ABSTRACT

Sharing instead of possessing, or using instead of owning is a commonly present buzzword which refers to using modern solutions in terms of joint ride systems by private cars, known in the world as carpooling, carsharing, or ridesharing. This paper will present in detail car sharing service which is a part of the smart city concept, referring to using private cars by more people in short time periods. The concept is based on the idea that the people, using their own private cars, directly increase the number of private cars on roads and air pollution and thus, they could use the system with cars available to everyone in every moment instead. The paper will present the functional system architecture, i.e. user demands, and support subsystem for carsharing service providers.

Keywords: carsharing, private car, smart city

INTRODUCTION

Because of the economic development, population increase, and urbanisation, traffic congestion in cities poses a great challenge on global, national and local level. Traffic congestion in cities is currently at its peak moments, and it is quite clear that such condition cannot be sustainable.

Because of the economic development and the widespread Internet usage through smartphones, the user behaviour gained the characteristic of sharing economy. By the definition in the Oxford dictionary, sharing economy is a system where assets or services are being shared among private users (free of charge or paid) usually by a web service. Such a system can put almost everything into usage – vehicles, bicycles, houses, apartments, services, etc. In addition, everyone can use anything owned by another people, if available. Nowadays, consumerism among people...
is replaced by post-material values, and contrary to owning and purchasing, more importance is being put onto accessibility, experience, adventure, environmental awareness, and sustainable mobility. In this manner, private car sharing, instead of owning, has become a part of the sharing economy worldwide.

To put it at its simplest, carsharing is a service in which cars are being shared. The idea for the service came for the first time in Switzerland in 1940s (Shaheen, 1998). Since the sharing economy is relatively recent concept, the idea in which cars are being shared was not recognized, nobody approved it, and it slowly diminished in the next 40 years. The first company offering carsharing service as it is known today was the Mobility Carsharing Switzerland (also from Switzerland), founded in 1987 (Shaheen, 1998). A carsharing system offers users to have car fleet available to them 24 hours a day and 7 days a week, without the expenses related to fuel, insurance, vehicle registration, tire purchase and replacement, and parking costs. The availability of the vehicles ensures citizens better mobility without the costs related to the car ownership. The citizens can use the vehicles anytime, anywhere, and must pay only for the vehicle usage costs.

The main idea of the carsharing concept is to use private cars by sharing, instead of owning a vehicle. According to the estimations, vehicles drive on the roads only 5% daily, and the remaining 95% belongs to remaining still in a car park (Brčić, 2012). This vehicle stillness, only by itself, causes demand for parking and low vehicle utilization due to parking, which can be gradually reduced if a carsharing system is implemented. A single carsharing vehicle can replace between 9 and 13 private cars, reducing the number of vehicles on roads and improving the network level of service (Innovative Mobility, 2014). Also, the need for parking reduces, and the existing, poorly utilized infrastructure designed for car parking can be replaced for other socially beneficial purposes. The less the number of vehicles on the roads, the better the quality of life for the citizens, because the reduced number of vehicles results in less impact on the environment. The impact on the environment is even more less if the carsharing fleet consists of hybrid and electric vehicles.
The carsharing service is being developed and increased in volume worldwide, as shown in Figure 26. At the end of 2014, carsharing service was present in 33 countries, 5 continents, and 1,531 cities. In the same year, there were 4.8 million users and 104,000 vehicles. The largest carsharing market is Europe, where 46% of the total users have 56% of the world carsharing fleet available. The second largest market is North America, with 34% of users and 23% of the car fleet (Berkley, 2016).

