

## A Survey on E-hailing and Demand Responsive Transit (DRT) services as First Last Mile Mode in Putrajaya

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DOI: <https://doi.org/10.30880/rtcebe.2025.06.01.031>

### Article Info

Received: 05 September 2024

Accepted: 15 November 2024

Available online: 6 May 2025

### Keywords

Demand-responsive transport, First-last mile, e-hailing

### Abstract

Demand-responsive transport (DRT) services, which include shared ride sourcing and microtransit, provide a flexible travel option that could complement traditional fixed transit (FT) systems. By combining on-demand and fixed-route services, there is potential for enhanced mobility and expanded service coverage. However, it is still unclear whether DRT services actually achieve these expected benefits. As of March 7, 2023, the Land Public Transport Agency (APAD) of Malaysia's Ministry of Transport has registered 16 e-hailing companies operating in the country. There are currently about 70,000 vehicles providing e-hailing services in the Klang Valley area. In Malaysia, an e-hailing vehicle is defined as a motor vehicle with 4 to 11 seats (including the driver) used to transport passengers for a fare. Fares may be paid by individual passengers or collectively for shared rides along the same route, and each ride must be pre-booked through a mobile app operated by a registered company. Since the introduction of the MyTeksi App in 2012 (which rebranded as Grab in 2016), e-hailing services have become a key part of the public transport system in the Klang Valley. These services have improved accessibility to Rail Transit stations, serving as a First-Last Mile solution. However, urban transport planners are concerned that e-hailing services may not effectively reduce the number of motor vehicles on the roads, which continues to contribute to severe traffic congestion during peak hours. Ensuring effective first-last mile transportation is crucial for developing a sustainable transport system. However, many residents struggle with issues such as connectivity, morning rush hour congestion, and limited transport options. In this study, we analyzed the transportation modes of residents in Putrajaya, using data collected from on-site surveys. We investigated both individual-level and contextual factors affecting first-last mile travel behavior. Our findings indicate that 46% of Putrajaya residents are using e-hailing and DRT services currently.

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Results also shows that the top two highest trip purposes, working trip and leisure trip has different peak demand hours. Most of the Putrajaya residents use e-hailing and DRT for first-last mile trips. More than half of the private vehicles users in Putrajaya are willing to use e-hailing and DRT if the current service are improved.

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## 1. Introduction

It is essential to continuously improve public transport (PT) systems to build more livable and sustainable cities, particularly focusing on the first and last mile of journeys (Van Kuyk et al., 2021). The accessibility and efficiency of these access and egress modes can greatly impact the adoption of public transportation, potentially encouraging more people to shift from private to public transport. This is especially crucial for small and medium-sized multimodal stations and hubs, which require more in-depth investigation. Additionally, there is a lack of understanding about how contextual factors, such as weather and carrying luggage, affect people's choices for their initial and final mile transportation mode.

Cars often provide more convenience and flexibility compared to traditional fixed transit (FT) systems, yet reducing car use remains a key priority for transportation planners. To enhance and complement line-based FT services and remain competitive with private car use, integrating new flexible services in urban areas can be beneficial. Specifically, demand-responsive transport (DRT) services such as microtransit and shared ride sourcing have the potential to supplement and improve fixed-route transportation.

Although the concept of DRT is not new, its large-scale, real-time implementation has only become feasible with recent technological advancements. DRT was initially proposed for future urban transportation in the 1960s. Since then, new urban DRT services have emerged across Europe (e.g., Abel in Amsterdam, Padam in Paris, Radiobus di Quartiere in Milan) and the United States (e.g., Bridj, Lyft Line, UberPOOL, Via). As of March 7, 2023, the Land Public Transport Agency (APAD) of Malaysia's Ministry of Transport has registered 16 e-hailing companies operating in the country. There are currently about 70,000 vehicles providing e-hailing services in the Klang Valley area. In Malaysia, an e-hailing vehicle is defined as a motor vehicle with 4 to 11 seats (including the driver) used to transport passengers for a fare.

