Analysis of electric vehicles used in urban logistics operations pilot projects

Tharsis Teoh[1], Oliver Kunze[2], Chee-Chong Teo[3], Gebhard Wulfhorst[4]

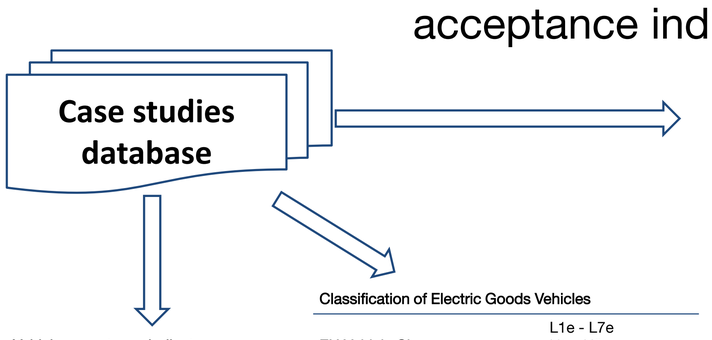
[1] TUM CREATE, 1 CREATE Way, #10-02 CREATE Tower, Singapore 138602, tharsis.teoh@tum-create.edu.sg
[2] University of Applied Sciences Neu-Ulm (Germany), [3] Nanyang Technological University (Singapore), [4] Technische Universität München (Germany)

Research Question

The electrification of goods vehicles for urban transport offers some benefits, in terms of the reduction of local air pollutants, reduction in noise emission, decoupling of transport from fossil fuelled-power generation, and the increase in energy efficiency and the decrease in operating costs borne by companies. However, there remains a lot of research needed to successfully incorporate electric vehicles in goods transport, since the incumbent conventional vehicles have shaped the operational characteristics of the firms. The study aims to synthesize various case study reports to develop theories for the suitability of market-available electric vehicles for selected urban logistics operation types.

Content

Each categorized pilot project case was assigned an acceptance indicator



Vehicle acceptance indicators	
"Generally fully accepted"	"1"
"Mostly, but not fully accepted"	"0.67"
"Mostly, but not fully unaccepted"	"0.33"
"Generally unaccepted"	"0"

The general feedback of the pilot project participants were taken as an indicator of whether the vehicles were suitable for the operations.

Classification of Electric Goods Vehicles	
EU Vehicle Class	L1e - L7e N1 - N3 M1 - M3
Total Vehicle Weight (GVW)	0.248 - 26 tonnes
Payload capacity	0.115 - 16 tonnes
Top speed	8 – 130 km/h
Battery type	Lead-based Lithium-based Sodium-based
Battery capacity	0.208 – 250 kWh
Electric driving range	50 – 190 km

The parameters provide an indication of the types of vehicles "sought after" by the firms involved.

Classification of Urban Logistics Operation	
Industry Sector	Singapore Standard Industrial Classification (SSIC) 3rd level and above
Product class	Classification of Products by Activity (CPA) 3rd level
Type of movement	Long-haul trucks Truck drayage Local truck deliveries Construction vehicles Utility and other residential service vehicles Van lines Package services
Major type of operations	Courier-Express-Parcel (CEP) services Retail delivery (to homes) Urban Consolidation Centre (UCC) transport Waste collection Construction logistics Food delivery (to homes) Store replenishment (of retailers) Internal mail

Due to a lack of available definitions of urban logistics operation types, the authors resorted to use three categorisations: based on the firm's establishment, on the product transported and on the types of movements associated with the operation. From this the operations were grouped into 8 major types to be further discussed.

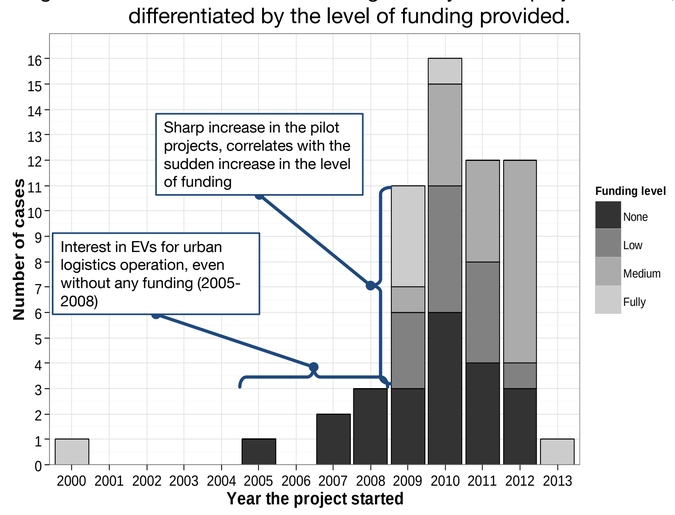
The 59 cases cover a variety of operation types and had different levels of funding

Major type of operations	Counts of cases	Acceptance Level Indicator			
		0	0.33	0.67	1.00
CEP services	14	3	2	0	9
Retail delivery	13	4	0	3	6
UCC transport	10	0	0	4	6
Waste collection	6	0	0	1	5
Construction logistics	6	1	1	2	2
Food delivery	6	3	0	0	3
Store replenishment	3	0	0	2	1
Internal mail	1	0	0	0	1
Total	59	11	3	12	33

The table shows the variety of cases, as well as the acceptance of their chosen electric vehicles. In general, electric vehicles were well accepted, however this must consider the possible bias that only case studies of successful endeavours are usually published.

