TRB

17-06251

An Investigation of Taxi Travel Patterns and Implications on the Feasibility of Electric Taxis

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Abstract

This paper studies the feasibility of deploying electric taxis in New York City, USA, by investigating the spatial and temporal travel patterns of 10,032 yellow taxicabs during the year of 2013.

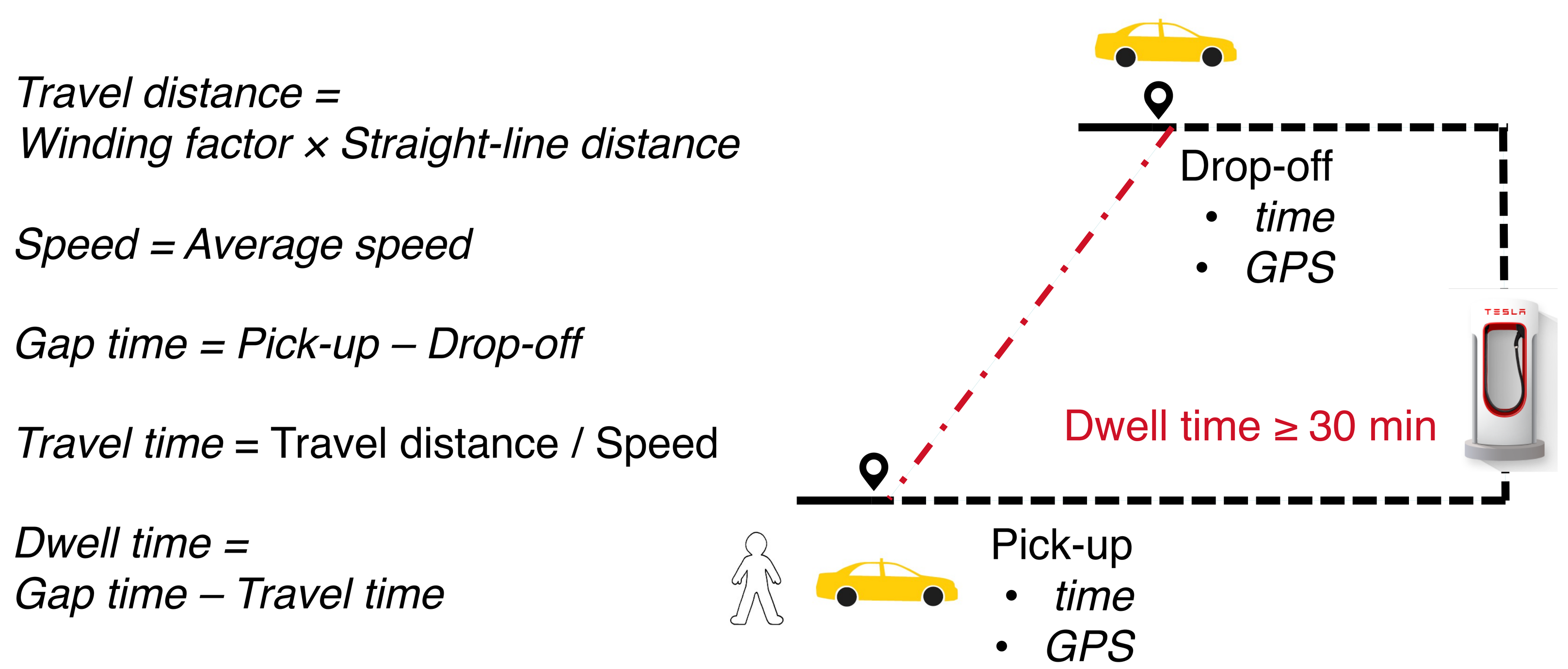
- ❑ Trip length, daily vehicle miles traveled, daily number of dwells, dwell time, and travel distance between charges are assumed to follow probabilistic distributions.
- ❑ It is found that BEVs with 80-mile range and 7-kW chargers can hardly satisfy taxi driving demands, while BEVs with 200-mile range or 50-kW chargers alone, or BEVs with 120-mile range and charged by 20-kW chargers are able to significantly improve the electric taxi feasibility.

