BUILT ENVIRONMENT AND AUTONOMOUS VEHICLE MODE CHOICE

A First-mile Scenario in Singapore

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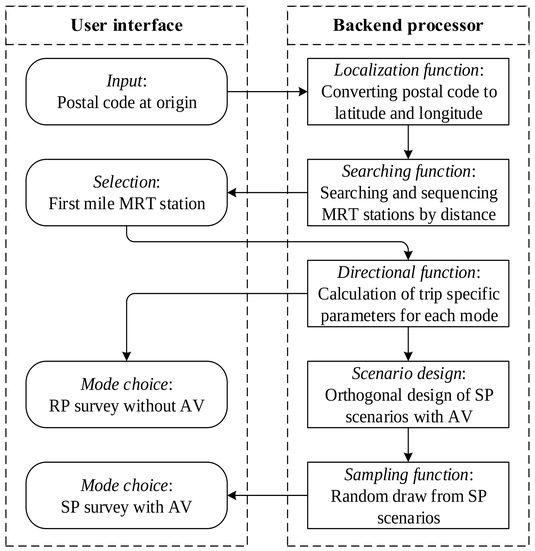
1 INTRODUCTION

This study investigates travel mode choice with on-demand autonomous vehicle (AV). It takes Singapore as the study area and specifically focuses on understanding the impacts of built environment (BE) on first-mile scenarios. The results reveal that BE factor is independent of trip specific and sociodemographic variables. Although including BE does not significantly improve the model fitting, it adds to explain the nuances of individual's preference on travel mode choice.

2 SURVEY DESIGN AND DATA COLLECTION

Dynamic Web-based SP Survey

we develop a dynamic web-based SP survey incorporating the first-mile scenarios generated from of the respondent's actual dwelling location, which allows us to capture the impact of BE on travel behaviors with AV. Both revealed preference (RP) and stated preference (SP) questions are generated, which enables a joint estimation based on RP and SP.

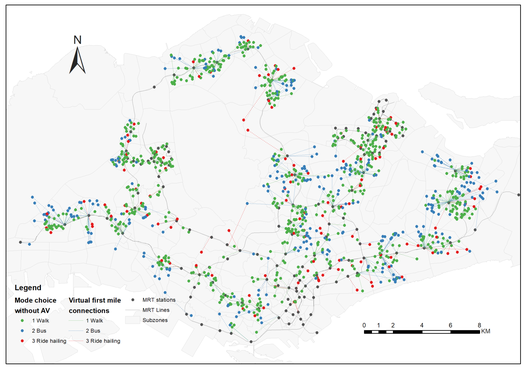


Four available travel modes are considered in this study, which are walk, bus, ride hailing such as Uber/Grab or taxi, and the on-demand AV. The availability of bus is determined by Google Map.

	Total Cost	Origin	Walk (min)	Wait (min)	In-vehicle (min)	Destin.	Total Time
1. Walk	$0.0		15	n.a.	n.a.		15 min
2. Bus	$0.9		4	5	8		17 min
3. Ride Hailing	$4.0		n.a.	3	10		13 min
4. Ride Hailing with AV	$5.0		n.a.	3	6		9 min

Respondents spatial distribution

1,242 valid samples collected, covering the main residential areas in the country. The locations of survey respondents are shown below. In general, walk and bus are still the dominant travel modes for the first-mile travel.



Built Environment

This study focuses on measuring land use and transportation infrastructure at the level of traffic analysis zone (TAZ). Floor area ratio (FAR) is computed for residential, commercial and industrial buildings. Density and diversity are also quantified using the POIs from Google Maps

