

Electric-Car-Sharing in Urban Logistics – The Analysis of Implementation and Maintenance

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The implementation of the sustainable transport policy in cities aims at finding various solutions that support the use of ‘clean energy’ in urban logistics. One of current global sustainable transport trends involves various measures related to electromobility. An example of electromobility in urban logistics is the e-car-sharing, or a short-term electric car rental.

Since electric car-sharing is rather new to the transport market, operators and cities and metropolises may face various difficulties while implementing such services. Based on still operating and discontinued e-car-sharing systems, the authors analysed strengths and weaknesses of those systems with the focus on implementation and maintenance issues.

The goal of the article is to determine strengths and challenges for e-car-sharing in urban logistics.

The article is designed to assist stakeholders interested in the implementation of e-car-sharing.

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Keywords: Electromobility, urban logistics, e-car-sharing, maintenance of car-sharing.

1. INTRODUCTION

The implementation of the sustainable transport policy in cities aims at finding various solutions that support the use of ‘clean energy’ in urban logistics (COM 2025, 2017). One of current global sustainable transport trends involves various measures and using alternative energy sources. Based on predefined objectives, the article focuses on electromobility in its broad sense (COM, 2013; Roman D., et. al., 2017; Słowiński P., et. al., 2017). The interest in it has been expressed in a number of research projects which studied, inter alia, the development of electric vehicle transport systems, formulation of infrastructure development plans needed to support electric vehicles, production and use of electric vehicles, development of environmental attitudes towards electromobility, and new electric vehicle transport services (Galińska B., 2018; Jacyna M., et.al., 2013; Pawłowska B., 2013; Sierpiński G., 2014). E-car-sharing, or a short-term electric car rental, is

an example of electromobility and new transport services in urban logistics.

Since electric car-sharing is rather new to the transport market, operators and cities and metropolises may face various difficulties while implementing such services. Based on still operating and discontinued e-car-sharing systems, the authors analysed strengths and weaknesses of those systems with the focus on implementation and maintenance issues. The goal of the article is to determine strengths and challenges for e-car-sharing in urban logistics. Elements of the article may be helpful while eliminating implementation and maintenance challenges in current and future e-car-sharing systems.

2. CLASSICAL AND ELECTRICAL CAR-SHARING

Car-sharing is one of the options available within the so called shared mobility in urban logistics. The service involves a short-term rental of vehicles by companies, partnerships between

cities and businesses, associations and individuals through a dedicated web-based platform and/or a mobile application (COM 288, 2016). Hence, car-sharing can be considered a more advanced form of popular city bike-sharing (Chen F., et. al, 2018; Czech P., et. al., 2018; Turoń K., et. al., 2017). Car-sharing services are an alternative to using one's own car in urban logistics (Britton E., 2000).

Although car-sharing has not developed recently (first car-sharing services date back to 1948) (Muheim P., 1998), it is currently the most popular concept improving transport services in cities and metropolises (Turoń K., et. al., 2018) due to its affordability and practical contribution to sustainable development. Depending on the type of the system, accessibility to vehicles, and the type of fleet, various car-sharing establishments apply different rental and return modes. Nevertheless, three basic types of car-sharing can be distinguished, including (Ciari F., et. al., 2014; Ferrero F., et. al., 2018; Nourinejad M. and Roorda M., 2015; Shaheen S.,A., et.al., 2015):

- 1) round trip car-sharing,
- 2) one-way car-sharing,
- 3) free-floating car-sharing.

Users of the first car-sharing type can rent a car in point A of a city and are required to return that car to the same location. This type is similar to the classical car rental (Ciari F., et. al., 2014; Ferrero F., et. al., 2018).

The second car-sharing type provides cars that can be rented in a point A and returned in another point within the city defined by the operator (Nourinejad M. and Roorda M., 2015; Shaheen S.,A., et.al., 2015). Usually this type of car-sharing is based on zones/stations where rented cars can be returned.

The third car-sharing type seems to be the most user friendly. It is possible to rent a car in point A and return it in any point B in the city/metropolis within the area covered by the operator (Nourinejad M. and Roorda M., 2015; Shaheen S.,A., et.al., 2015).

While operating in cities, car-sharing systems seem to be very well suited to use small city-type cars. Although ordinary systems are still based on cars with traditional combustion engines, more environmentally friendly electric cars are becoming more popular. Electric vehicles are marked EV. Examples of e-car-sharing vehicles are presented in figure 1.



Fig. 1. Examples of e-car-sharing vehicles.
Source: authors' own materials.

The first car-sharing systems providing EVs are based on a conventional car-sharing model that enables to rent and return a car at the same location (Gambella C., et. al., 2017). Such solutions enabled to avoid one of main problems, i.e. the shortage of charging stations or developing them in locations where no real demand is present. The market, however, forced to offer free floating car-sharing, which results in a number of challenges related to the implementation and maintenance of car-sharing systems. This article presents examples of cities where car-sharing using EVs has been gradually developed. It also includes examples of cities where bad practices resulted in the collapse of car-sharing systems. Those examples may provide guidelines while implementing new e-car-sharing systems or modernizing those that are already in operation and use traditional cars.