**Two carsharing business models**

Peer-to-peer or customer-to-customer (P2P or C2C) model enables private cars to be rented by other people when their owners do not use them. There is no central fleet management present, because each vehicle is taken care of by its owner, who provides maintenance and ensures roadworthiness (Hampshire, 2011). The idea behind this model lies in increasing incomes or reducing costs for private car owners by leasing them in periods when they do not use them. The first step is the user registration (the owner or the client) at the offered platform—a website or an app designed by the company offering such kind of carsharing service. At the registration, the users must provide personal data and vehicle data. In some cases, the users should provide the photos of the vehicle that will be leased. The price is determined by the service provider considering vehicle type, production year, etc. The owners are compensated for the service with 65% to 75% of the fee charged to the driver (user). The vehicle rental begins when users are given the vehicle documents and keys. The system is more often modernized with information technology equipped into the carsharing system. The costs of the carsharing equipment and its installation in the vehicle must be covered by the vehicle owner (Autotrader, 2015).
Business-to-customer (B2C) model is currently more popular among carsharing users. In this model, the carsharing company is the sole owner of the vehicles, leasing them for users. Based on the decision by the company, the distance crossed or the time spent are usually charged. The price of one minute or kilometre includes fuel, insurance, parking, registration and maintenance. To access the vehicles, the users have to register on the web site of the provider, usually paying for the registration fee. The vehicles can be rented 24 hours a day and 7 days a week, by a smartphone and the app installed on them, or by website. The car keys are always in the vehicle, and the vehicle can be unlocked by the application or by the member card recognized by the vehicle card reader. The same process applies to locking – the keys remain in the vehicle, and the vehicle is locked by the application or the member card recognized by the card reader.

**THREE CARSHARING OPERATING MODELS**

A station-based model is characterized by one-directional trips – the users can pick up a vehicle at a spot or car park, and then return it to another spot or car park. These parking spots and parking spaces are dispersed throughout the city, and only carsharing vehicles can use them. Also, if the fleet consists of electric vehicles, some spots can be also equipped with charging infrastructure. In this model, the service is less flexible for users; however, car fleet management is much simpler for the provider (Le Vine, 2014).

A round-based model is characterized by circular trips – the users must return the vehicle to the same spot where they picked them up (Le Vine, 2014). Like the station-based model, the vehicles are parked at certain parking spaces or the parking spaces of the service provider. The implementation of this kind of model significantly reduces flexibility for the users; however, car fleet management becomes even simpler.

A free-floating model is characterized by picking up and returning vehicles at any parking space in the determined zone (usually a city). Like in the station-based model, the trips are one-directional (Le Vine, 2014). The difference between the models is in the way the vehicles are returned – in the free-floating model, the vehicles can be returned at any parking space in the zone, ensuring maximum flexibility for the users. An additional advantage from the user perspective is spontaneity. The vehicle reservations are possible, but they are not necessary; instead, the users can spot a vehicle and unlock them to drive instantly.

**THE CITY OF ZAGREB**

As the capital of Croatia, the City of Zagreb, as the rest of the cities in the world, did not sustain the urbanisation process and the population increase. In addition to every other problem, this led to traffic problems, especially in private car traffic, to satisfy the needs of citizens. In 2015, the City of Zagreb had a population of 790,177 and 346,230 vehicles; these two values result with a motorisation rate of 438 vehicles per 1,000 inhabitants (Grad Zagreb, 2016).
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Private car occupancy in Zagreb is 1.38 passengers per vehicle (Grad Zagreb, 2017). According to the data from Zagrebparking (car parking authority in the City), there are 32,327 parking spaces in Zagreb, divided into private car parks (29,661 spaces in three zones), and business car parks (2,666 parking spaces) (Brčić, 2016). These numbers clearly indicate that there is a great demand for car parking in the City, with supply obviously not meeting the demand. This leads to traffic congestion in the City, especially the city centre, which increases the impact on the environment. If the average vehicle age is considered as well (13 years in the Republic of Croatia), the whole situation has even worse image, having impact mostly on the air quality and liveability. The citizens are required to be informed about the new sustainable modes of transport in the City, and they need to be encouraged into using them.

The Spin City was firstly presented to the City of Zagreb in June 2016 as the first carsharing service ever. Spin City is a project of the private company Urban Mobility d.o.o., which is focused on developing shared, connected and sustainable modes of transport in the urban environment. The goal is to provide the citizens with better mobility by upgrading the existing public transport network in form of a car-sharing scheme, as an alternative to private car and its ownership costs. The purpose is to unburden the existing road network with environment-friendly sustainable transport in the city. The business model is B2C, and the operating model is free-floating. The vehicle fleet currently consists of 30 VW Up! Vehicles (20 conventional and 10 electric). The Spin City sharing zone covers almost the City of Zagreb entirely, and the vehicles can be picked up and left at any parking space within that zone. There are also nine parking spaces intended for carsharing vehicles exclusively. The first step for the users is the registration on the official website, with a fee paid for the registration. After a successful registration, the users send their documents via e-mail (ID or passport and a driver’s license) for validation. After the driver passes the validation, the member ID, used to unlock the cars, is delivered to the driver. Besides the member ID, the vehicles can be unlocked via the app. The app provides the information about vehicle availability, including the vehicle information (conventional or electric, fuel or battery level, and the shortest path to the vehicle considering the current location of the user).