Introduction

- ❑ Battery electric vehicle (BEV) taxis can improve urban air quality, improve public health, and save fuel costs.
- ❑ BEV taxis face obstacles: long travel distance, limited range, and long charging time.
- ❑ The feasibility of replacing gasoline taxis with BEVs is predicted based on taxi travel patterns.
- ❑ New York City taxi trip data are used.

Data

- ❑ Only occupied trips are recorded: pick-up time and GPS location, drop-off time and GPS, trip length, travel time.
- ❑ Empty trips are reconstructed from the data.
- ❑ *Winding factor* is calculated as occupied trip distance / occupied trip straight-line distance = *1.4413.*
- ❑ A potential charging opportunity when dwell time ≥ *30* min.



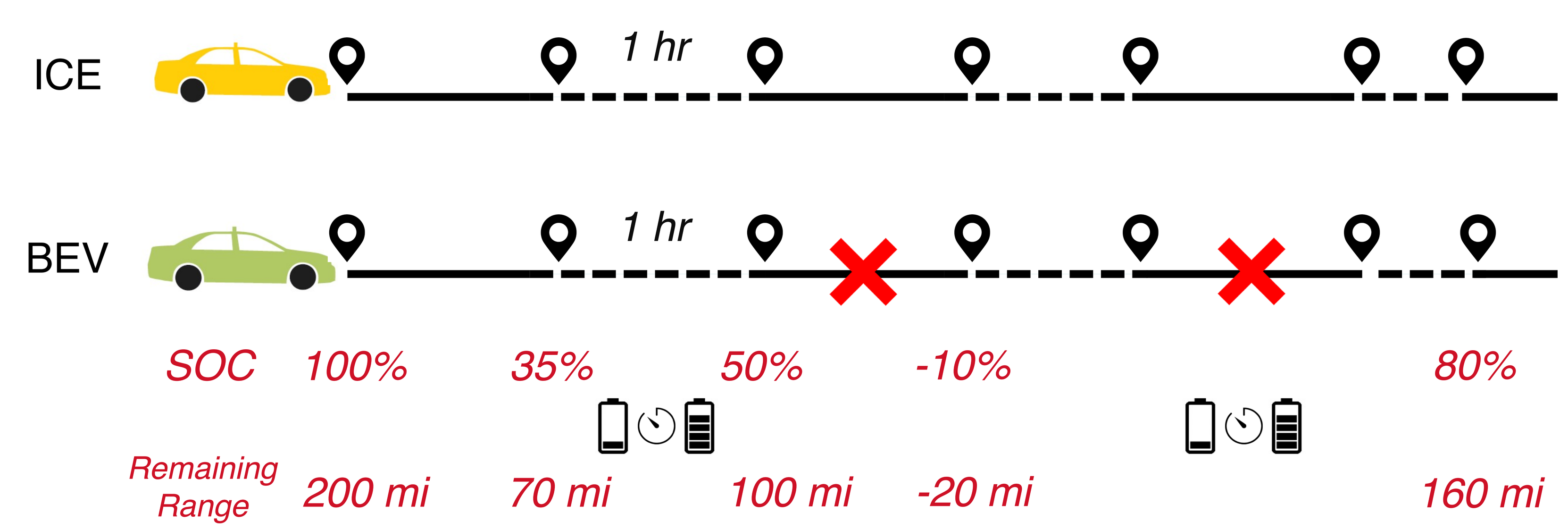
❑ Summary statistics

- *10,032* taxis with *≥70* days data
- *39 million* occupied trips
- *124 million* miles traveled
- *23%* of taxi population

Travel Patterns	Min	Mean	Max
Occupied trip length (mi)	*0.01*	*3.1*	*97*
No. of occupied trips a day	*1*	*31*	*92*
Daily VMT (mi)	*0.3*	*152*	*591*

Methodology

❑ Quantify BEV feasibility by developing a model from the data.



