Shared Dockless E-Scooters in the City: System Analysis and the Novel Management Policy.

Ofer Shahal*, Itzhak Benenson*&, Aleksey Ogulenko*, Arik Talor&

*Porter School of the Environment and Earth Sciences, Tel Aviv University, Israel
&Motus Tech LTD, Israel
ofershahal@mail.tau.ac.il, bennya@tauex.tau.ac.il, alekseyo@tauex.tau.ac.il, arikt@motuscity.com

Abstract

We present an initial analysis of Tel Aviv's Shared Dockless E-Scooters (SDES) system operation. The SDES system consists of three interacting components: operators, scooters, and users that act within the constraints defined by the regulator – Tel Aviv municipality. Our analysis reveals under-supplied and over-supplied areas, proves that the users prefer routes with a higher share of the bike paths, and, operationally, exposes street segments where these paths are most lacking. Data analysis evokes a novel shared e-scooter regulatory policy that focuses on the control of long-unused scooters.

Keywords. Location-Based Services, Shared Urban Mobility, Shared Dockless e-Scooters, Urban Transportation Policy.

1. Introduction

The Shared Dockless E-Scooters (SDES) were first introduced in Singapore in 2016 and are expanding all over the world (Bikeshare, 2023; Statista, 2023; E-scooter, 2023). Most of the cities successfully accommodated this new transportation mode and only a few have banned it. Overall, scooter trips mostly substitute trips with public transport and walking; the average ride distance varies between 2 and 3 km; when riding, SDES users prefer bike paths; while the non-users are mostly concerned about safety issues, like riding on the sidewalk or against the traffic (Li et al, 2022). The long-term municipality's goal is to make the SDES easily available to the users while preserving safety and non-conflict interaction between the riders and non-riders. This demands a spatio-temporal assessment of the interactions between operators, scooters, and users.

2. The Data

Our study is based on the anonymized trip data collected by the Tel Aviv municipality using the POPULUS software (Populus, 2023) that employs the Mobility Data Specification format (MDS, 2023) for storing geo-located trip data. We analyze 730K rides made during 22 working days of March 2023 with 7500 e-scooters operating over the 52 km² city area populated by 480K residents and visited by the same number of visitors. The routes of 10% of the trips have a full GPS presentation at a 10-second frequency. The data on scooters supplied by five city operators are combined. Figure 1 presents the workday dynamics of the SDES use and their speed.

Figure 1. The workday dynamics of the SDES use and e-scooter speed in Tel Aviv
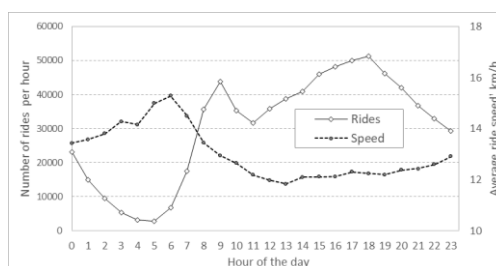
3. E-Scooter Users' and Operators' Behavior

3.1. How do riders choose a route?

About 90% of riders' routes essentially deviate from the shortest paths (Figure 2a). The view of individual trajectories, like in Figure 2b, suggests that riders may prefer routes with a higher share of the bike paths.
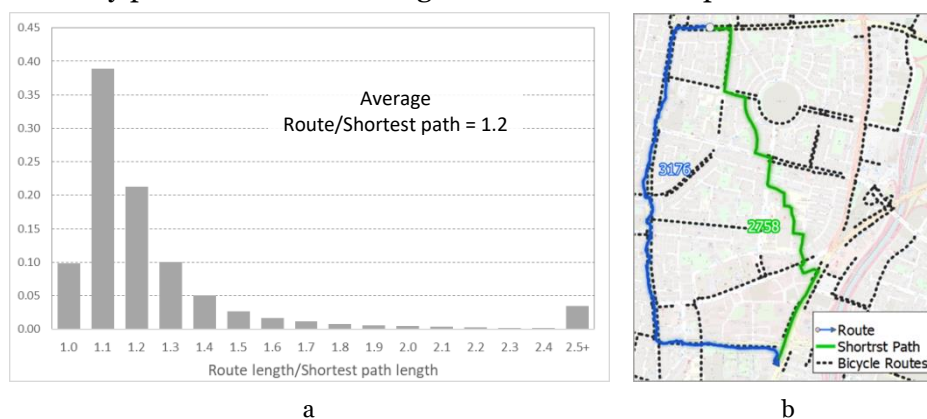

a   b

Figure 2. (a) The ratio of the actual route to the shortest path length; (b) Example of the chosen route and the shortest path between the rider's origin and destination

