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IMPLEMENTATION OF ECO-VEHICLES IN CITY LOGISTICS

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Abstract: *Air quality in urban areas is key for the health and well-being of citizens, and urban freight transport is one of the main participants in the emission of harmful greenhouse gases and noise. Furthermore, urban freight transport is dominant in creation of congestion on city roads. Although much has already been done in the last decades for the improvement of air quality and environmental protection, in realization of commodity flows changes are very slow. Regarding sustainability, logistics processes, above all urban freight transport, are far from optimal. Urban freight transport growth, negative impact on the environment, inefficient use of land and the delivery costs growth are all affecting the research and definition of different initiatives of city logistics. This paper describes the initiatives of implementation of eco-friendly vehicles in urban delivery of goods, such as cargo bikes, e-scooters, cargohopper and drones.*

Keywords*: city logistics, eco-vehicles, environmental impact.*

1. INTRODUCTION

Rapid urbanization has a negative impact on urban freight transport. Goods are often transported in ways that are not optimal. Deliveries are more frequent, there are time frames that need to be respected, which requires sending more vehicles onto the city streets, and that is the cause of high energy use and carbon-dioxide emission. Urban freight transport is specifically complex in historic parts of the city, as the streets are often very narrow, utilize one-way system and have access restrictions and speed limitations, which complicates the urban delivery operations even more (Navarro et al., 2016).

Local authorities see logistic operations, primarily urban freight transport, as undesirable and want them forbidden or strictly regulated. In many cities in Europe, by access restrictions, licensing and application of different regulations, local authorities are forcing logistics service providers to make their operations more sustainable (Tadić & Zečević, 2016). Access restrictions are defined based on different criteria (individually or in combination): time frames, vehicle weight, vehicle dimensions, noise emission, air pollution, loading factor (vehicle availability of cargo space), type of goods (dangerous goods, valuable goods, live animals, etc.) (Dablanc, 2007). Still, researches show that measures of prohibition and access restrictions are limiting urban delivery operations instead of making them more efficient and sustainable.

According to several empirical studies urban freight vehicles account 6-18% of total urban travel (Frigliozzi, 2010), for 19% of energy use and 21% of carbon-dioxide emissions (Russo & Comi, 2012; Schliwa et al., 2015). Finding new strategies for increasing the quality of life of their

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citizens is essential for cities, along with retention of economic competitiveness and availability of goods and services. Whereby, over 50% of the world's population already lives in urban areas (Grimm et al., 2008), around 75% in Europe (European Commission, 2014), without any significant systematic changes, urbanization trend will lead to constant congestion and environmental pollution growth.

Problems and complexity of logistics in urban areas have caused definition, research and use of different city logistics measures and initiatives. Initiatives differ based on initiator, participants, goals, demands and implementation possibilities, but also the effects on urban sustainability (Tadić & Zečević, 2016). This paper shows initiatives of implementation of eco-vehicles for urban delivery operations. Main goal of these initiatives is reducing the negative impacts of urban freight transport on life in cities. Further, this paper shows the possibilities and effects of using cargo bikes, cargohopper, e-scooters and drones.

2. CARGO CYCLES

One of the ecofriendly solutions to urban delivery operations are cargo cycles. There are different types of cargo cycles on the market, the ones with two, three or four wheels. Main difference is transport capacity, as is locking system during delivery. Transport capacity varies from 80 to 400 kg, or 0,4 to 3 m^3. When it comes to locking system, it differs from open cargo boxes, to padlock and electronic devices which open and lock automatically in order to save time per delivery stop and protect goods (Daggers, 2013).

Goods that can be transported by cargo cycles are food, documents, medications, as well as the rest of the small consumer products. Cargo cycles are being used for B2B and B2C transport, but also as solutions for "last mile" package delivery in densely populated areas (Schliwa et al., 2015). Studies in European cities (Koning & Conway, 2016) show that potentially around 42% of courier deliveries can be transferred to cargo cycles. A study that referred to CEP shipments in cities of Europe, it has been noticed that 92% of the bicycle shipments and 56% of car shipments have 10km or less shipment distance, and 99% of the bicycle shipments and 87% car shipments are shorter than 20km (Gruber et al., 2014). Besides, some companies do not use cargo cycles only for transport, but for sale of products, such as coffee, snacks and sweets as well (Koning & Conway, 2016).