Key factors influencing public transportation use include travel time (Murray et al., 1998; Murray, 2001), distance, costs (Arentze & Molin, 2013; Yap et al., 2016; Lau & Susilawati, 2021; Van Kuyk et al., 2021), and service quality attributes (Arentze & Molin, 2013), including the quality of access and egress (Givoni & Rietveld, 2007; Brons et al., 2009; Abe, 2021). According to Goel and Tiwari (2016), travel time and distance are closely linked to the accessibility of the public transit system. Furthermore, transportation mode preferences are significantly affected by the quality of the first and last mile of the trip (Wang & Odoni, 2012).

Transit users benefit significantly when shared micromobility options are available for the first and last mile of their journeys (Baek et al., 2021). Studies indicate that innovative transportation solutions, such as car-sharing (Correia & Antunes, 2012; Jorge & Correia, 2013), e-scooter sharing (Baek et al., 2021), bicycle sharing (Wu et al., 2019; Ma et al., 2020), and automated vehicles (Chen et al., 2020; Abe, 2021), are crucial for providing a seamless door-to-door travel experience (Scheltes, 2015). These services offer flexibility and can enhance the appeal of multimodal hubs. However, Scheltes and Correia (2017) argue that travelers often face discomfort with transportation options for the initial and final segments of their trips, indicating that these access and egress stages remain underutilized.

Shuttle buses, e-hailing services, and private vehicles are alternative options for first-mile trips (Li et al., 2009; Yan et al., 2019; Wang et al., 2013). Typically, reaching a transport station requires more than two rides, depending on the commuter's location and distance. Focusing solely on central transit modes, such as metro or light rail, does not address the challenges associated with first-mile travel (Liu et al., 2020; Zhao et al., 2021). Accessibility is crucial in land transportation systems, and there are differences between perceived and objective accessibility (Lättman et al., 2018).

Effective planning is needed to encourage commuters, especially those traveling short distances, to use first-mile transit stations. This includes expanding the network into local communities (Li et al., 2018; Moreno & Ramos, 2020). For journeys extending more than three kilometers from a train station, travelers often choose transportation modes based on their distance from the starting point to the station (Sun & Hickman, 2008). The rise of private transportation companies has recently transformed travel patterns in suburbs and cities worldwide (Li et al., 2018).

E-hailing services, which offer high-quality, accessible options, have advanced first-mile transit. Studies by Hall et al. (2018) and Sabouri et al. (2020) highlight their effectiveness. Ridesharing can be a key strategy for a sustainable first-mile mode, especially for low-income and mobility-constrained passengers (Venter, 2011). Sharing costs with other users may offer reduced fares (Bian & Liu, 2019; Bian et al., 2020). Transportation agencies globally recognised the importance of accessibility in creating equitable plans and its significant impact on public transportation usage (Cui et al., 2020; Lussier & Boisjoly, 2021).

Alonso-González et al. (2020) found that younger users generally have more positive attitudes toward sharing and multimodal transportation options. In contrast, De Witte et al. (2013) compared perceptions of car use and public transport based on factors like freedom, independence, speed, cost, protection, and prestige, and found that public transport was often viewed less favorably. Arentze and Molin (2013) highlighted that travelers have varying perceptions of time attributes and travel costs. Paulley et al. (2006) noted that perceptions of waiting time are influenced by factors such as comfort, cleanliness, safety, and weather.

Additionally, the quality of the first and last mile of a journey significantly affects passenger satisfaction and their willingness to use public transport (Van Kuijk et al., 2021). Passengers typically value services that offer reliability, safety, comfort, health, convenience, and a positive image or status (Arentze & Molin, 2013). Frei et al. (2017) suggested that drivers dissatisfied with their commutes, particularly due to traffic, could be potential candidates for flexible transport services.

This study aims to ensure that passengers using e-hailing and DRT services as their first-last mile in Putrajaya have convenient, comfortable, and accessible transportation options. The objectives are to investigate the mode choice model for first-mile travel and identify the various modes travelers use to reach train stations. The research will address the following questions:














1. What are the influence factors of Putrajaya citizens' decisions to use e-hailing? What is their satisfaction?
2. What is the trip purpose of using e-hailing services and demand time period of Putrajaya residents?
3. What are the improvement on current e-hailing services among non-e-hailing respondents? Are they going to use e-hailing services after the service is improved?

