Exploring the Characteristics of Light Electric Vehicle Performance in Urban Logistics

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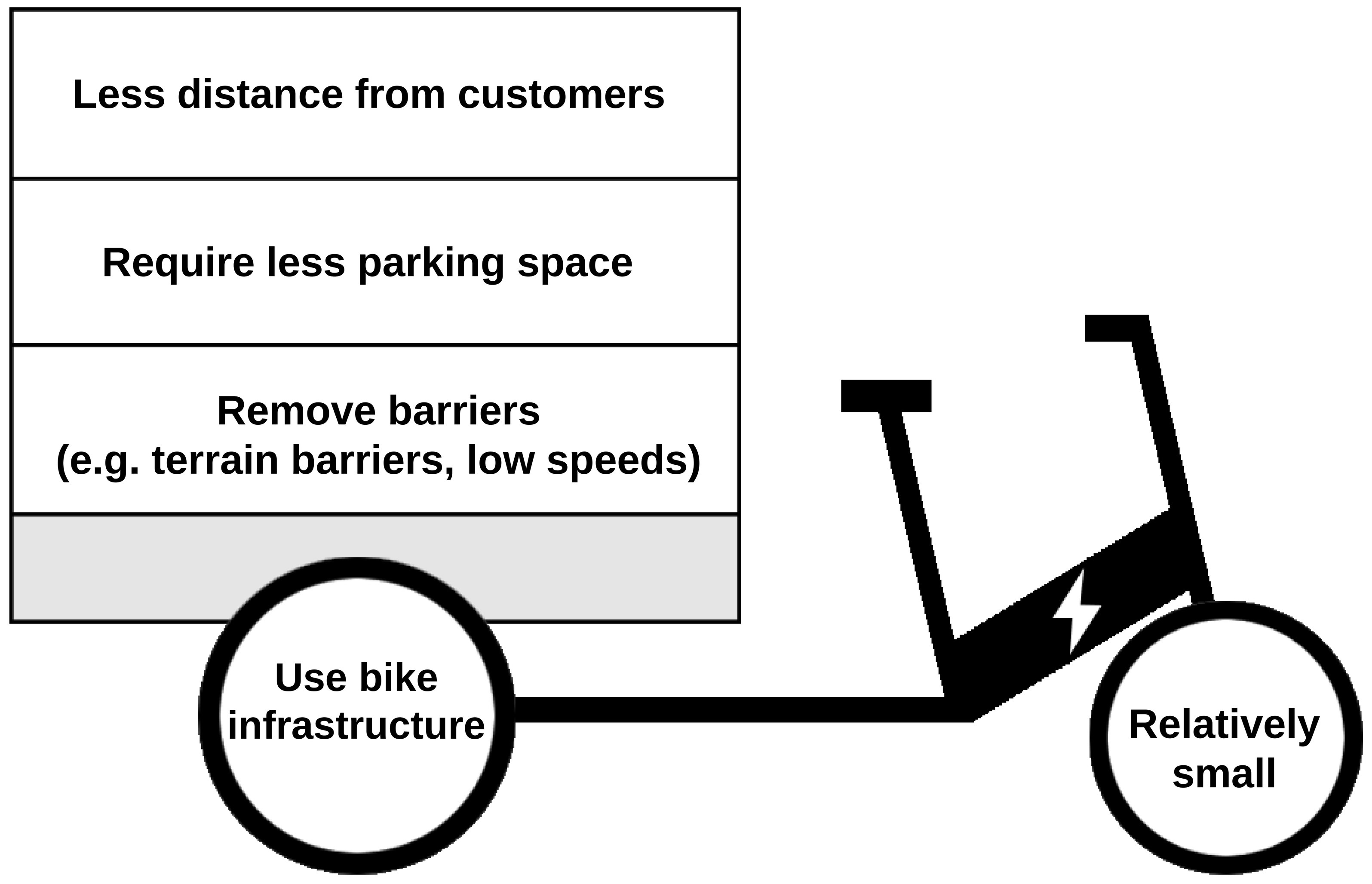
Take Away Message

