An Investigation on the Emission Performance of Ride-hailing

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Applied Energy Symposium
MIT A+B
Co-organized with Harvard
icae International Conference on Applied Energy

Introduction of the poster

(1) The high proportion of traffic-related green house gas emission (Fig 1)

(2) There is potential of emission reduction in ride-hailing by less void cruising (Fig 2)

(3) There is a demand to investigate whether ride-hailing can serve the purpose of reducing traffic-related emission; how the emission performance changes through external and internal factors.

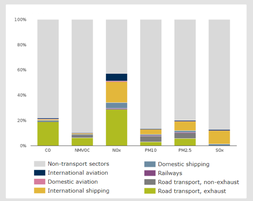


Fig.1. Contribution of the transport sector to total emissions of the main air pollutants

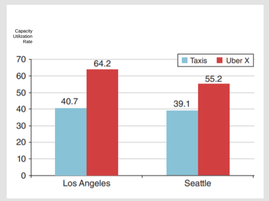


Fig.2. Capacity utilization rate (Percent of Miles Driven with a Passenger) for taxi and UberX drivers in Los Angeles and Seattle

Dataset

(1) Location: Chengdu

(2) Ride-hailing data :

Didi Chuxing ride-hailing order service data (from 26000 private cars)

driver ID, order ID, timestamp of starting, longitude of origin, latitude of origin, timestamp of end, longitude of destination, latitude of destination (recorded every 3 seconds)

(3) Taxi data (form 13000 taxis) :

driver ID, longitude of position, latitude of position, status(occupied or vacant), timestamp recorded every 30 seconds.

(4) Date:

Both datasets are ranged from November 1, 2016 to November 31, 2016.

Conclusion of the Poster

(1) The online ride-hailing has a better emission performance that help solve the problem of high quantity and proportion of on-road traffic-related emission

(2) This presentation also try to explore two of the mechanisms that affect the emission performance of ride-hailing:

- User scale
- Technology

(3) In the future, more critical mechanisms can be further explored, like the optimization of dispatching algorithm, the adoption of cleaner energy vehicle;

(4) This presentation can provide the guideline for the future promotion of ride-hailing from the perspective of policy making and service improvement.

Subtopic 1

Whether ride-hailing can serve the purpose of reducing traffic related emission?

1.1 Introduction

(1) Traditional taxi industry becomes one main contributor of the emission of green house gas.

(2) The rising online ride-hailing and traditional taxi serve as the same role of immediately taking the passenger to the desired destination in the mobility service system.

(3) The upper two points lead to the question of whether online ride-hailing can be more energy saving and emission reducing than taxi.

1.2 Methodology

Main Target:
Comparing the quantity of green house gas emission of both taxi and ride-hailing vehicle during the operation

(1) The computation of travelling distance

Didi data

No data recording the void cruising trip → The shortest path between the previous drop-off location and next pick-up location (Baidu Map API) → void distance

order trajectory data (3s) → delivery distance

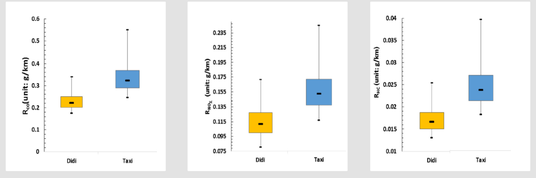
Taxi data

trajectory data (30s) → travel distance (Baidu Map API) → void distance, delivery distance

(2) The calculation of fuel consumption and green house gas emission

COPERT model
Parameter:
- velocity of vehicle in the trip segment
- vehicle standard (Euro 4)

1.3 Result



(a) CO (b) NO x (c) HC

Fig.3. The statistic result of fuel consumption and emission per trip

1.4 Conclusion

(1) The ride-hailing consumes less fuel and emits fewer exhausts because of shorter void cruising

(2) Current on-demand dispatching system of ride-hailing can reduce the fuel consumption and emission

(3) The different spatial distributions of emission between ride-hailing vehicle and taxi:

- Didi trips are mainly distributed in the northeast corner (commercial districts);

  Because of shortage of traffic supply in central center

- Taxi trips are averagely distributed from city center to rural areas;

  The void cruising makes taxi away from area with traffic congestions

Subtopic 2

How the external factor: user scale, impacts the emission performance of ride-hailing?