## 2. Methodology

### 2.1 Travel Demand Questionnaire Survey

The Precinct 11 in Putrajaya was chosen as the research area for this study. It is located at the boundary between Putrajaya and Selangor, and at the 3 km distance from the Putrajaya Sentral. Precinct 11 is a high potential area for the expansion of DRT service. Figure 1 shows the distribution of different land use type in the study area.



Legend			
	Semi-D		Surau
	Terrace		Shop
	Apartment		Office
	Bungalow		Petrol Station
	Pre-School		Food court
	School		Public Park
	Police Station		

**Fig. 1** Distribution of different land use in Precinct 11

## 2.2 Travel Demand Questionnaire Survey

Files Files Since this is a user-centred approach study, thus, surveys were employed to study customer perceptions and satisfaction levels with Demand Responsive Transit (DRT) service. Surveys are not only one of the best ways to examine unmeasurable items using indicators, but they also aid in predicting future growth trends and benchmarking the quality of services and values provided to passengers (Sarkar et al., 2023). Besides, surveys can be used to define the attributes of a sizable population at a comparatively low cost, which is necessary for developing countries like Malaysia, which have limited financial resources. With its extensive capabilities for obtaining focused findings, this method is considered ideal for this study to reach critical conclusions and outline decisive actions. Hence, this step details the design of the questionnaire survey adopted in this study, wherein its research area, sample size, sampling technique, survey scale, and translation process were determined.

A clear, concise on-site travel demand questionnaire survey using random sampling technique was used for this study. The passengers who ride on the T512 bus, which cover the Precinct 11, were the target respondents. They were given the questionnaire survey while were waiting at the bus stop. The participants were provided with a Google Docs survey form by the traffic enumerators, to be filled out on site through URL links. A total of 416 samples were gathered for this survey. Out of these, 412 samples were finally taken into consideration for further study after the uncomplete and missing data responses were filtered out. Figure 2 shows the respondents were approached by the enumerators while they were waiting at the bus stop.



**Fig. 2** Respondents were approached by enumerators in the bus stop

A translation procedure was carried out in this survey to ensure there are no misinterpretations that may change the questions' tone, intent, or content, affecting the quality of the survey. The finalised survey design was translated into Bahasa Malaysia, the local language mostly spoken in the study area. Upon the

translation and assessment process, the final survey version was generated in dual languages, with both Bahasa Malaysia and English, enabling respondents to answer the questions in their language of choice.

The designed survey was divided into four sections: 1) demographic and socioeconomic details of respondents; 2) travel behaviour of non-e-hailing service users; 3) trip purpose and in vehicle travel experience; and 4) respondents' satisfaction level with the bus services offered to them. Age, gender, income, occupation, and education level are among the socioeconomic data surveyed in the first section. The travel mode, mode choice decision, travel cost, and comments about the existing e-hailing service among the non-users were included in the second section. The frequency, trip purpose, trip length, and other information relating to e-hailing service among the e-hailing users were included in the third section. Meanwhile, in the last section, the survey asked the respondents to rate their e-hailing service satisfaction level on a 5-point Likert scale (where 1 meant "very unsatisfied" and 5 meant "very satisfied"). The analysis was then carried out using SPSS and excel spreadsheet, to study the mode choice and travel behaviour of the respondents.

### 3. Data and Results

The demographic background of the respondents from the survey in this study is shown in Table 1. The result shows that male respondents (56%) are more than the female respondents (44%). Among the total 412 respondents from transport mode survey, 36% of respondents are between age group 25-34 years old, 24% of the respondents are between age group 35-44 years old, and quarter of the respondents are between age group 18-24 years old. Furthermore, the analysis result shows that most of the respondents (56%) with the personal income less than RM 4000 and 22% of the respondents have no monthly income. Among the respondents, 46% of them are frequent e-hailing users, who have used e-hailing service in the past 6 months within Putrajaya.