- With the **increasing rate of the population living in urban areas**, the inevitable changes in land use, environment, demographics, and consumer behavior would **magnify the challenges of last-mile delivery**.
- In this study, we present the **characteristics of an electric-trike urban delivery system** in Portland, OR and show how the GPS data can be used to understand the performance of e-trike last-mile deliveries within a city.
- In order to provide sufficient space for cargo delivery systems, it is important for cities to consider other **potential purposes of bike lanes** within urban cores.
- Results of this study can help both cities and operators to improve green city logistics by identifying the potentials of using GPS data to improve the operating performance of the system

Introduction

- Today, over 50% of the world's population is living in urban areas and it is expected to increase up to 70% in 30 years (1).
- Due to the growing interest and importance of innovative and sustainable solutions for city logistics, light electric vehicles (LEVs) deployment is becoming popular in different cities (2, 3).
- Additionally, several studies and projects such as the EU's Cyclelogistics have started tackling the last-mile urban freight challenges through the implementation of cargo bikes in urban areas (4).
- At the intersection of LEVs and cycle logistics, e-trikes can be considered a sustainable alternative in urban core deliveries.



Data

- Data collected from the fleet of B-line Urban Delivery vehicles that used five e-trikes to deliver goods to shops, retail stores, and restaurants, mainly distributed in the urban core of Portland, Oregon.
- GPS data at 1 Hz resolution was collected during October and November 2017 (55 days); total number of tours = 192 and total distance traveled = 4,504 km
- Carrying capacity of e-trikes ranges from 800-1300 pounds with the average speed estimation from 13-19 km/h, the average range of 19-24 km, and the vehicle width from 48-50 inches