Cargo cycles are in advantage compared to electric cars, because of their smaller dimensions and easier adjustments (Navarro et al., 2016). Besides, by comparison of economic (Tipagornwong & Figliozzi, 2013) and traffic performances (Conway et al., 2014) between cargo tricycles and motorized delivery vehicles, it has been determined that cargo tricycles are cost-effective, simpler for maintenance, more reliable and more flexible for parking. However, they also have certain deficiencies such as limited capacity and distance, expensive loading area in densely populated areas and higher number of vehicles and drivers compared to motorized vehicles, which limits their cost competitiveness (Navarro et al., 2016).

The structure of some city centers requires indirectly that smaller vehicles are used, because of the width of the streets, congestion, regulations and historical value that needs to be preserved, as well as requirements for constant improvement of quality of life. A study conducted in Barcelona and Valencia (Navarro et al., 2016) examined the impact of cargo tricycle use in combination with specific loading points, instead of different delivery vehicles. In both cities the same vehicles were used, two electrically assisted pedal tricycles, with closed containers that carry parcels, with a loading capacity of 1.5 m^3, and measuring 2.78 m in length, 1.03 m in width and 1.95 m in height. Maximum load per vehicle is 280 kg, although the average weight of transport is 180 kg. Tricycles were used for "last-mile" delivery, from urban consolidation centers in which transshipment from different delivery vehicles was completed. During this study all processes were monitored, and several different effects of initiative implementation were measured, such as economic, energetic, ecological and social effects. The research has shown that it is possible to save 32 km per each tricycle in vans in Barcelona and 20.5 km in Valencia. These savings are due to car restrictions in the area, which tricycles do not have, and for that reason vans have to detour, while tricycles can drive more directly. Energy savings were minimal, because the whole system is small. It is estimated that it is possible to save approximately 2 tons of carbon-dioxide per year using this solution. Also, regarding society, the whole system showed a high acceptance level (Navarro et al., 2016).

A research conducted in Paris, different environmental impacts of 4 types of vehicles (cargo bicycle, motorized two-wheeler, truck and van) were determined: carbon-dioxide emission, local pollution, congestion and noise emission. Cargo bicycle doesn't generate any kind of costs in regards to local pollution, congestion and noise, and costs for carbon-dioxide emission are significantly lower than any other tested vehicle generates (Koning & Conway, 2016).

3. CARGOHOPPER

Cargohopper is an electric vehicle that is used for distribution of goods in inner city area. Its use had been tested in cities Utrecht (Browne et al., 2012) and Amsterdam (Duin et al., 2013), in which it is currently in use. At the moment, there are two types of Cargohopper. Cargohopper 1 is an electric road train with three trailers, 16 m long and 1.25 m wide, designed for distribution of goods in the small street networks in city centers. Trailers are loaded with containers with parcels that are distributed in urban areas (Browne et al., 2012). Containers are preloaded at a consolidation center outside the city and transported to hub located in the inners city by regular trucks. At the hub containers are loaded onto Cargohopper trailers and are then delivered to the inner city. This vehicle can be used during different time limitations in pedestrian areas. Its implementation lowered the number of freight trips by 4 080 and achieved saving 88 332 km of diesel vehicles. This led to reduction of CO_2 (73%), NO_x (27%) and PM10 (56%) emissions (Rooijen & Quak, 2014).

Cargohopper 2 is electric truck with trailer with solar panels, and its top speed is approximately 55 km/h. Loading space is constructed so it's wide enough to fit two pallets next to each other and high enough to fit roll-containers. Its maximum load capacity is 10 Euro pallets or 16 roll-containers, as well as 500 packages. Operation range of Cargohopper 2 is approximately 100 km, although, considering solar panels that are located on the trailer that range could be increased (Duin et al., 2013).