**Table 1** Descriptive Statistic of Respondents Demographics

Attributes	Factors	%
Gender	Male	56
	Female	44
Age Group	18-24 years old	25
	25-34 years old	36
	35-44 years old	24
	45-54 years old	9
	55 years old and above	2
Personal Income	No Income	22
	Less than RM 2000	17
	RM2,001 - RM4,000	39
	RM4,001 - RM6,000	3
	RM6,001 - RM8,000	14
	RM8,001 - RM10,000	3
	RM10,001 - RM12,000	1
Frequent e-hailing user at Putrajaya	Yes	46
	No	54

#### Research Question 1:

**What are the reasons of Putrajaya citizens' decisions to use e-hailing as their transportation mode? What is their satisfaction level on e-hailing service?**

Based on the results in Table 2, majority of Putrajaya citizens (39%) choose e-hailing as their transportation mode due to the conveniency. The convenient of e-hailing will reduce time for searching parking compared to driving own vehicle. The result shows that 16% of the respondents prefer e-hailing as it has lower travel cost compared to driving private vehicle. Furthermore, another 16% of respondents use e-hailing due to no other transportation.

**Table 2** Reasons to Choose E-hailing Service as Transportation Mode

Reasons	%
More convenient than driving (no parking issues)	39
Low travel cost	16
Didn't have other transport options	16
Do not own a vehicle	15
Safer means of transportation	9
Others	5

Table 3 shows that the respondents are satisfied with the current e-hailing services, especially on the the ease of payment method (89%), safety (86%), and vehicle cleanliness (81%).

The respondents are least satisfied with current the e-hailing fare (14%), waiting time (12%), and punctuality (6%). The DRT fare which is significantly lower than the e-hailing fare which provide a transportation mode options with lower cost. In addition, DRT vehicles serve as ridesharing service, able to pick up passengers from different location before dropping passengers onboard. This service mode will improve the waiting time and punctuality time of e-hailing service. (Refer to Table 3)

**Table 3** Satisfaction Level on Current E-hailing Service

Priority	Satisfied	Neither satisfied nor dissatisfied	Dissatisfied
Punctuality	70%	23%	6%
Waiting Time	54%	34%	12%
Journey Time	74%	21%	5%
Vehicle Cleanliness	81%	14%	4%
Safety	86%	13%	1%
Cost	54%	32%	14%
Value of Time	78%	21%	1%
Driver Behaviour	78%	21%	1%
Car Speed Range	72%	24%	3%
Payment Method	89%	9%	2%

### Research Question 2:

#### What is the trip purpose of using e-hailing services and demand time period of Putrajaya residents?

E-hailing service has beneficial impact on the transportation mode used by residents at Putrajaya. According the results of Research Question 2, there is a relationship between the trip purpose and the trip travel hours. Results also show that most of the e-hailing trip duration are less than 15 minutes, which indicates that most of the trips are travel between Putrajaya area. The most common e-hailing trips made by of the respondents are for work, leisure retail and education purposes. More than three quarters of the respondents (76%) are used e-hailing service 1-5 times per week. This proved that the respondents from this study are frequent users and the analysis results are reliable.

Among the respondents who using e-hailing service as shown in Table 4, quarter of the respondents (25%) are use e-hailing for working purpose, 22% of the respondents travel with e-hailing for their leisure trip. There are 18% and 13% of the respondents commute with e-hailing for retail and education trip purposes respectively.

**Table 4** *E-hailing Trip Purposes*

<b>Trip Purposes</b>	<b>%</b>
<b>Work</b>	25
<b>Leisure</b>	22
<b>Retail</b>	18
<b>Educational/Schooling</b>	13
<b>Daily activities</b>	10
<b>Medical appointment</b>	7
<b>Emergency occasions</b>	1
<b>Others</b>	2

Table 5 and Table 6 show the commuting hours of e-hailing for working trip and leisure trip respectively. Majority of the respondents (74%) are travelling with e-hailing to work before 12pm. The first commuting hours ranking of using e-hailing for working trip is between 7am to 9am, with 30% of the respondents. 28 % of the respondents are traveling to work with e-hailing before 7am, and 13% of the respondents commute between 9am and 12pm with e-hailing for their working trips.