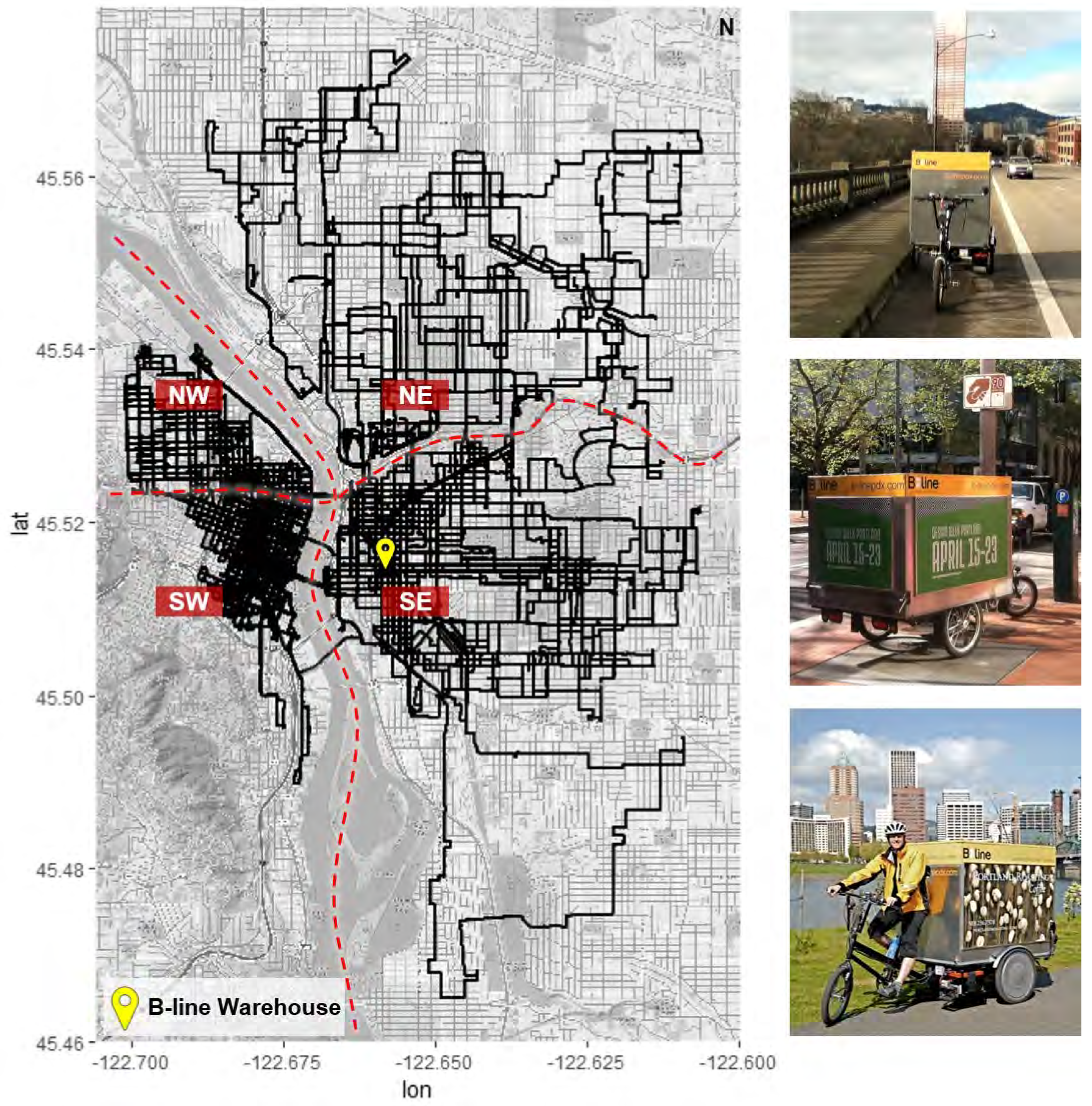


Fig 1: Distribution of data in Portland and the boundaries (left), Delivery e-trikes adapted from the company's Facebook page at facebook.com/pg/blinedelivers (right)

Results

Speed, distance, and travel time profiles per e-trike per day

- **Average speed** excluding stops is **13.2 km/h** (SD= 4.75, 95% CI= 0.01), **average daily travel distance** per e-trike is **23.5 km** (SD= 8.44, 95% CI = 1.20), and **average daily travel time** per e-trike is **3.57 h** (SD= 1.42, 95% CI = 0.20)

