Ridership impacts of the introduction of a dockless bike-sharing scheme, a data-driven case study
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Introduction
In recent years, growing concerns over climate change, pollution, congestion and unhealthy lifestyles have contributed to increasing attention to sustainable transport modes such as cycling in general and more particularly the bicycle-transit combination [Kager 2016, Shelat et al. 2018]. As part of the policy to promote cycling, bike-sharing programs were introduced in the past decades. Figure 1 shows a timeline illustrating the development of 4 generations. The development of smart bicycle locks in combination with the possibilities of smartphones, made a new type of bike-sharing possible, in literature known as dockless, free-floating or fourth generation bike-sharing [Shi et al. 2018]. In the new dockless, model, users are able to start and end their trip at their origin and destination without having to find a nearby docking station. Compared with traditional bike-sharing programs, dockless bike-sharing systems integrate mobile payment and global positioning system (GPS) tracking into the system; these features greatly increase the ease of use and management of the system [Shi et al 2018].

Fig 1: Time line development of bikesharing schemes

This paper is set up around a pilot implementation of the dockless bike-sharing system of Mobike in Delft, the Netherlands. Our research deals with what can be learned from this pilot and analyzing the critical success factors for a sustainable bike-sharing system based on the data of the Delft Mobike pilot. The focus of this paper is on the combined bicycle and transit mode. More insights and other perspectives can be found in [Boor, 2019]. This research is based on an experimental method for collecting operational data from the bikesharing system, being the first research based on trip data of a dockless bike-sharing system in Western Europe.

Mobike Delft pilot
Mobike was found in 2015 in China. It was one of the first fully dockless bike-sharing services. Now it’s the biggest bike-sharing platform in the world [Wu et al. 2017]. Mobike started with the Delft pilot in March 2018. Delft has about 100,000 inhabitants and there are two railway stations, served by 4 and 10 trains per hour per direction respectively. Delft University of Technology is located in the south-east of the city, with 22,000 students and 5,000 employees.
The challenge for this study was to obtain data about the usage of Mobike in Delft, since the municipality of Delft has no conditions on data sharing attached to the permission for the pilot. An alternative approach has been chosen for this study, by which data can be collected. Starting point for the data collection are the bike position data showed on a map in the Mobike app. To get these data the same HTTP-call performed by the app should be performed by the software that collects the data and write these in a database. To derive how the HTTP-call worked the Mobike app was reverse engineered. By trying out it has been determined that the app shows up to 50 free bikes simultaneously around the GPS position. Only bicycles within a radius of up to 500 meters are shown on the map. Based on these preconditions, the grid around Delft for the sample locations (GPS positions in HTTP-call) of the collection software is determined. Every 5 minutes a complete sample of the city was made, on average a complete sample took 2 minutes and 37 seconds. The data are collected and stored in a database between 28th of May 2018 and 10th October 2018. In total 21,152,525 detections are stored in the database.

A trip is derived out of the sample data if a bike made a position change of at least 200m in consecutive samples. During the research period 149,193 trips are collected in the data set. This is by far the biggest free-floating bike sharing dataset ever collected in the Netherlands and gives an unique insight in the performance of this new mobility concept.

Results

The data showed that between 1,000 and 2,100 daily trips are made with a Mobike in Delft. The value for the average daily trips per bicycle in Delft is 1.6. The average number of trips per active bicycle day by day is between 2.5 and 3.8. This indicates the average daily trips per bicycle may be increased by controlling the quantity of shared bikes in the service area and by reducing the size of the service areas.

The average trip great-circle distance is 1.6 km, over the road between 1.7 and 2.3 km, depending on directness of bicycle routes. This rather short average distance corresponds to the distances found in research in the Chinese cities of Nanjing [Ma et al. 2018] and Beijing [Shi et al. 2018]; Mobikes are mainly used for distances shorter than 3 km.

In Figure 1 the trips in the period 3 - 7 September 2019, the first college week, are presented on a map.

Most trips have their origin and/or destination in the University campus zone (TU campus). This indicates that a lot of users are students. Important relations are with the city center (Centrum), the railway stations (Delft and Delft Zuid) and Voorhof, where several large student flats situated.

The share of trips related to one of the railway stations was 18.7%.

Especially the number of trips to/from the Delft Zuid station is interesting. In the period between 27 Augustus and 16 September 2018 more then 1,000 trips started or had their destination there, that is on average 50 trips per day. This indicates the potential need for shared bicycle bikes here.

In Figure 2 the usage of Mobike in Delft is related to the general daily pattern in number of trips with all transport modes in the Netherlands [CBS 2018] on an average working day.
During periods without local public transport, for example during the night and during the weekends to and from the TU-Campus, the usage of Mobike is relatively high. Remarkable in this figure are the peaks in the usage of Mobike Delft, this pattern corresponds more or less with the start and ending times of lectures (08:45, 10:30-45, 12:30, 13:45, 15:30-45, 17:30).

In Figure 3 the arriving and departing shared bikes at Delft Station is shown. During the rush hour in the morning there is a peak in the departing bicycles, in the afternoon the number of arriving bicycles is higher. Based on this pattern it’s possible to conclude that more people are using Mobike at the activity side than at the home side of a train journey.

The Netherlands have a unique issue compared with other countries: the bike use to and from railway stations is very popular and even growing. Despite years of expansion of the number of parking places at station, bicycle shelters at many large train station remain (over) full [KiM 2018]. Further expansion of bicycle parking places is often not easily possible in terms of space or involves high costs. KiM concluded that bicycles waiting at railway stations for transport to work, training or another activity (egress) provide 45% of the parking pressure. These bicycles are on average parked for about 2.68 day/train-trip. Bike-sharing may contribute to reducing the bicycle parking pressure at railway stations because shared bikes only need to stand still for a short time.

The blue line in Figure 3 shows the average number of parked bikes in het station area during working days. This average varies between 25 and 65. In the period between 8:00 and 11:00 hour on average 60 Mobikes depart from the station area. In this period on average 20 bikes arrive in the station area.

In comparison with the usage of second bikes or the OV-fiets (i.e. docked bike sharing scheme) at the activity side of a train trip, the use of shared bikes results in less needed parking places during the nights and weekends. During the nights and weekends the occupancy in het railway station bicycle shelters is very high. Regularly the shelter is completely full during the weekends. The higher use of shared bikes at the activity side than at the home side, indicates the potential for further reducing the number of bicycle parking spaces at the railway station. By stimulating the use of a shared-bike instead of an own bike at the home side of a train journey the number of arriving bikes in the morning peak and departing bikes in the evening peak may increase. The use of bike-sharing at the home side can be made more attractive by offering a preferred position in the bicycle parking, close to the access to the train platforms. A guaranteed place gives shorter transfer times with less spread.
This, combined with an attractive subscription model, can tempt commuters to use the bicycle at the home side of the train journey.

References