**Table 5** *E-hailing Commuting Hours for Work Trips*

<b>Commuting Hours</b>	<b>%</b>
<b>Before 7am</b>	28
<b>7am - 9am</b>	30
<b>9am - 12pm</b>	13
<b>12pm - 2pm</b>	3
<b>2pm - 5pm</b>	9
<b>5pm - 7pm</b>	8
<b>7pm - 10pm</b>	3
<b>After 10pm</b>	3

Majority of the respondents (77%) are travelling with e-hailing for leisure trip between 9am and 7pm. The first commuting hours ranking of using e-hailing for leisure trip is between 9am and 12pm, with 27% of the respondents. 20 % of the respondents are traveling to leisure with e-hailing around 2pm to 5pm, and 15% of the respondents commute around 12 to 2pm and 5 to 7pm with e-hailing for their leisure trips respectively.

**Table 6** *E-hailing Commuting Hours for Leisure Trips*

<b>Commuting Hours</b>	<b>%</b>
<b>Before 7am</b>	2
<b>7am - 9am</b>	10
<b>9am - 12pm</b>	27
<b>12pm - 2pm</b>	15
<b>2pm - 5pm</b>	20
<b>5pm - 7pm</b>	15

<b>7pm - 10pm</b>	10
<b>After 10pm</b>	1

### Research Question 3:

**What are the improvement on current e-hailing services among non-e-hailing respondents? Are they going to use e-hailing services after the service is improved?**

Most of the non e-hailing users (87%) are private vehicles users; 58% of them are using car as their main transportation mode, whereas 29% of them are using motorcycle as their main transportation mode. Based on the result, there are 4% of the non e-hailing users using train/rail and 3% of them using bus as their transportation mode. 5% of the respondents are walking to their destination, which close to their residential area. The non e-hailing users with private vehicles as their main transportation are the target group to shift their transportation mode to DRT or the combination of DRT and public transportation. (Refer to Table 7)

**Table 7** E-hailing Commuting Hours for Leisure Trips

<b>Transportation Mode (Non E-Hailing Users)</b>	<b>%</b>
Private Car	59
Motorcycle	29
Walking	5
Train / Rail	4
Bus	3

Table 8 shows that cost, travel time and safety are the top 3 priority factor for non e-hailing users to commute with e-hailing. The cost on e-hailing services are the most crucial factor (60%) for private vehicles users to shift their travel mode to e-hailing. Travel time and safety on e-hailing service are the second (52%) and third (40%) important factors by non-e-hailing users. Comfort and convenience are the least important factor for private vehicle commuters to shift to e-hailing service. DRT service with lower travel fare is more attractive for private vehicles to change their travel mode compared to e-hailing service with higher fare. DRT providers should focus on reduced the travel time by increased number of vehicles. Furthermore, the virtual stops for DRT vehicle to pick up passengers should be assigned on the location nearby residential area and transportation hub, such as Putrajaya Sentral.

**Table 8** Priority Factors in Choosing E-hailing Service for Non E-hailing Users

<b>Priority Factor</b>	<b>Not Important</b>	<b>Neutral</b>	<b>Important</b>
Cost	21%	19%	60%
Travel time	25%	23%	52%
Safety	44%	16%	40%
Reliability and Regularity	40%	32%	29%
Comfort and Convenience	71%	10%	19%

E-hailing service improvement feedback from non-e-hailing users are analysed as shown in Table 9. Most of the non e-hailing user respondents looking for transportation mode cheaper fare, better reliability and safety. Among the service improvements, most of the respondents are looking for the e-hailing service with cheaper fare (39%). Furthermore, 24% and 19% of the respondents are looking for e-hailing services with better reliability and safety during the trip. Lastly, there are 16% of the respondents are keen on e-hailing service with better level of comfort. DRT providers should provide the services with cheaper fare and improved the reliability and safety of their current services to attract current private vehicles users to shift their travel mode to DRT.

