LCV and have a maximum loading capacity of 750 kilogram. It includes electric cargo bikes and L-category vehicles.

This brings a first limitation of the vehicles as large or heavy goods are not suitable to be delivered with LEFV. Next, LEFV have a limited range in terms of kilometers and speed and are consequently not suitable to drive on high ways. Private and/or public infrastructure is needed to charge the batteries before or between trips, depending on the intensity of use.

Figure 1 Examples of light electric freight vehicles

3 Research on electric freight vehicles

In projects like DELIVER [6], FREVUE [7] and ENCLOSE [8] the potential of electric delivery vehicles has been explored extensively, from both a technical, financial, logistical and policy perspective. Despite the time and money spent on research and development, large-scale implementation of electric vehicles has not taken place yet. In fact, the development slows down [9]. While electric vans are considered to be credible [8][10], the share of electric vans in the total fleet of LCV is only 0.1% [9]. The EU project FREVUE concludes after four year of research that the business case of EV’s remains a challenge. The environmental friendly vehicles do not offer sufficient operational advantages to compensate for the significant higher purchase price [11]. Next, there is a lack of efficient manufacturer support in case of breakdowns and development in charging infrastructure is needed.

In the meantime, the discussion on the negative impact of transport has developed into a broader debate including not only climate change, but also health issues (air quality and noise nuisance), public space occupancy and the attractiveness of cities in general. From that point of view, light electric freight vehicles offer an additional social benefit compared to conventional LCV as they are smaller in size. Next, LEFV are competitive with conventional LCV in purchase price [12]. Also, operational benefits have been observed as the vehicles are faster in congested cities [13]. The vehicles are (often) allowed on cycle lanes and can park more easily and closer to the delivery address, i.e. save time searching for a place to park.

4 Design of LEFV

City logistics is very diverse in terms of type of goods, volumes, conditions and transport units. A survey among current users of LEFV in The Netherlands shows the diverse usage of LEFV in urban freight transport, see Figure 2. However, the respondents mention the lack of suitable LEFV’s as the main barrier for upscaling. The main problems encountered are related to the capacity and battery/charging system.

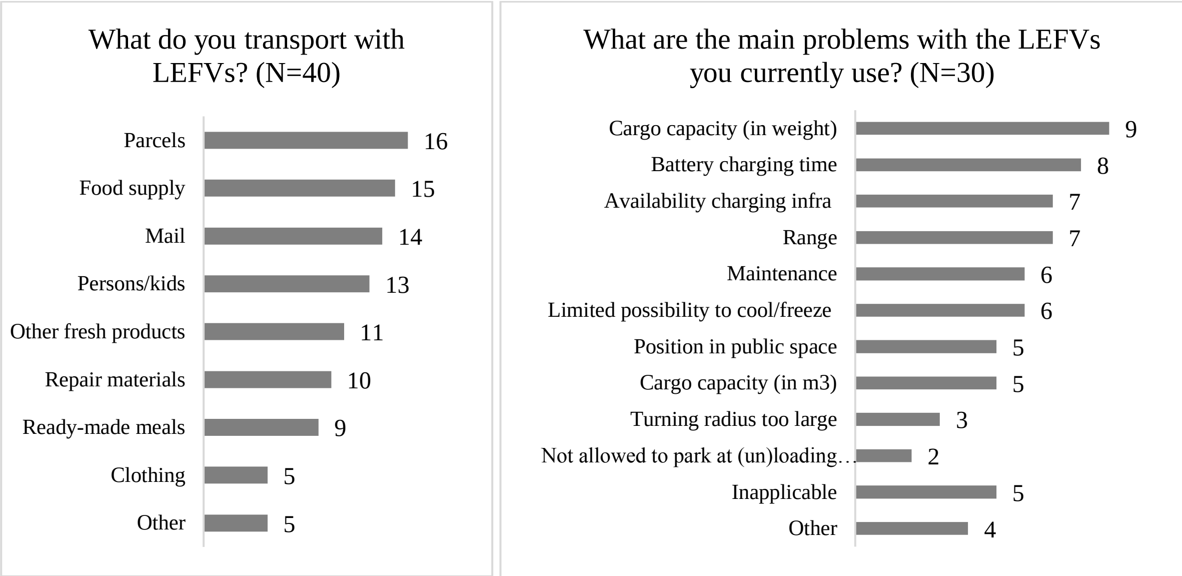

Figure 2. Results LEFV survey in The Netherlands.

Presently, LEFV concepts are being developed from two directions: up scaling bicycles and down scaling freight vehicles. For a successful transition to larger number of LEFV's in urban traffic, understanding of the fundamentals on functional requirements, performance and passive and active safety is crucial. During the first half year of LEVV-LOGIC, the functional requirements and challenges for the design of LEFV have been defined as follows:

- There is a need to design LEFV for larger loading capacity (mass and volume)
- There is a growing delivery market in the food sector, both B2B and B2C, and therefore a need for standardization in volumes, load units and cooling systems.
- There is a need for easy battery replacement or fast charging.
- The interaction with other traffic and the existing infrastructure should be taken into account during the design phase as it currently creates uncertainty among users.

The research on vehicle design and charging infrastructure will therefore look at standards to enable efficient transfer of goods from larger to smaller modalities. Three standards have been selected as vehicle loading: Euro pallets, roll containers and a standard small container. Based on the drive cycle and the homologation category of the vehicles are designed on the maximum loading of 750 kg, maximum speed of 45 km/h (cruising speed around 30 km/h), replaceable battery units of 4 kWh and a driving range of about 50 km on one battery unit.

Based on these functional requirements the design of the technical and functional packaging has been made. Parallel to this design process the 'body of knowlegde and skills' with focus on performance and passive and active safety has been composed from preceding projects [14][15], literature and automotive engineering standards on the specific education on the RUAS.

Following the product definition, detailed design will been made with the focus on standardization in components and subsystem design. Results will be the basis for optimization of existing LEFV's or the development of new LEFV's in the second year of the project, together with the LEVV-LOGIC project members.

5 Conclusion

The research shows the feasibility of the design of LEFV for different freight flows and the potential of LEFV in the development towards more efficient and sustainable city logistics. However the LEFV velocity and mass range are lower than the automotive standards, the interaction of the LEFV with urban traffic and infrastructure requires a proper standards for the design, production, maintenance and application of LEFV's.

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