Transportation Research Part C 77 (2017) 207–225

Contents lists available at ScienceDirect

Transportation Research Part C

journal homepage: www.elsevier.com/locate/trc

Modeling the impact of parking price policy on free-floating carsharing: Case study for Zurich, Switzerland ☆

Milos Balac *, Francesco Ciari, Kay W. Axhausen

IVT, ETH Zürich, 8093 Zürich, Switzerland

A R T I C L E   I N F O

Article history:
Received 17 June 2016
Received in revised form 5 November 2016
Accepted 26 January 2017
Available online 9 February 2017

Keywords:
Carsharing
Free-floating
Parking
MATSim

A B S T R A C T

The research on carsharing has already shown that a non-negligible part of carsharing members give up a vehicle after joining a carsharing program, or avoid a vehicle purchase. This arguably reduces overall parking space needed. This might well be one of the most important impacts of a carsharing program on the transportation system, but also one of the least researched. The rapid diffusion of free-floating carsharing, which for its very nature might have a stronger impact on parking, makes the relationship between carsharing and parking an appealing topic for new research. This work presents a method for the investigation of this relationship using an agent-based simulation and explores the impacts of different parking prices on the demand for free-floating carsharing in the city of Zurich, Switzerland. Three levels of free-floating fleet-size in the city of Zurich coupled with three levels of parking prices were simulated. The obtained results show that free-floating vehicles are able to use parking spaces more efficiently than private vehicles. Moreover, the average parking occupancy tends to be more homogeneous with higher fleet-size of free-floating carsharing and with the increase of parking prices, thus avoiding spatial parking pressure peaks.

1. Introduction

Several studies have found that a non-negligible part of carsharing members give up a vehicle after joining a carsharing program, or avoid a vehicle purchase (Millard-Ball et al., 2005; Becker et al., 2016). This arguably reduces overall parking space needs. This might well be one of the most important impacts of a carsharing program on the transportation system, but also one of the least researched. The studies on the relationship between carsharing and parking are indeed sparse (Millard-Ball et al., 2006; Shaheen et al., 2010). The rapid diffusion of free-floating carsharing, which for its very nature might have a stronger impact on parking, makes this relationship an appealing topic for new research.

Traditional, round-trip based carsharing has an impact on parking exclusively through the reduction of the number of vehicles in the system. With such a scheme the vehicle remains reserved for the whole duration of a round-trip. This implies that the vehicle needs to be parked while the user is performing an activity at a given location, like with a private car. With free-floating carsharing, however, the vehicle is generally booked for a single trip only. As soon as the destination is reached, the vehicle is parked, the rental ends and the vehicle becomes available for the next user. Potentially, this allows a more efficient vehicle's use, increasing the time the vehicle is traveling and reducing the time the vehicle is occupying a parking slot.

☆ This article belongs to the Virtual Special Issue on "Emerging Urban Mobility Services: Characterization, Modeling and Application".

* Corresponding author.
E-mail addresses: milos.balac@ivt.baug.ethz.ch (M. Balac), ciari@ivt.baug.ethz.ch (F. Ciari), axhausen@ivt.baug.ethz.ch (K.W. Axhausen).

http://dx.doi.org/10.1016/j.trc.2017.01.022
0968-090X/

This would mean a larger positive impact on parking than that of traditional carsharing. Moreover, the increased efficiency, could help avoiding parking-pressure peaks. A higher turnaround of parking spaces might increase the ease of finding an empty parking space, therefore increasing the satisfiability of people.