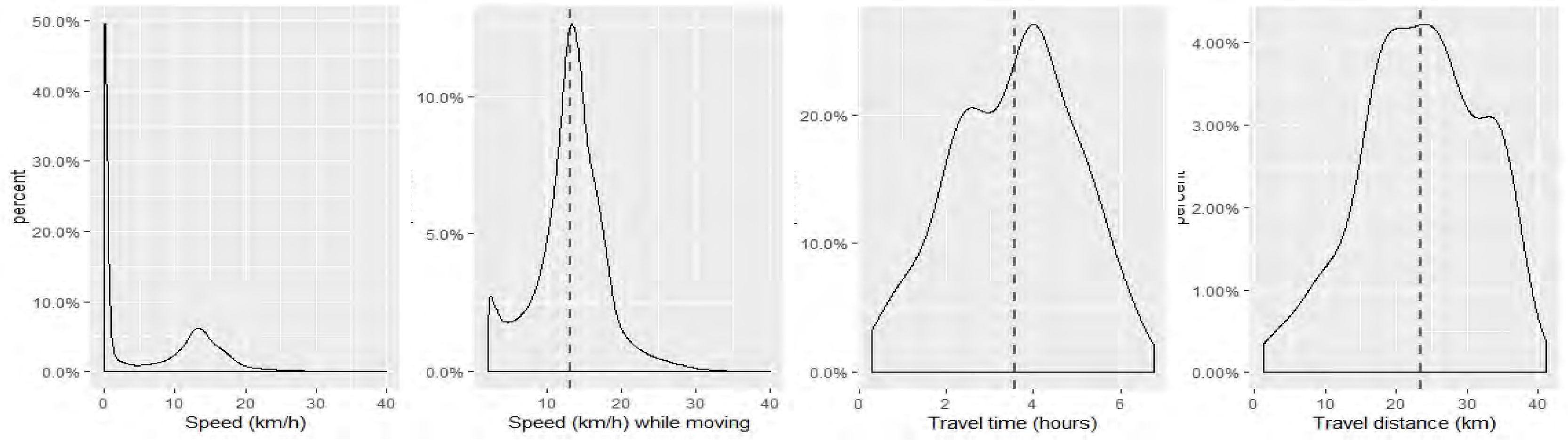


Fig 2: Speed, travel time, and travel distance distribution

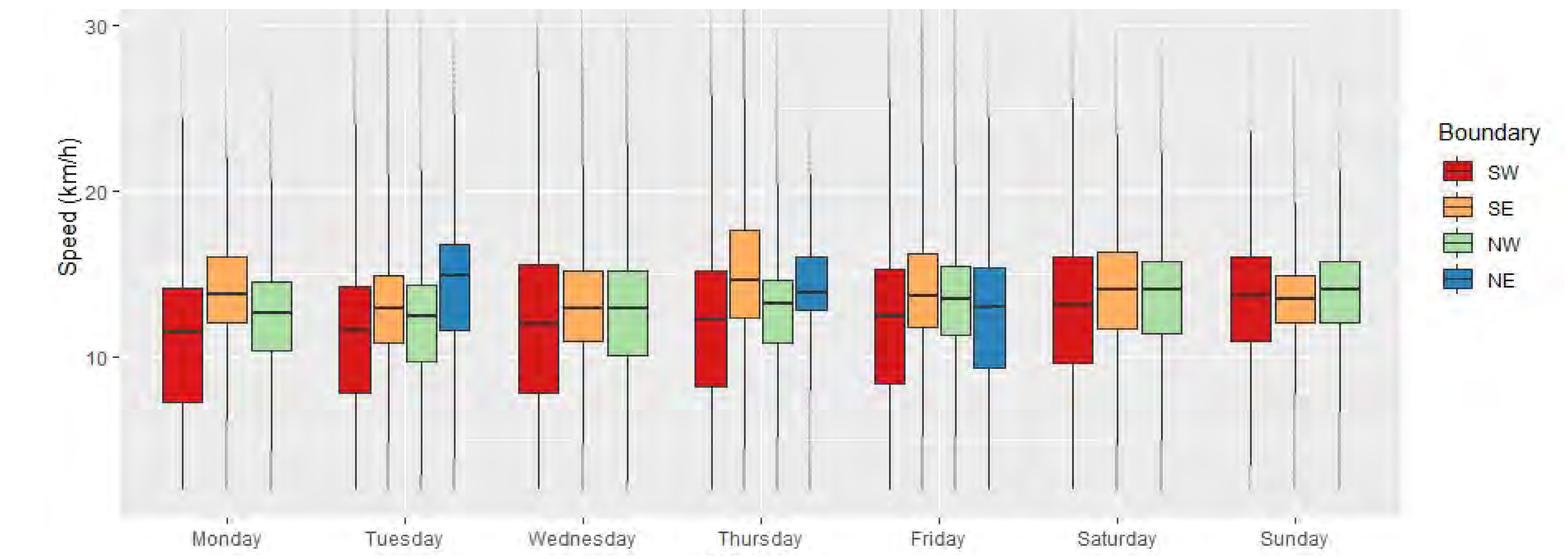


Fig 3: Average speed profiles by day of the week and boundary

TABLE 1 Descriptive statistics of the average speed (km/h) on busy road segments based on bike facility type