3. E-CAR-SHARING – SELECTED BAD AND GOOD PRACTICES

The European e-car-sharing pioneer, referred to in every publication, is the Paris based AutoLib'. It is a French car-sharing system that has been operating since 2011 (AutoLib', 2018). Despite world-wide recognition, the local council plan to discontinue the service due to the lack of profitability (Matlack C. and Nussbaum A., 2018). The AutoLib' System has offered 4,000 cars and 1100 charging stations (AutoLib', 2018). The Paris car-sharing system is based on the one-way car-sharing model. With the development of other free floating car-sharing systems in the French capital, AutoLib' ceased to be profitable. The drawback of the solution is that vehicles cannot use separate lanes designated for buses. AutoLib' is going to be closed on 31st July 2018, and some of the cars will be scrapped (AutoLib', 2018; Matlack C. and Nussbaum A., 2018). They plan to sell remaining vehicles to individuals or companies (Meunier N., 2018). Despite its failure, AutoLib' will be replaced with a new e-car-sharing system based on Renault cars. The system will provide rental of city cars, such as Renault Zoe and Twizy, and delivery vans, e.g. Kangoo ZE and Master ZE (Matlack C. and Nussbaum A., 2018). The local government keeps an open door policy regarding e-car-sharing services, and the current electric vehicle demand is estimated at 20 thousand (Matlack C. and Nussbaum A., 2018).

The second example of a successful e-car-sharing system has been developed in San Diego, the US (Blanco S., 2018). The challenge was, however, insufficient electric car infrastructure (Edelstein S., 2016). It should be mentioned that on establishing of the service in 2011 the city revealed plans for the development of electric vehicle infrastructure, including 1000 charging stations (Edelstein S., 2016). Nevertheless, in 2013, the city had only 400 charging stations and failed to attract sufficient number of users to the one-way car-sharing system. Moreover, only one type of a city car and two seaters have been offered, which, in the opinion of the operator, were suitable to the then trends. Finally, in 2016, the company decided to withdraw electric vehicles from San Diego (Edelstein S., 2016).

Another city where e-car-sharing stopped operating is Berlin. After 5 years of its operation, in 2017, PSA discontinued its e-car-sharing service (Green Congress Portal, 2018). The company offered Citroën C Zero and C1. In the opinion of

the operator, they gave in to its competitor Car2Go. Moreover, the operator declared that the problem was a limited fleet of 200 cars (Green Congress Portal, 2018).. The walking distance to be covered by users to reach their booked cars was more than 1 km (Green Congress Portal, 2018).

Main implementation and maintenance e-car-sharing challenges are listed in table 1.

Table 1. Implementation and maintenance e-car-sharing challenges.

Challenge	Type
Shortage of infrastructure supporting e-car-sharing	implementation & maintenance
Insufficient capacity of charging stations	implementation & maintenance
Limited fleet	maintenance
Limited fleet diversity	maintenance
Inappropriate system type	implementation & maintenance
Unsuitable EV charging policy	maintenance
Lack of or insufficient cooperation with city/cities	implementation & maintenance
Excessive time to reach vehicles booked	maintenance
Strong competition	maintenance

Source: authors' own materials

Despite several failures to implement electric car-sharing, there are examples of cities where electric car-sharing successfully develops and becomes popular. Although the car-sharing system run by Car2Go failed in San Diego, it proved to be successful in Europe. In 2017, Car2Go had 300,000 registered users in three cities focusing on e-car-sharing, namely Stuttgart, Amsterdam and Madrid (Green Congress Portal, 2018). Moreover, according to the operator, Car2Go electric vehicles were rented every 8.7 seconds (Green Congress Portal, 2018).. Success of the service was secured by the city infrastructure supporting the use of electric vehicles. At the moment, Stuttgart has 290 public charging stations for electric vehicles (Charge Map Portal Stuttgart, 2018), whereas Amsterdam operates one of the best EV charging infrastructures (Roman D., et al., 2017) 675 various charging stations (Green Congress Portal, 2018). Madrid is also interesting with three main e-car-sharing operators, namely Emov, Car2Go and Zity. During its first year of operation, Emov attracted more than 150,000 registered users (Manthey N., 2018), whereas Car2Go had 187,000 registered users already in 2015. Considering that since June 2018 the core city centre in Madrid has been closed to cars, the city concentrated their

effort to develop e-car-sharing. (Galán D., 2018). For this reason, Zity expanded its fleet to 500 vehicles (Car2go Car-sharing, 2018). Although each system provides possibility of driving beyond the operator's area, the car needs to be returned within a zone specified by the operator. This means that they provide the one-way car-sharing service. All three Madrid-based operators offer 1600 electric vehicles, including Renault Zoe ZE, Smart Fortwo and Citroën C-ZERO.