The results of the riders' route choice analysis are presented in Figure 3, where (1) the share of segments with the bike path in the actual route is essentially higher than in the shortest path and grows with the increase in the route length, and (2) the speed on the segments with a bike path is on average ~20% higher than on those without. These differences are steady in the hours

of the day. The by-product is a map of the street links' usage (Figure 3c) that will serve to establish the priorities for bike path construction.
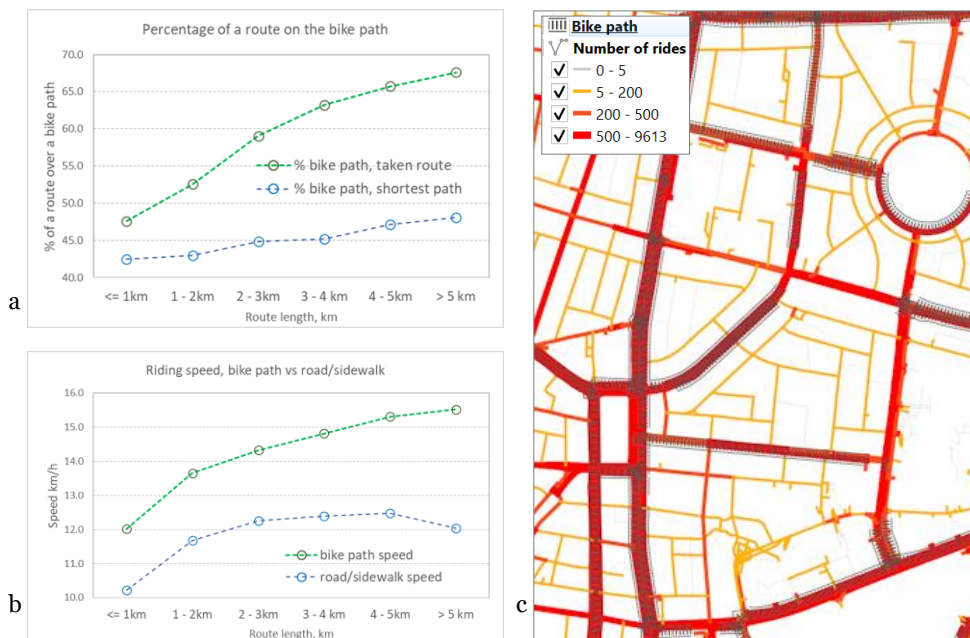

Figure 3. (a) The share of the bike paths in the actual and shortest path; (b) The speeds of the riders on the bike path and non-bike-path parts of the route: (c) Monthly utilization of street segments by riders

3.2. Users' Demand and Operators' Attempts to Match It

On average, each scooter is used 3-8 times a day, and its parking time essentially depends on the location (Figure 4).
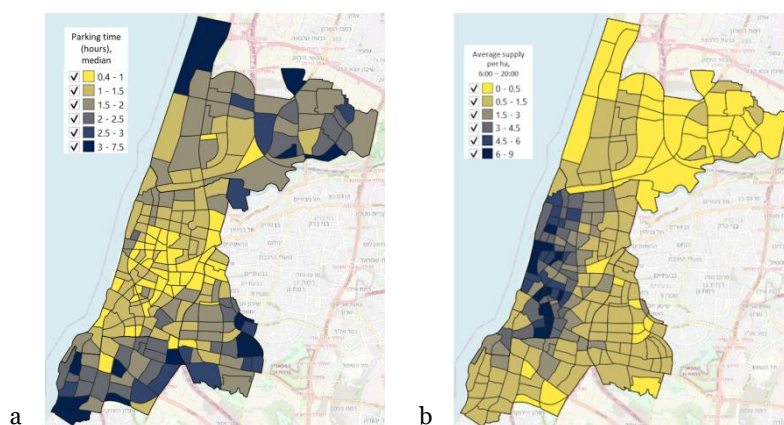

Figure 4. Tel Aviv Traffic Analysis Zones (TAZ) by (a) the median parking time, an indicator of users' demand; (b) e-scooters supply per hectare.

In addition, scooters that are parked (1) close to the bike paths or (2) in the parking cells are used 20%-25% more frequently than those parked far from the bike paths or cells.