	Mean	SD	Max	Min
FAR of public residence at origin	0.913	0.674	3.285	0.000
FAR of public residence at destination	0.693	0.626	2.933	0.000
FAR of private residence at origin	0.201	0.339	1.808	0.000
FAR of private residence at destination	0.173	0.284	1.773	0.000
FAR of commercial buildings origin	0.047	0.147	2.310	0.000
FAR of commercial buildings destination	0.297	0.559	3.744	0.000
FAR of industrial buildings at origin	0.025	0.134	1.712	0.000
FAR of industrial buildings at destination	0.011	0.074	1.495	0.000
Entropy at origin	0.516	0.124	0.949	0.000
Entropy at destination	0.552	0.104	0.949	0.000
Number of POIs at origin per km² (scaled by 0.001)	0.064	0.040	0.206	0.000
Number of POIs at destination per km² (scaled by 0.001)	0.073	0.034	0.185	0.000
Distance to bus stop (km)	0.286	0.243	4.141	0.000
Distance to MRT station (km)	1.244	0.775	8.965	0.000
Number of bus stops at origin per km² (scaled by 0.01)	0.114	0.061	0.344	0.000
Number of bus stops at destination per km² (scaled by 0.01)	0.116	0.054	0.262	0.000

3 MODELS AND RESULTS

Mixed Logit Model

The mixed logit model with panel data structure is implemented to investigate the choice behaviors, which also allows us to capture the heterogeneity of taste across the cohorts. Each parameter and the alternative specific constant (ASC) follow normal distribution. The deterministic part of utility function V_{njt} for individual n choosing alternative j in choice situation t is:

$$V_{njt} = \alpha_{nj} + \beta'_{nj} T_{njt} + \gamma'_{nj} B_n + \delta'_{nj} X_n$$

- T_{njt}: vector of trip specific attributes;
- B_n: vector of BE variables;
- X_n: vector of sociodemographic variables;
- α_{nj}: ASC to estimate the inherent preference;
- β'_{nj}, γ'_{nj} , δ'_{nj}: corresponding coefficients.

Model Results

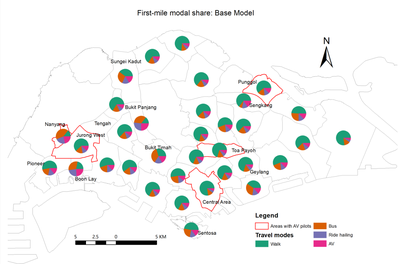
Two models are built for comparative purpose. The Base Model only includes trip specific and sociodemographic variables, while the BE information is incorporated in the BE Model. The results imply that:

- BE variables offers more details in explaining the impacts of BE on individual's behavior but do not improve goodness of fit.
- People are more likely to choose bus if there a nearby bus stop.
- Longer distance leads to increased market share of bus and on-demand AV.
- The Floor-Area Ratios (FARs) of commercial and industrial buildings at origin present positive effects on choosing ride hailing.
- The FARs of commercial and industrial buildings at origin and destination are found positive to the utility of on-demand AV.
- The density of POIs at destination is found positive to the utility of on-demand AV.
- Only a few of BE variables show significant variation of taste.

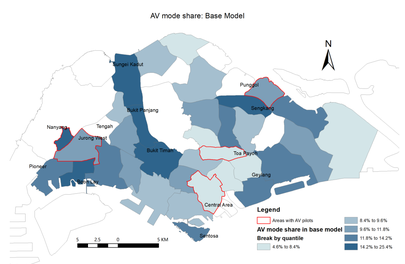
4 POLICY IMPLICATION WITH SIMULATION PRACTICE

Simulation design

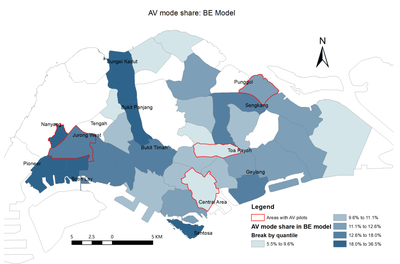
The choice model implemented to simulate the potential modal share of AV in different planning areas (PA) in Singapore. The samples for simulation are set as the first-mile trips extracted from the Singapore household survey data.



In most of the PAs, walk and bus are still the dominant selections for first mile connections, even after the deployment of AV.



Comparing with Shen et al. (2018)'s research, higher first-mile bus demand does not necessarily lead to the highest potential first-mile AV demand.



Incorporating the impact of BE makes the spatial distribution of the highest AV demand areas shifts to the peripheral areas of the country.

5 CONCLUSION AND DISCUSSION

- BE variables offers more details in explaining the impacts of BE on individual's behavior but do not improve goodness of fit.
- Revisiting the planning of pilot areas for future AV deployment may be needed to avoid a spatial mismatch of on-demand AV service.