4. E-SCOOTERS

One of the options for delivering goods with positive environmental impact is electric cargo scooters. Most of the electric scooters available are those with two or three wheels. As there is no legal framework for scooters three-wheelers in Europe, their use hasn't expended. E-scooters are used for transport of lightweight goods, mostly food, like for example. pizza delivery, but there are also examples of books delivery, as their capacity is 40 kg, or 0,08 m^3. The advantage of scooter delivery is their speed of 60-100 km/h (Daggers, 2013).

The difference between e-scooter and the traditional one is that e-scooter decreases the greenhouse effect, and also reduces the level of pollutant emission, locally equal to zero. Compared to e-bike, e-scooter has higher capacity, it is faster and has better autonomy, but they are also more expensive. E-scooter is double the price of the e-bike (Lia et al., 2014).

During the project Pro-E-Bike, 39 companies tested 74 e-vehicles for delivery in urban areas. Company TNT GLOBAL Express tested usage of e-scooter instead of the traditional one for letter and smaller parcels delivery in Genoa, during the 6 months' period. The company has notices some savings. Energy costs were reduced by 0.036 €/km, carbon-dioxide emission by 160 kg, or 0.045 kg/km (Nocerino et al., 2016). During the e-scooters usage, fear of battery duration was present. However, travelled km during the day are often lower than the battery autonomy, thereby enabling charging during the night (Nocerino et al., 2016).

5. DRONES

Negative effects of urbanization, such as congestion, pollution and lower efficiency due to delays of flows of people and goods, affects “door-to-door” delivery. Drones can facilitate delivery in urban areas, by relocating transport from roads to the sky (Heutger & Kückelhaus, 2014).

An airborne first and last-mile network would function in a way where shipments that arrive in city are sorted in certain centers (hubs, warehouses, cross-docking centers), and those meeting certain criteria are separated automatically. Besides classic criteria such as size, weight and time sensitivity, criteria like air pollution, current road conditions or network load would also be considered. Each drone would then take the assigned shipment from a conveyer and take off. On the way back to the hub, drones could deliver smaller “point-to-point” deliveries, located along its route. Routing decisions would be dynamic, meaning that thanks to an advanced network, all users would be served in real time, depending on the load and shipment urgency. If an assignment for urgent shipment appears (e.g., time sensitive shipment of blood from blood bank), this shipment is prioritized (Heutger & Kückelhaus, 2014).

The system uses GPS data from user’s smartphone, so it can locate it wherever he is, even if user changes his location after ordering. If user is moving outdoors, drone could meet him and, after identifying him via NFC or QR code on his smartphone, hand over the delivery. In case of return, drones collect shipments from users and transport them directly to hub (Heutger & Kückelhaus, 2014).

6. CONCLUSION

Urban freight transport is one of the main participants in lowering the quality of life in city and negative environment impacts (Tadić & Zečević, 2016). This paper provides an overview of some representatives of eco-vehicles, their characteristics and how they can contribute to the environment.

Although eco-vehicles can’t often be seen on the city streets, and aren’t used in many cities, they have a wide range of application. E-bikes and e-scooters can be used in CEP delivery, “last-mile”, and any short-range delivery of small and medium packages (Navarro et al., 2016). These vehicles have small dimensions, so they can be used in narrow city streets, where the passage of trucks is difficult. Therefore, they can respond to large number of delivery requests in the city area. Considering the rise of e-commerce (Daggers, 2013), and increase of requests for home delivery, these vehicles are ideal for completing these tasks, with positive environment impact and reduced road transport. Also, one of the advantages of eco-vehicles lies in legislation, as there are numerous restrictions applicable to traditional vehicles and not to eco-vehicles, allowing eco-vehicles deliveries during rush-hour and city areas where access for trucks is forbidden (Rooijen & Quak, 2014).

One of the possible reasons of under-representation of eco-vehicles could be a lack of information and knowledge about advantages they bring. Also, it can be hard for a company to change the entire way of doing business. But, the benefits that the implementation of eco-vehicles brings are not just good for the environment, but for the company’s image as well. At the time when environmental protection and quality of life are so important, it’s crucial not to ignore the impact that urban freight transport has. Only with suitable initiatives on reducing negative environmental impact, a better future of life in city can be assured, and urban freight transport can be an advantage of city’s environmental concern, instead of its faultiness.

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