CASE STUDY

The research on habits and experiences of using the Spin City carsharing service was conducted by a survey. The survey was sent to the users by e-mail. At the time, the user database consisted of:

- Users who provided their information on the website, but they still have not paid for the registration fee
- Users who paid for the registration fee, but they still have not sent their information to validation
- Users who passed the entire registration and validation process

The survey did not encompass the potential users who have not decided for the service yet. The goal of the survey was to get the insight about the user attitude and thoughts, for improving the service and predicting future trends and
future behaviour change among the users. The questionnaire included eight questions, and 80 users successfully completed it.

**Research Results**

Figure 27 and Figure 28 show that more than a half of the users (43 users or 54%) live in a household with one vehicle, and 34 users (42%) have two household members with a valid driver’s license.

![Figure 27: The number of private cars per household (by authors)](image)

A half of the users tried Spin City service due to curiosity, i.e. they only used it once just to try it. The number of people who use the service several times a month is slightly less (47.5%), and the least percentage (2.5%) belongs to the people who use the service several times a week. According to the survey, there are no people who use the service daily, although the experiences suggest other – the presumption is that a few users who require the service daily have not completed the questionnaire.

Most users would not sell their private car, if they used only the carsharing service (64.4%). The rest would sell their vehicle in such a scenario. This question was answered by only the users who own a private car (73 users).
The crucial factors in mode choice for the most users were speed, time and costs. The third place on the factor scale belongs to comfort and availability (Figure 29).

If the users had every mode of transport available to them, 46% users would still decide upon using their private cars. The ones who would choose the carsharing service, nevertheless the situation, make up the 23% (Figure 30).

The lower service price would encourage 65% of people to use carsharing service more frequently, and 22% would use the service more if the availability of the vehicles (number of available cars) was higher. If the service was better integrated with other modes of transport (taxi or Uber, public transport, or public bicycles), the service would be used...
more frequently by 9% of the users. As little as 3% of people would use the service more just because it offers the comfort and independent driving.

**Conclusion**

The results of the survey show that most carsharing users have one vehicle in their households, and that the vehicle is used mostly by both household members – the ones who possess a driver’s license. Therefore, one household member can move freely, and the other is limited, so the carsharing service perfectly compensates for the people who are occasional private car users in the household.

A half of the people used the carsharing service only once to get familiar with the concept. The experience suggests that such users mostly wanted to try out the electric vehicle, because they did not have an opportunity to drive one. In addition, it was noted by the observed vehicle routes that users, for whom the electric vehicle was not the nearest one, drove with the conventional vehicle to the nearest electric vehicle, so they could continue their ride in an electric one.

Approximately one third of users would sell their own vehicle if they decided to use only the carsharing service. That percentage could be higher if the users were more aware of the financial and environmental benefits of carsharing.

Travel time and low prices are the leading factors influencing the mode choice. Theoretically, if most people used the carsharing service, there would be less vehicles on roads. This would result in improved traffic flow, and reduced travel times. The reduction of travel time would then result in the reduction of travel costs, because the carsharing service is mostly charged by the time spent in a vehicle, (Spin City also charges per in-vehicle time).

The relatively large proportion (46%) of users would still use their private cars, if every mode of transport was available to them. This number of users needs to be reduced by information, education and behaviour change.

According to the responses, the people would use carsharing service more frequently if the service was cheaper, and if more vehicles were available. Spin City is constantly working on offering better service for the price. In less than a year of providing service in the City of Zagreb, the carsharing was expanded several times to satisfy user needs and requirements for mobility. There are several charging schemes which are, by price and by experience, competent to every mode of transport in the city, especially private cars. The information and education among citizens is the most important part whenever a carsharing service is going to be implemented. If the users are properly introduced with the multiple advantages of the service, the carsharing is likely to succeed in any type of urban environment.
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