It is also worth referring to other European cities which have been developing e-car-sharing services. For example, Warsaw has established a pilot project with 6 Innogy electric vehicles available from February to April 2018. According to the report by the operator, the total distance covered by users was nearly 15 thousand km and the project helped to reduce emission of CO₂ and other noxious substances by 1.6 t (Manthey N., 2018). Moreover, the proof of the growing interest is that other European cities started developing e-car-sharing as well. Some examples of the above include:

- Vozilla in Wrocław, Poland, with the fleet of 200 passenger cars and 10 electric delivery vehicles (Vozilla, 2018),
- MOL in Budapest, Hungary, with 100 passenger cars (Werwitzke C, 2018), and
- Spark operating 25 passenger cars and delivery vehicles in Sofia, Bulgaria (Novinite Portal, 2018).

The list of e-car-sharing services in selected cities in Europe is presented in table 2.

Table 2. Development of e-car-sharing in selected cities in Europe.

Country	City	Operator	Established	Fleet type
France	Paris	AutoLib'	2011	electric only
Netherlands	Amsterdam	Car2Go	2011	electric only
Czech Rep.	Prague	Car4Way	2014	Selected models only
Slovenia	Ljubljana	Avant2Go	2016	electric only
Spain	Madrid	emov	2016	electric only
Spain	Madrid	Zity	2017	electric only
Germany	Stuttgart	Car2Go	2017	electric only
Poland	Wrocław	Vozilla	2017	electric only
Bulgaria	Sofia	Spark	2017	electric only
Slovak Rep.	Bratislava	eUp!	2017	electric only
Portugal	Lisbon	emov	2018	electric only
Hungary	Budapest	MOL	2018	electric only

Source: authors' own materials based on: AutoLib', 2018; Avant 2go, 2018; Car2go Car-sharing, 2018; Ca4Way, 2018; Emov Madrid, 2018; Emov Lisbon, 2018; Mol Limo, 2018; Novinite Portal, 2018; Up City, 2018; Vozilla, Werwitzke C., 2018; 2018; Zity, 2018).

We can conclude from the data presented that electric car-sharing systems have become increasingly popular year after year - mostly from 2017.

4. OPPORTUNITIES AND THREATS TO E-CAR-SHARING SYSTEMS

Based on examples of operating and discontinued electric car-sharing systems, it seems that apart from opportunities the implementation of those solutions in urban transport creates numerous threats.

As regards main opportunities, we may distinguish the following:

- global politics focused on electromobility,
- cities implementing sustainable transport plans look for vehicles with alternative propulsion systems,
- implementation of national laws on electromobility provide for incentives, such as tax exemptions, use of lanes designated for buses, access to locations with restricted combustion engine traffic,
- e-car-sharing systems show that everyday use of electric vehicles instead of combustion engine cars is possible (Car2go, 2018), and
- e-car-sharing systems are excellent pilot, test and experimental projects facilitating the implementation of electromobility in cities (Car2go, 2018).

Threats related to car-sharing systems include the following:

- appearance of free floating car-sharing competing with one-way and station-based systems,
- mismatch between the fleet and demand, e.g. lack of delivery vehicles,

- too little fleet,
- to large distance from the booking location to the rental establishments to collect the car,

- poor diversity of the fleet, e.g. one type vehicles only,
- fleet mismanagement, e.g. cars with flat batteries waiting to be delivered to charging centres by technical teams,
- lack of or insufficient collaboration with the city/cities where car-sharing is provided,
- driving beyond the e-car-sharing zone not possible in the one-way system,
- excessive competition at a given location, and
- classical car-sharing services available at lower price or larger diversity and size of the fleet than e-car-sharing.

5. SUMMARY

Summarising, the article shows that electric car-sharing is one of possibilities to complement urban logistics with individual transport options that meet sustainable development requirements. We should remember, however, that the implementation, operation and maintenance is a multi-stage process that involves a number of factors, such as:

- provision of infrastructure matching electric vehicles requirements,
- charging stations that ensure quality charging for every vehicle,
- developed information system providing information about availability, efficiency and charging station capacity,
- regulations defining user responsibility for charging, and
- user education regarding electric vehicles.

For this reason, while implementing such systems, it is worth examining a number of issues and confronting the following questions:

- ✓ Is the number of charging stations sufficient?
- ✓ Is the parking space sufficient at a charging station?
- ✓ Are charging stations available in desired locations?
- ✓ Is a charging station capable to provide simultaneously charging for more than one vehicle?
- ✓ How much time is needed to charge a vehicle?
- ✓ Should the system have its own charging stations or use public charging stations?
- ✓ Is the user able to charge their vehicle themselves or operator's personnel is needed?
- ✓ What is the liability of a user for leaving a vehicle with a flat battery?
- ✓ Can the user drive beyond the operator's zone?

- ✓ Is the e-car-sharing fleet diverse in terms of vehicle classes and types?
- ✓ Is there another operator providing services in the same area?
- ✓ Is the classical car-sharing offered in parallel to e-car-sharing?

Despite high vehicle purchase price and infrastructure cost, e-car-sharing systems can be successfully developed and contribute to electromobility in urban logistics.

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