The work presented in this paper aims at producing knowledge which can support, or oppose, the hypothesized mechanism for the city of Zurich. A methodology to model carsharing operations is developed and is implemented as a pluggable module inside of the open-source, Java based, multi-agent transport simulation framework (MATSim, www.matsim.org). The methodological aspects of using MATSim for carsharing simulations has been presented by Ciari et al. (2009) and since then, the carsharing module in various stages of development, has been used in several studies (Ciari et al., 2014; Ciari et al., 2015; Balac et al., 2015; Balac et al., 2016). It was shown before, that the simulation using the carsharing module is capable of generating plausible predictions of carsharing usage according to given characteristics of the service. A pluggable MATSim module modeling parking choice behavior, has also been developed in the past few years (Waraich et al., 2013). The current paper presents a framework that integrates carsharing and parking modules and is flexible and easily pluggable into MATSim. It features newly developed, flexible and pluggable carsharing framework. The proposed methodology is used to evaluate impacts of parking price policies on free-floating carsharing usage and parking in general. This demonstration shows how the tool will help designing effective policies for easing parking pressure in an urban area.

2. Background

2.1. Carsharing and parking in Zurich

The first implementation of carsharing in Switzerland date back to the 1948 (Harms and Truffer, 1998). Currently, in Switzerland, there is a nationwide round-trip carsharing service provided by Mobility (Mobility, 2016) whereas Catch-a-Car (Catch-a-Car, 2016) a subsidiary of Mobility, provides free-floating carsharing in the city of Basel since 2014 and at the time of writing this paper about to start operations in Geneva. Round-trip carsharing, besides having dedicated parking slots at stations, requires parking spaces at the locations where the individuals perform their activities. Therefore, it can be said that round-trip carsharing vehicles require the same amount of parking space as privately owned ones.

At the moment, the city of Zurich offers approximately 50,000 curb parking spaces, 16,000 spaces in parking garages and over 200,000 private parking spaces (Tiefbau- und Entsorgungsdepartement der Stadt Zürich, 2016). Parking spaces on the streets are part of the blue- or white zone. In the blue zone they are free of charge, but there is generally a park time limit of one to two hours (except on Sundays and public holidays). Spaces in the white zone are managed with parking meters. Residents also have the possibility to obtain a parking permit for 300 CHF (1 CHF = 1.04 USD on 15.06.2016) per year that allows them to park inside the blue zone in the district of the city where they live, without a time limit. Prices in parking garages on a workday vary from 0.5 to 4.40 CHF per hour depending on the location. There is also a guidance system, in a form of traffic signs, that helps drivers to find parking garages with empty spaces (Stadt Zürich, 2016).

Zurich also has a peculiarity in terms of parking policy, as back in 1996, a regulation was introduced that limits the amount of parking space in the center of Zurich to the level of 1990. This, coupled with increasing number of vehicles over the last decades increased the parking pressure in the city.

To decrease parking pressure, a free-floating carsharing service might be a viable solution. Moreover, the increasing popularity of free-floating carsharing worldwide and its recent introduction in Basel and Geneva, suggest that it might be launched soon in Zurich and that gives us a solid base to place the current study in the Zurich area.

2.2. Carsharing simulation models

Carsharing is a service with limited supply and unpredictable availability. Therefore, its modeling requires detailed representation on both spatial and temporal dimensions. In the last decade there were increasing number of proposed methods to model and observe the impacts of carsharing. A paper by Jorge and Correia (Jorge and Correia, 2013) provides a review on methods to model carsharing. However, the paper is clearly outdated in the meantime, as the field evolved very quickly and several methodological innovations were introduced in the last few years (Balac et al., 2016). Among several agent-based simulations proposed to model carsharing, most of them usually lack some of the following important aspects: a learning process of agents, demand being sensitive to supply, demand depending on dynamic interaction among agents, high level of spatial and temporal resolution. All these processes are implemented in MATSim and are explained in the following sections.

2.3. Parking simulation models

Work done by Hess and Polak (2004) suggests that there is a substantial variance in individual preferences when different aspects of parking are considered, like search time, parking costs, walking time etc. Parking supply, on the other hand, also influences other aspects of the daily schedule, like location, route or mode choice. Therefore, it is very important to have a tool that can take into account all these aspects and their interactions. In this sense, agent-based models seem appropriate, as individual preferences are taken into account and agents have the possibility to adapt their schedule to a given situation.