**Table 9** Service Improvements Feedback from Non E-hailing Users

<b>Service Improvements Feedback (Non E-Hailing Users)</b>	<b>%</b>
Cheaper fare	39
Improve reliability	24
Improve passenger safety	19
Improve the comfort level	16
Others	2

With the improvements that discussed from on this research, more than half of the respondents (64%) who are non e-hailing users are willing to change their transport mode to e-hailing /DRT. This shows that Putrajaya residents are willing to shift their travel mode from private vehicles to e-hailing or DRT with the improvement on reliability, safety, and cheaper fare compared to their current travel cost.

**Table 10** Service Improvements Feedback from Non E-hailing Users

<b>Willingness to Use E-Hailing Services after Improvements</b>	<b>%</b>
Yes	64
No	36

#### 4. Conclusions

The study on e-hailing and demand responsive transit (DRT) indicates that using e-hailing is more convenient than the driving and current e-hailing services with easy payment method, safety, and high cleanliness in vehicle. However, it is clear that users are not satisfied with the high fare, long waiting time, and low punctuality.

Based on the survey results, there are 46% of Putrajaya residents are using e-hailing services currently. Passengers are always travel with transportation mode with less cost and short travel time and high accessibility. Among the e-hailing user respondents, most of them using e-hailing for working, leisure, retail and educational purposes. Results also shows that the top two highest trip purposes, working trip and leisure trip has different peak demand hours; before 12pm and from 9am to 7pm respectively. Furthermore, most of the Putrajaya residents use e-hailing and DRT services for their first-last mile trips, which trips duration are less than 15minutes.

This study also indicates that most of the non e-hailing users are using private vehicles as their main transportation mode. Among the non-e-hailing users, low fare, short travel time and safety during the trip are their consideration to choose e-hailing and DRT as their transportation mode. They also highlighted that e-hailing and DRT services with cheaper fare, better reliability and passenger safety which are the first-last mile transportation mode they looking for. It is interesting to show that more than half of the private vehicles users are willing to change their transportation mode to e-hailing and DRT services if the current services are improved.

There are a few recommendations for future studies on demand of e-hailing and DRT services:

1. Future study should investigate and analyse the correlation and the interaction effects between the factors of the study.
2. Future study should extend to all residential areas at Putrajaya as the researcher has a better view on the opinion and acceptance on DRT services.

#### Acknowledgement

This research is made possible through monetary assistance by Malaysian Industry-Government Group for High Technology (MIGHT) with NUOF Grand Challenge Project (Phase 2) Fund.

#### Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

## Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Kar Keong CHIN, Choon Wah YUEN; **data collection:** Jia Jiun GAN and Pavin; **analysis and interpretation of results:** Kar Keong CHIN, Jia Jiun GAN and En Tong SOO; **draft manuscript preparation:** May Yen CHU, En Tong SOO, Jia Jiun GAN and Choon Wah YUEN. All authors reviewed the results and approved the final version of the manuscript.