2.1 Introduction

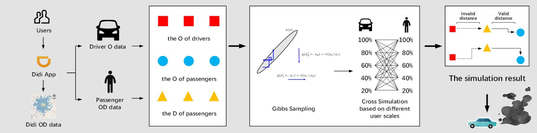
(1) As a crowd-sourcing service, the emission and efficiency of ride-hailing system is sensitive to the user scale

(2) According to subtopic 1 , the ride-hailing can save more energy, the emission performance during the growth of user scale is still a mystery

(3) The study on correlation between user scale and emission performance provide a clear pattern during the development of ride-hailing and suggestion for policy making.

Void distance proportion $P_{\text{void}} = \frac{D_{void}}{D_{void} + D_{valid}}$

2.2 Methodology



(1) Data Processing

(2) Gibbs Sampling :With the reduction of user scale, different remainders can lead to different emission performances of ride-hailing

(3) Dispatch Simulation : Redispatch drivers to orders under different combinations of drivers and passengers (greedy algorithm)

(4) Emission computation method : COPERT model

2.3 Result

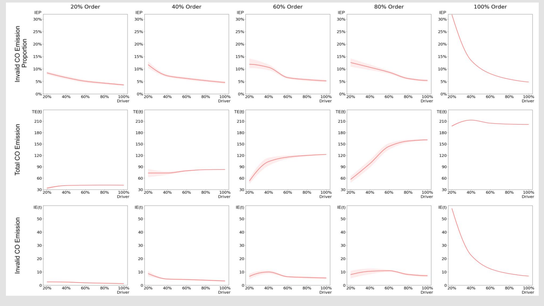


Fig.4. the emission of CO

2.4 Conclusion

(1) Under the circumstance of a certain scale of travel demands in the scenario, the void distance proportion and invalid emission proportion are decreasing with the increasing of scale of drivers and when the scale of travel demands increases, the efficiency of supplement of driver increases.

Under different circumstances of user scales, the invalid emission proportion can vary from 3.69% to 31.75%.

(2) The trend of rising of the void distance proportion as well as invalid emission proportion vary by different scales of travel demands. The greater the travel demand is, the more rapidly the both increase.

Subtopic 3

How the internal factor: technology, impacts the emission performance of ride-hailing?

3.1 Introduction

(1) The traditional dispatching system of ride-hailing which always send the closest driver to pick the passenger up is not an optimal solution from the global perspective.

(2) Ride-hailing demand prediction models based on deep learning architecture have been proposed to improve the efficiency and dispatching of ride-hailing

(3) Scarce evidence of quantifying this improvement.

3.2 Methodology

(1) Data Processing

- Geographical grid division of study area: 256x256
- Temporal time window division: every 5 minutes
- Count the number of travel demands in each grid unit in each time window.

(2) Proposed prediction model: Convolutional LSTM

(3) Dispatching simulation

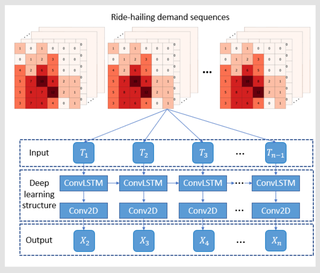


Fig.5. The structure of proposed prediction model

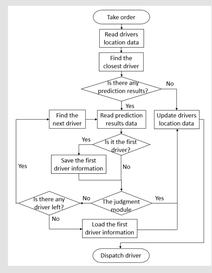


Fig.6. The flowchart of ride-hailing dispatching system simulation

3.3 Result

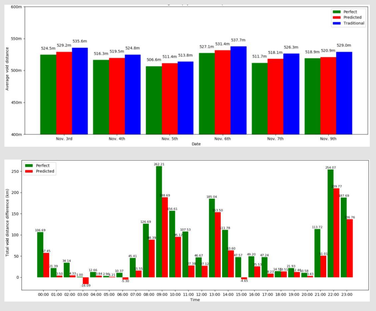


Fig.7. The temporal distribution of average empty distance difference

3.4 Conclusion

(1) The deep learning architectures is able to make up for the shortcomings of traditional dispatching System

(2) Simulation results reveal that the total void distance reduced 1,164 kilometers per day by using our prediction model, but it still has 41.1% upside potential.

(3) For the future work, we plan to introduce a more complicated deep learning architecture, graph convolutional network, to improve the prediction of ride-hailing demand.