BEV Feasibility = % of occupied trips completed by BEVs

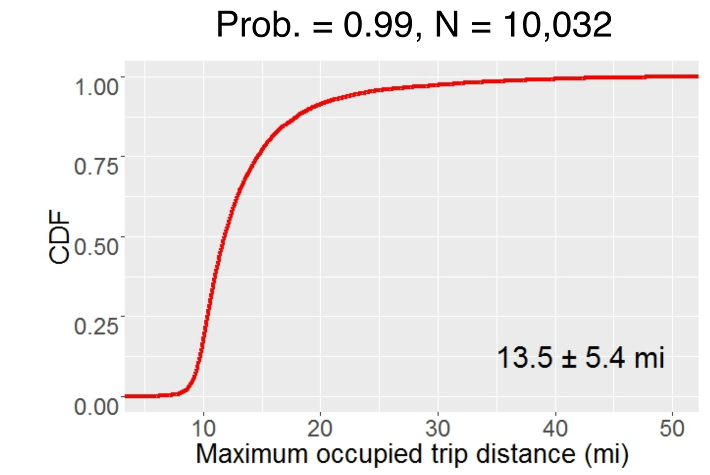
❑ Differentiate EV feasible/infeasible taxis by studying travel patterns.

- # of shifts per day (mode/mean)
- Occupied trip distance: Gamma
- DVMT: Gamma, or Mixture Gamma
- Distance between charges: Gamma
- Dwell locations
- Daily number of dwells: Weibull
- Dwell times: Gamma

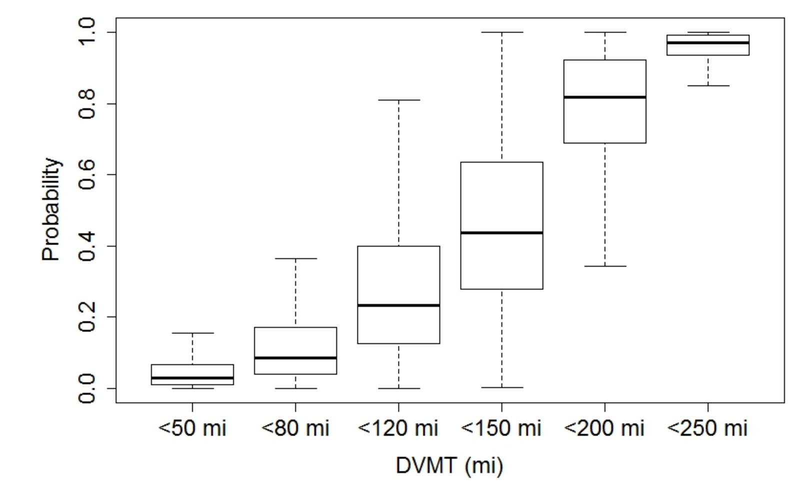
Results

Power	Completion	80 mi	120 mi	200 mi
7 kW	100%~99.5%	0.2%	2.2%	24.0%
	99.5%~95%	2.9%	22.0%	50.4%
	95%~90%	3.1%	16.4%	10.8%
	<90%	93.9%	59.4%	14.8%
20 kW	100%~99.5%	0.3%	4.1%	59.4%
	99.5%~95%	12.9%	72.5%	40.1%
	95%~90%	19.3%	15.6%	0.3%
	<90%	67.5%	7.7%	0.2%
50 kW	100%~99.5%	0.3%	4.8%	67.1%
	99.5%~95%	17.7%	84.9%	32.9%
	95%~90%	26.6%	8.5%	0.0%
	<90%	55.3%	1.8%	0.0%