Facility	n[1]	mean	sd	median	Q0.25	Q0.75
Buffered Bike Lane	24707	13.23	4.08	13.74	11.19	15.64
Enhanced Shared Roadway [2]	4662	13.41	4.36	13.71	10.94	15.98
Protected Bike Lane	7839	13.76	4.80	14.16	11.1	16.27
Neighborhood Greenstreet *[3]	84095	13.91	3.97	13.96	11.76	16.21
Bike Lane	110759	14.08	4.83	14.09	11.5	16.45
Off-Street Path/Trail *	29312	14.32	3.82	14.43	12.05	16.41
Bike infrastructure	1852	13.4	4.65	13.9	10.8	16.1
Non-bike infrastructure	6544	13.6	5.01	14.0	11.0	16.2

*[1] number of GPS points-segments | *Significantly different than all other bike facilities.*
Definitions below are adapted from Portland Bicycle Plan For 2030 adapted from portlandoregon.gov
[2] "Roadways where bicycles are not given priority but bikeway signage and markings are used to increase driver awareness of bicycles on the roadway and traffic calming devices and/or intersection crossing treatments enhance bicycle travel."
[3] "Manages stormwater on site through use of vegetated facilities, creates attractive streetscapes that enhance neighborhood livability by helping to calm traffic by introducing park-like elements into neighborhoods, serves as an urban greenway segment that connects neighborhoods, parks, recreation facilities, schools and main streets."

Stop detection

- Average number of stops per e-trike in a day: 13,
- Average stop duration of 7.67 minutes (SD= 4.32, 95% CI=0.19, median=6.35)

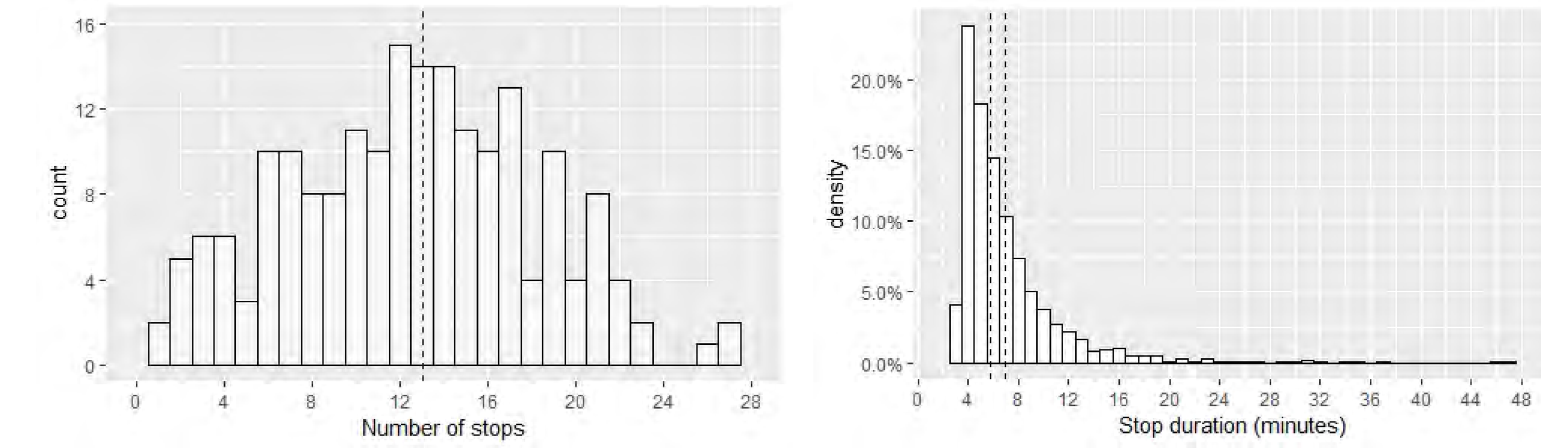


Fig 4: Number of stops and stop duration

Conclusion

- This study characterized the performance and potential benefits of easily-collected GPS data for operators, planners, and regulators.
- Many factors including traffic condition and infrastructure could lead to a great diversity in the performance of the service.
- Development of a framework to systematically generate and collect data using various sources (e.g., rider/e-trike travel log and GPS) from public and private delivery sectors to overcome the huge current gap in data and information is recommended.

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