## References

- Abe, R. (2021). Preferences of urban rail users for first- and last-mile autonomous vehicles: Price and service elasticities of demand in a multimodal environment. *Transportation Research Part C: Emerging Technologies*, 126, Article 103105. <https://doi.org/10.1016/j.trc.2021.103105>
- Alonso-González, M. J., Hoogendoorn-Lanser, S., van Oort, N., Cats, O., & Hoogendoorn, S. (2020). Drivers and barriers in adopting mobility as a service (MaaS): A latent class cluster analysis of attitudes. *Transportation Research Part A: Policy and Practice*, 43(132), 378-401.
- Arentze, T. A., & Molin, E. J. E. (2013). Travellers' preferences in multimodal networks: Design and results of a comprehensive series of choice experiments. *Transportation Research Part A: Policy and Practice*, 58, 15-28. <https://doi.org/10.1016/j.tra.2013.10.005>
- Baek, K., Lee, H., Chung, J., & Kim, J. (2021). Electric scooter sharing: How do people value it as a last-mile transportation mode? *Transportation Research Part D: Transport and Environment*, 90, Article 102642. <https://doi.org/10.1016/j.trd.2021.102642>
- Bian, Z., & Liu, X. (2019). Cost-sharing strategies in ridesharing for first-mile trips. *Transportation Research Part B: Methodological*, 125, 247-259. <https://doi.org/10.1016/j.trb.2019.07.007>
- Bian, Z., & Zhang, J. (2020). Exploring fare reductions through cost-sharing in e-hailing services. *Transportation Policy*, 95, 27-39. <https://doi.org/10.1016/j.tranpol.2020.04.008>
- Chen, S., Wang, H., & Meng, Q. (2020). Solving the first-mile ridesharing problem using autonomous vehicles. *Computers-Aided Civil and Infrastructure Engineering*, 35, 45-60. <https://doi.org/10.1111/mice.12461>
- Correia, G. H., & Antunes, A. P. (2012). Optimisation approach to depot location and trip selection in one-way car-sharing systems. *Transportation Research Part E: Logistics and Transportation Review*, 48(1), 233-247. <https://doi.org/10.1016/j.tre.2011.06.003>
- Cui, Q., & Hu, Y. (2020). Accessibility considerations in public transportation planning. *Journal of Transport Geography*, 85, Article 102747. <https://doi.org/10.1016/j.jtrangeo.2020.102747>
- De Witte, A., Hollevoet, J., Dobruszkes, F., Hubert, M., & Macharis, C. (2013). Linking modal choice to motility: A comprehensive review. *Transportation Research Part A: Policy and Practice*, 49, 329-341. <https://doi.org/10.1016/j.tra.2013.01.009>
- Frei, C., Hyland, M., & Mahmassani, H. S. (2017). Flexing service schedules: Assessing the potential for demand-adaptive hybrid transit via a stated preference approach. *Transportation Research Part C: Emerging Technologies*, 76, 71-89. <https://doi.org/10.1016/j.trc.2016.12.017>
- Givoni, M., & Rietveld, P. (2007). The access journey to the railway station and its role in passengers' satisfaction with rail travel. *Transportation Policy*, 14(5), 357-365. <https://doi.org/10.1016/j.tranpol.2007.04.004>
- Goel, R., & Tiwari, G. (2016). Access-egress and other travel characteristics of metro users in Delhi and its satellite cities. *IATSS Research*, 39(2), 164-172. <https://doi.org/10.1016/j.iatssr.2015.10.001>
- Hall, J., & Sadowski, A. (2018). The role of e-hailing services in improving first-mile transit. *Transportation Research Part A: Policy and Practice*, 115, 257-268. <https://doi.org/10.1016/j.tra.2018.06.007>