The operators know the areas of high demand and focus on supplying scooters there. However, they overdo it, and the share of scooters allocated at "hot" parking cells (ones with short average parking time) that are not activated for long is essential (Figure 5a), while in the areas of low demand, scooters that are not used for long are located randomly (Figure 5b). Notably, the same scooters are repeatedly chosen or ignored (Figures 5c, 5d).
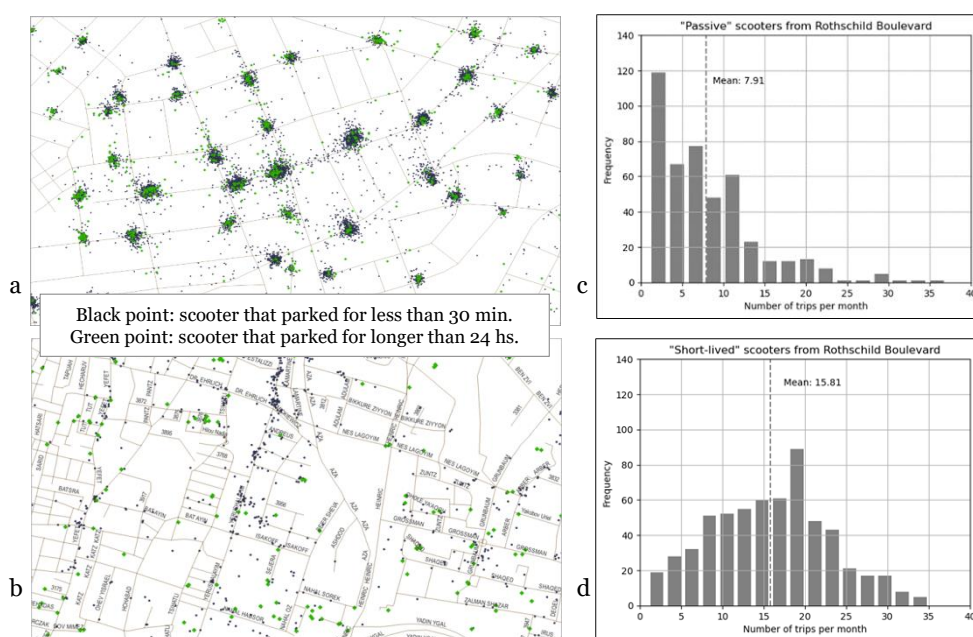

Figure 5. Locations of scooters that were used again after less than 30 minutes of parking (black dots) and were not used for 24 hours (green dots) in the areas of (a) high and (b) low demand (b); the monthly number of rides with scooters that (c) at least once were not used for 24h or longer and (d) at least once were used after less than 30 min parking.

We thus hypothesize the Mohring-like demand-supply feedback (Bar-Josef et al, 2013): Operators over-supply vehicles to the high-demand areas that guarantee a stable profit. Given the fleet limitation, this entails an under-supply and a subsequent decline in demand in the rest of the city.

Figure 6 thus completes Figure 4, by displaying the demand-supply relationship and separating between TAZ of possible under- and over-supply:

Figure 6. The relation between the demand and supply, by TAZ, with the domains of possible over- and under-supply.
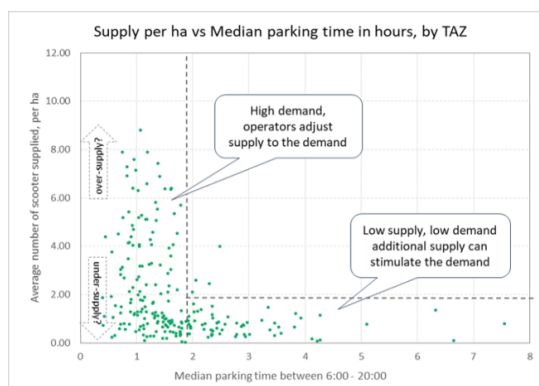
3.3. Policy proposal

The current Tel Aviv scooter policy is based on two principles: (1) each operator's fleet is limited to 1800 vehicles and (2) an operator must allocate 6% of its fleet to the economically low-status city south. We suggest a policy that is based on two other principles: (1) establishing parking cells all over the city, and (2) operators are obliged to relocate scooters that have not been used for long to the nearest parking cell in the under-supplied area.

4. Conclusion

High-resolution analysis of the Tel Aviv shared e-scooter data exposes the inherently complex dynamics of this system. Based on the basic features of the riders' and operators' behavior, we propose a novel policy for scooter management in the city.

References

Bikeshare (2023) Bikeshare and E-scooter Systems in the US, https://data.bts.gov /stories/s/Bikeshare-and-e-scooters-in-the-U-S-/fwcs-jprj/, Accessed 14/07/2023.

Statista (2023) E-Scooter-sharing https://www.statista.com/outlook/mmo/shared-mobility/shared-rides/e-scooter-sharing/worldwide, Accessed 14/07/2023.

E-scooter (2023) E-scooter regulations in Europe https://www.evz.de/en/reisen-verkehr/e-mobilitaet/zweiraeder/e-scooter-regulations-in-europe.html, Accessed 14/07/2023.

Li A, Zhao P, Liu X, Mansourian A, Axhausen KW, Qu X (2022) Comprehensive comparison of e-scooter sharing mobility: Evidence from 30 European cities, Transportation Research Part D: Transport and Environment, 105, 103229, DOI: 10.1016/j.trd.2022.103229.

Populus (2023) https://www.populus.ai/products/mobility-manager, Accessed 14/07/2023.

MDS (2023) https://www.openmobilityfoundation.org/about-mds, Accessed 14/07/2023.

Bar-Yosef, A, Martens, K, Benenson, I, 2013, A model of the vicious cycle of a bus line, Transportation Research Part B, 54, 37–50.