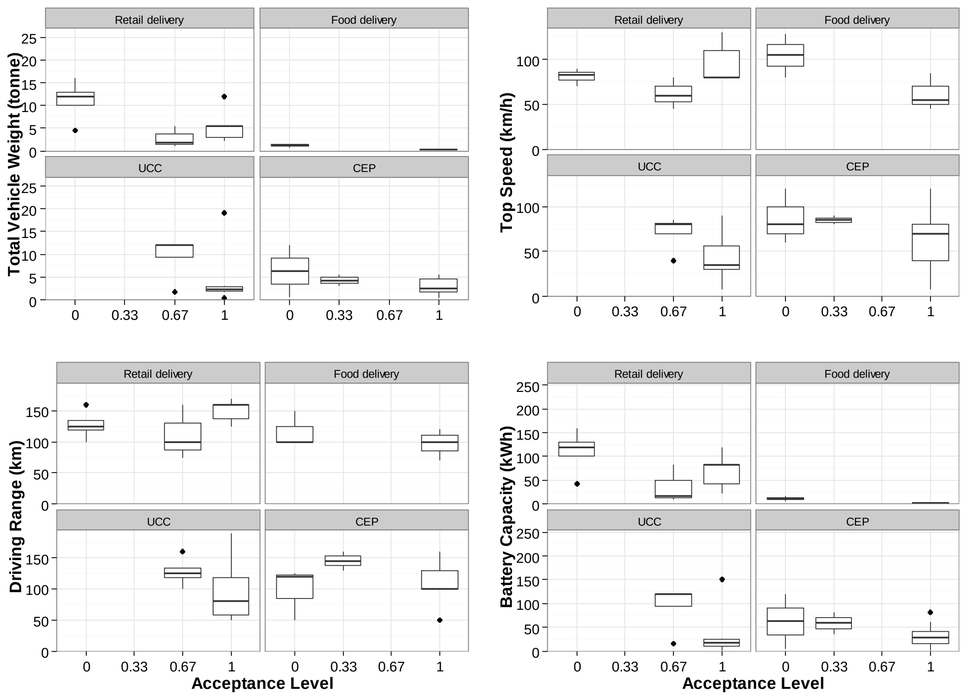
The results of selected operation types will be presented in other segments.

Figure 1: Number of cases according to the year the project started, differentiated by the level of funding provided.



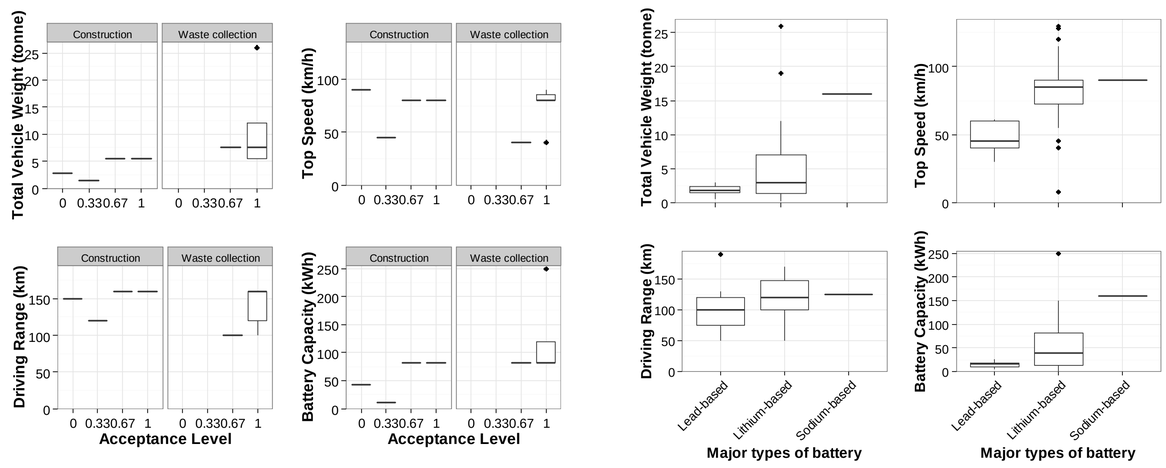
Note: Funding did not correlate to acceptance level, which meant that even if heavy subsidies were provided, companies consider other factors to evaluate the success of the implementation.

The parameters of the vehicles trialled and those which were found suitable to the operations



The type of vehicles chosen strongly depends on the operation demands. For instance, comparing retail and food deliveries (to homes), the weight of the vehicle for food is much lower than what retail deliveries require. In this case, the product's "lead time", the degree of consolidation of shipments, and the number of customers served per tour makes a large difference.

Existing electric vehicles can be used for heavier applications, depending also on future research to improve batteries



Construction logistics and waste collection typically require a heavy weight capacity for their vehicles. The vehicles chosen for construction logistics here only represent the "light-duty" construction, such as road maintenance. Waste collection routes require also a high driving range but not necessarily a high speed.

Batteries, which are an extremely important component in an electric vehicle, exhibit different characteristics depending on the chemical composition. Research is going particularly in the direction of improving the lithium-based batteries, since they currently show the most potential.

Conclusion

The paper introduced a methodology to gain generalized insights from case studies in very heterogeneous urban logistics settings. These are:

- the type of electric vehicles chosen for selected major categories of urban logistics operations,
- the type of electric vehicles which were "generally accepted",
- the trend of battery types used in vehicles in the pilot projects, and
- a comparison between the specification of the vehicles in terms of total vehicle weight, electric driving range, top speed and battery capacity for the three battery types.

Literature

Source of case studies: Laugesen, Michael Stie (2013): E-Mobility NSR. Comparative Analysis of European Examples of Schemes for Freight Electric Vehicles. Compilation Report.

Acknowledgement

This work was financially supported by the Singapore National Research Foundation under its Campus for Research Excellence And Technological Enterprise (CREATE) programme.