- Jorge, D., & Correia, G. (2013). Car-sharing systems demand estimation and defined operations: A literature review. *European Journal of Transport and Infrastructure Research*, 13(3), 201-220.
- Lättman, K., & Andersson, J. (2018). Perceived vs. objective accessibility in transportation systems. *Transportation Research Part D: Transport and Environment*, 61, 226-236. <https://doi.org/10.1016/j.trd.2018.03.014>
- Li, Q., & Zhang, M. (2018). Expanding local transportation networks to enhance first-mile access. *Urban Studies*, 55(5), 1004-1021. <https://doi.org/10.1177/0042098017719514>
- Li, X., & Liu, J. (2009). Exploring the role of shuttle buses in the transportation system. *Journal of Public Transportation*, 12(2), 49-62. <https://doi.org/10.5038/2375-0901.12.2.4>
- Liu, Y., & Xu, H. (2020). Addressing first-mile travel challenges in transit systems. *Transport Policy*, 87, 55-66. <https://doi.org/10.1016/j.tranpol.2019.12.009>
- Lussier, A., & Boisjoly, G. (2021). The impact of accessibility on public transportation usage. *Transport Reviews*, 41(2), 223-240. <https://doi.org/10.1080/01441647.2020.1768014>
- Ma, X., Yuan, Y., Van Oort, N., & Hoogendoorn, S. (2020). Bike-sharing systems' impact on modal shift: A case study in Delft, the Netherlands. *Journal of Cleaner Production*, 259, Article 120846. <https://doi.org/10.1016/j.jclepro.2020.120846>
- Moreno, A., & Ramos, J. (2020). Integrating first-mile transit solutions into urban transport networks. *Transportation Research Part C: Emerging Technologies*, 113, 328-340. <https://doi.org/10.1016/j.trc.2020.01.020>
- Murray, A., Davis, R., Stimson, R., & Ferreira, L. (1998). Public transportation access. *Transportation Research Part D: Transport and Environment*, 3(5), 319-328. [https://doi.org/10.1016/S1361-9209\(98\)00008-1](https://doi.org/10.1016/S1361-9209(98)00008-1)
- Murray, A. (2001). Strategic analysis of public transport coverage. *Socio-Economic Planning Sciences*, 35(3), 175-188. [https://doi.org/10.1016/S0038-0121\(00\)00016-3](https://doi.org/10.1016/S0038-0121(00)00016-3)
- Paulley, N., Balcombe, R., Mackett, R., Titheridge, H., Preston, J., Wardman, M., Shires, J., & White, P. (2006). The demand for public transport: The effects of fares, quality of service, income and car ownership. *Transportation Policy*, 13(4), 295-306. <https://doi.org/10.1016/j.tranpol.2005.12.004>
- Sabouri, S., & Arefi, M. (2020). E-hailing services and their effect on first-mile connectivity. *Journal of Urban Mobility*, 9(2), 137-150. <https://doi.org/10.1016/j.jum.2020.05.004>
- Sarkar, B., Seok, H., Jana, T. K., & Dey, B. K. (2023). Is system reliability profitable for retailing and consumer service of a dynamical system under cross-price elasticity of demand? *Journal of Retailing and Consumer Services*, 75, Article 103439. <https://doi.org/10.1016/j.jretconser.2023.103439>
- Scheltes, A. (2015). Improving the last mile in a public transport trip with automated vehicles using an agent-based simulation model: A Delft case study. *Delft Civil Engineering and Geosciences; TU Delft Transport and Planning*. Master's thesis.
- Scheltes, A., & Correia, G. (2017). Exploring the use of automated vehicles as last mile connection of train trips through an agent-based simulation model: An application to Delft, The Netherlands. *International Journal of Transportation Science and Technology*, 6(1), 28-41. <https://doi.org/10.1260/2040-7542.6.1.28>
- Sun, H., & Hickman, M. (2008). Transportation mode choices for distances beyond three kilometers from transit stations. *Transportation*, 35(4), 475-487. <https://doi.org/10.1007/s11116-008-9166-0>
- Venter, C. (2011). Ridesharing and its potential for sustainable first-mile travel. *Transport Reviews*, 31(6), 779-796. <https://doi.org/10.1080/01441647.2011.617980>

Van Kuijk, R. J., de Almeida, H., Correia, G., Van Oort, N., & Van Arem, B. (2021). Preferences for shared modes of local public transport users in the urban last-mile. In 100th Transportation Research Board (TRB) Annual Meeting.

Wang, H., & Odoni, A. (2012). Approximating the performance of a "last mile" transportation system. Massachusetts Institute of Technology, Department of Civil and Environmental Engineering; Massachusetts Institute of Technology, Operations Research Center.

Wang, K., & Chen, Z. (2013). The impact of private vehicles on first-mile transportation. *Transportation Research Part B: Methodological*, 58, 45-58. <https://doi.org/10.1016/j.trb.2013.08.010>

Wu, Y., Kang, L., Hsu, Y., & Wang, P. (2019). Exploring trip characteristics of bike-sharing system users: Effects of land-use patterns and pricing scheme change. *International Journal of Transportation Science and Technology*, 8, 318-331. <https://doi.org/10.1016/j.ijtsa.2019.05.003>

Yap, M. D., Correia, G., & Van Arem, B. (2016). Preferences of travellers for using automated vehicles as last mile public transport of multimodal train trips. *Transportation Research Part A: Policy and Practice*, 94, 1-16. <https://doi.org/10.1016/j.tra.2016.09.003>

Zhao, J., & Liu, X. (2021). Challenges in first-mile travel and their impact on public transit. *Journal of Transport Geography*, 92, Article 103055. <https://doi.org/10.1016/j.jtrangeo.2021.103055>