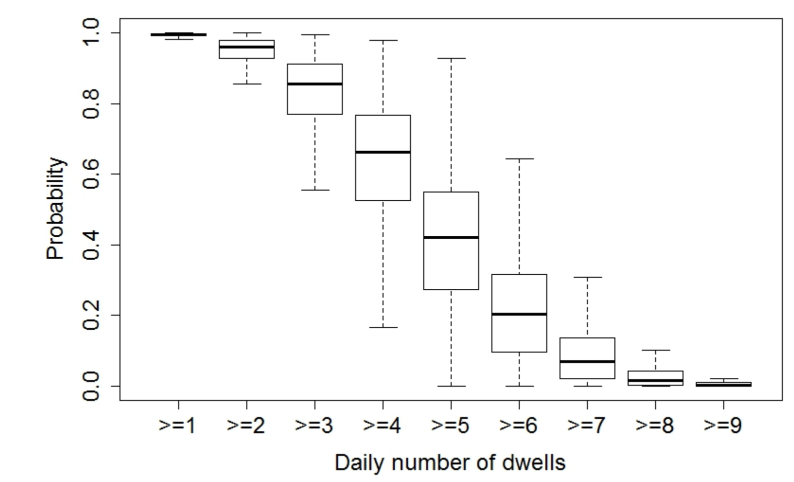
❑ *≥ 95%* trip completion, or *≤ 5%* adaptation, is expected



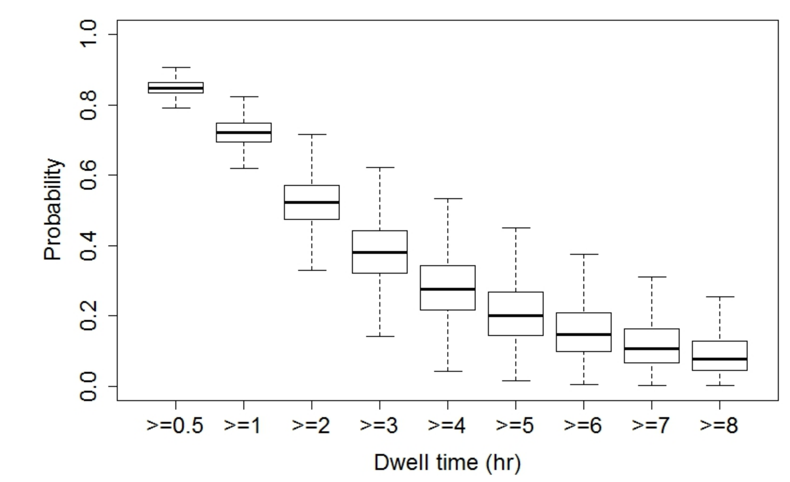
❑ Maximum distance of a single occupied trip is *13.5 ± 5.4* mi



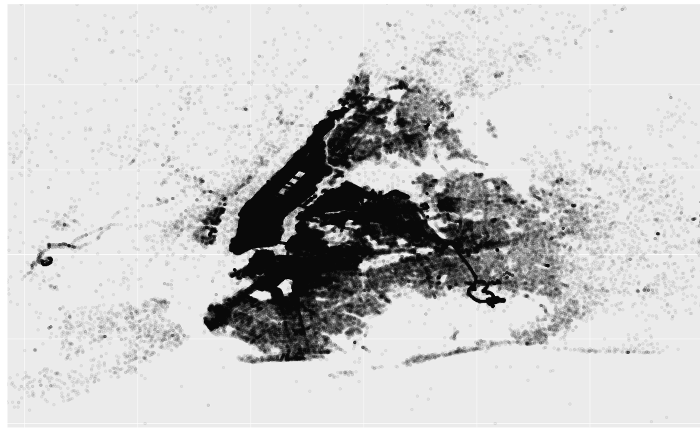
❑ In *79%* cases, DVMT is shorter than *200* miles



❑ In *82%* cases, daily number of dwells *≥ 3* times



❑ Dwell duration usually lasts *1~2* hours



❑ Locations of dwells, mainly in Manhattan, Queen, Brooklyn

Conclusions

- ❑ Length of an occupied trip *hardly* exceeds BEV range
- ❑ DVMT is *difficult* to be completed by short-range BEVs, without charging
- ❑ *82%* probability that dwell *≥ 3 times/day*
- ❑ Each dwell most likely lasts for *1~2 hr*
- ❑ *120 mi & 20 kW* enable *77%* of taxis to drive with *≤ 5%* adaptation
- ❑ More chargers need to be built where many dwells occurred

Acknowledgements

This research is partially sponsored by Oak Ridge National Laboratory. The views and opinions expressed are those of the authors and do not necessarily reflect the views of the sponsoring agency.

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