When and where are e-scooters serving as First-mile/Last-mile feeders to transit in Washington DC?

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Introduction

The integration of micromobilities and public transit is widely believed to be a very important way to promote the construction of smart and sustainable urban transport systems and achieve a transit city. E-scooters have shown the potential to help supplement fixed-route services such as Metro service, public transit through providing efficient first-mile/last-mile (FMLM) connections. In this study, we explore the spatiotemporal patterns of FMLM trips and use Washington DC as a case study, considering there are both Metro system and diverse micromobility options operated. We aim to figure out where and when are e-scooters serving as FMLM connections for Metro transit in Washington DC.

Research Question:

RQ1. What's the temporal distribution of FMLM trips and how do they vary during time of the day?

RQ2. What's the spatial distribution of FMLM trips and which Metro station used to generate more FMLM trips?

RQ3: How does the proportion of FMLM trips in total trips vary during the time of a day and over the study period?

Methods and Results:

Before analysis could be done with data, e-scooter OD trips records are filtered by certain thresholds for the duration, speed, and distance. Total 150,743 trips are used in this study. ArcGIS is used to create 100-feet buffers for each Metro station to identify FMLM trips and summarize at the station level.

RQ1: Temporal patterns

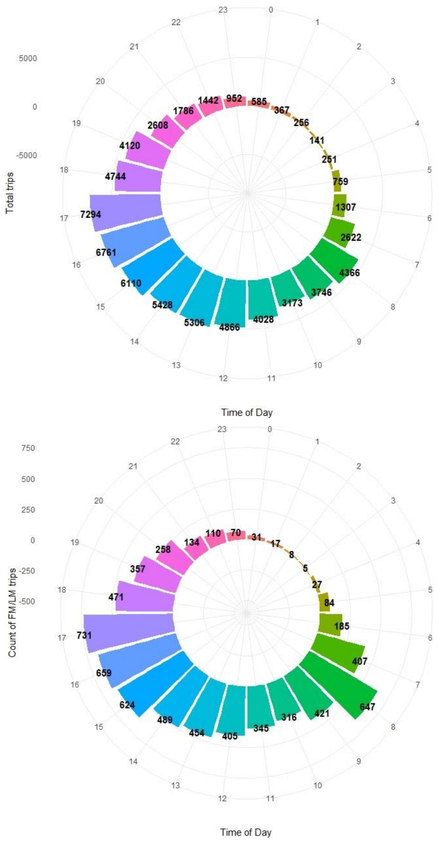

Figure 1. The number of Total trips (top) and FMLM trips (bottom)per hour of the day

From Fig.1., total trips and FMLM trips present a similar temporal distribution pattern. Starting at 6 am, the number of total trips and FMLM trips begins to increase and reach the first peak at 8 am. It can be inferred that e-scooters show potential to provide an affordable option for commuters to make up the connection gap. After 10 am, the number of total trips and FMLM trips show an increasing trend again until the evening peak at 5 pm, both reaching the top trips volume of a day. From 5 pm to 6 pm, total trips and FMLM trips dropped by almost the same proportion by 35%, and after 10 pm, the number of trips maintained a lower level.

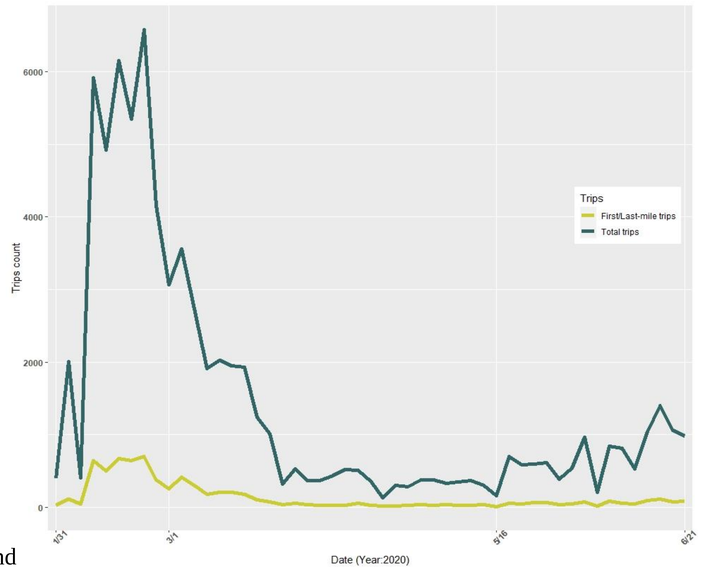

Figure 2. Daily number of FMLM trips and total trips

RQ2: Spatial patterns

(a) First-mile (FM) trips (b) Last-mile (LM) trips

Figure 3. Spatial distribution of First-mile trips (left) and Last-mile trips (right) at each Metro station.

The spatial distribution of FM and LM trips presents a similar pattern. Metro stations located in the DC center generate more FMLM trips in general. As the distance away from the center gets farther, the number of FMLM trips at Metro stations gradually decreases. Specifically, the station named 'COLUMBIA HEIGHTS' generates the most First-mile and Last-mile trips. As shown in Fig.4., FMLM trips are scattered outward from the Metro stations in the DC center.

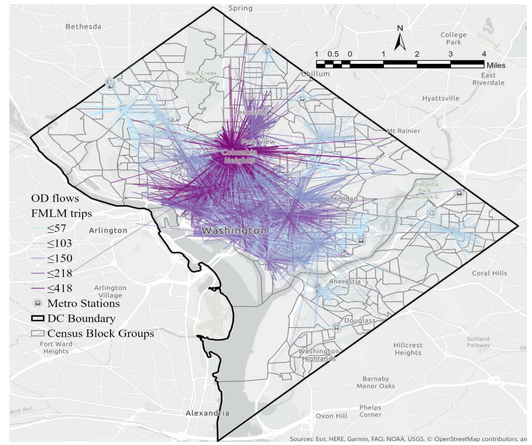

Figure.4. OD flows for FMLM trips

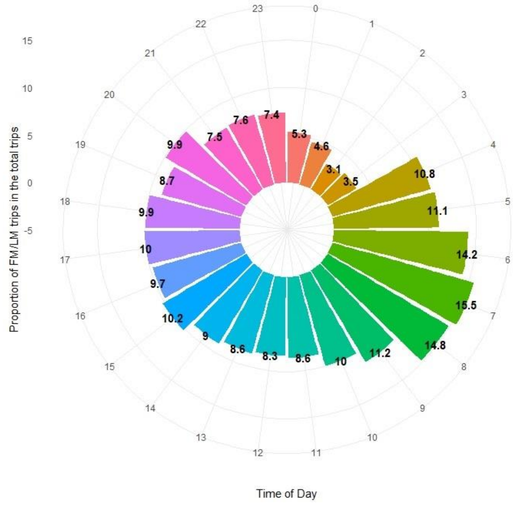

Figure 5. The proportion of FMLM trips in total trips per hour of the day

RQ3: Proportion of FMLM trips in total trips

The results shown in Fig. 5. are consistent with Fig. 1. The trips that occurred around Metro station share a large population in the early morning from 4 am to 8 am. After the morning peak, the proportion of FMLM begins to decline.

Combined with Fig.2., the number of total trips remained at a high level before March, and daily FMLM trips accounted for nearly 10%. But after that, the trips volume decreased significantly since the daily total trips in. The possible reason is that the interference of the Covid-19 has greatly decreased the number of commuters taking public transit and micromobilities, and working at home allowed has also reduced people's travel demands.

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