Impacts of Subjective Evaluations and Use of Existing Travel Modes on Adoption of Autonomous Mobility-on-Demand

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1 INTRODUCTION

With the quick advance of autonomous vehicle (AV) technology, understanding AV's potential demand and user characteristics has increasingly become a popular area of research. This study combines RP and SP data to investigate how people's subjective evaluations and use of existing modes into forecasts of demand for autonomous mobility on demand (AMoD). The study takes Singapore as the study area, as Singapore is a leader in the world of adopting new transport technologies.

2 SURVEY DESIGN

The survey consisted of three parts: a revealed preference (RP) trip diary, a series of stated preference (SP) choice experiments that are generated online based on RP responses, and a block of questions about respondents' perceptions of existing modes and socio-demographic information. A flow diagram below illustrates the process. The study is administered by Qualtrics and a total of 2000 individuals took the survey.
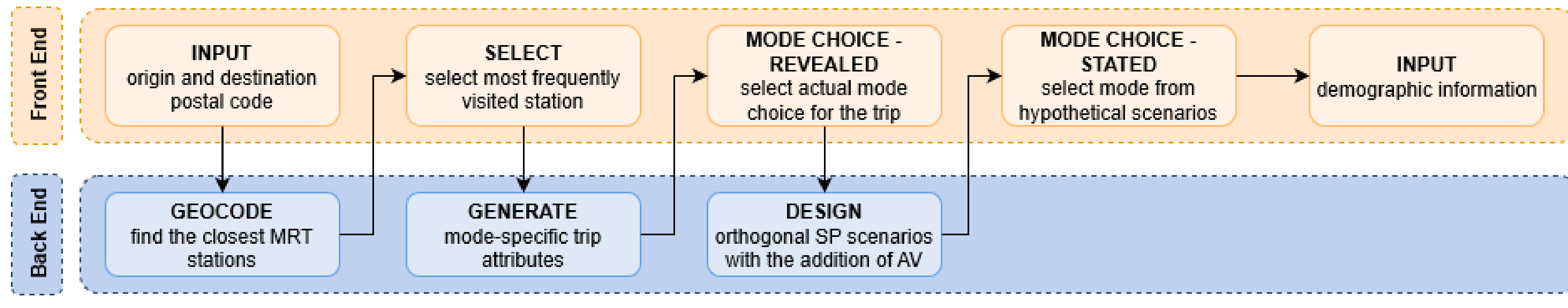
Example Interface for Stated Preference Choice Experiment

		Total Cost	Origin	Walk (min)	Wait (min)	In-vehicle (min)	Destin.	Total Time
1. Walk		$0.0		30	n.a.	n.a.		30 min
2. Bus		$1.3		4	5	18		27 min
3. Ride Hailing		$4.0		n.a.	3	12		15 min
4. Ride Hailing with AV		$5.0		n.a.	3	8		11 min
5. Drive		$4.0		3	n.a.	9		12 min

In the second part, AMoD is added as a choice with its characteristics similar to ride hailing (form of AV pilot in Singapore).

Hypothetical trip scenarios are generated from the trip attributes from RP responses (each attribute with 3 levels with the median anchored to RP response) so that the respondent is familiar with the given situations. Each respondent is presented with six scenarios.

Indicator Questions for Subjective Evaluation of Existing Modes

Subjective evaluation (latent variable)	Indicator	Question
Pro-walk	Walk safe	I think walking feels safe.
	Walk comfortable	I think walking is comfortable.
	Walk reliable	I think walking is a reliable mode.
	Walk easy	I think walking feels easy.
	Walk enjoyable	I enjoy walking.
Pro-public transit (PT)	PT safe	I think taking public transport feels safe.
	PT comfortable	I think taking public transport is comfortable.
	PT reliable	I think public transport is a reliable mode.
	PT easy	I think taking public transport is easy.
	PT enjoyable	I enjoy taking public transport.
Pro-ridehailing (RH)	RH safe	I think ride hailing feels safe.
	RH comfortable	I think ride hailing is comfortable.
	RH reliable	I think ride hailing is a reliable mode.
	RH easy	I think ride hailing is easy.
	RH enjoyable	I enjoy ride hailing.
Pro-drive	Drive safe	I think driving feels safe.
	Drive comfortable	I think driving is comfortable.
	Drive reliable	I think driving is a reliable mode.
	Drive easy	I think driving is easy.
	Drive enjoyable	I enjoy driving.

The next part of the survey included 5 Likert-scale questions about each existing travel mode to make up a subjective evaluation of all existing modes. The five mode descriptors used are safety, comfort, reliability, easiness, and enjoyment.

3 MODELS SPECIFICATION

Model Structure
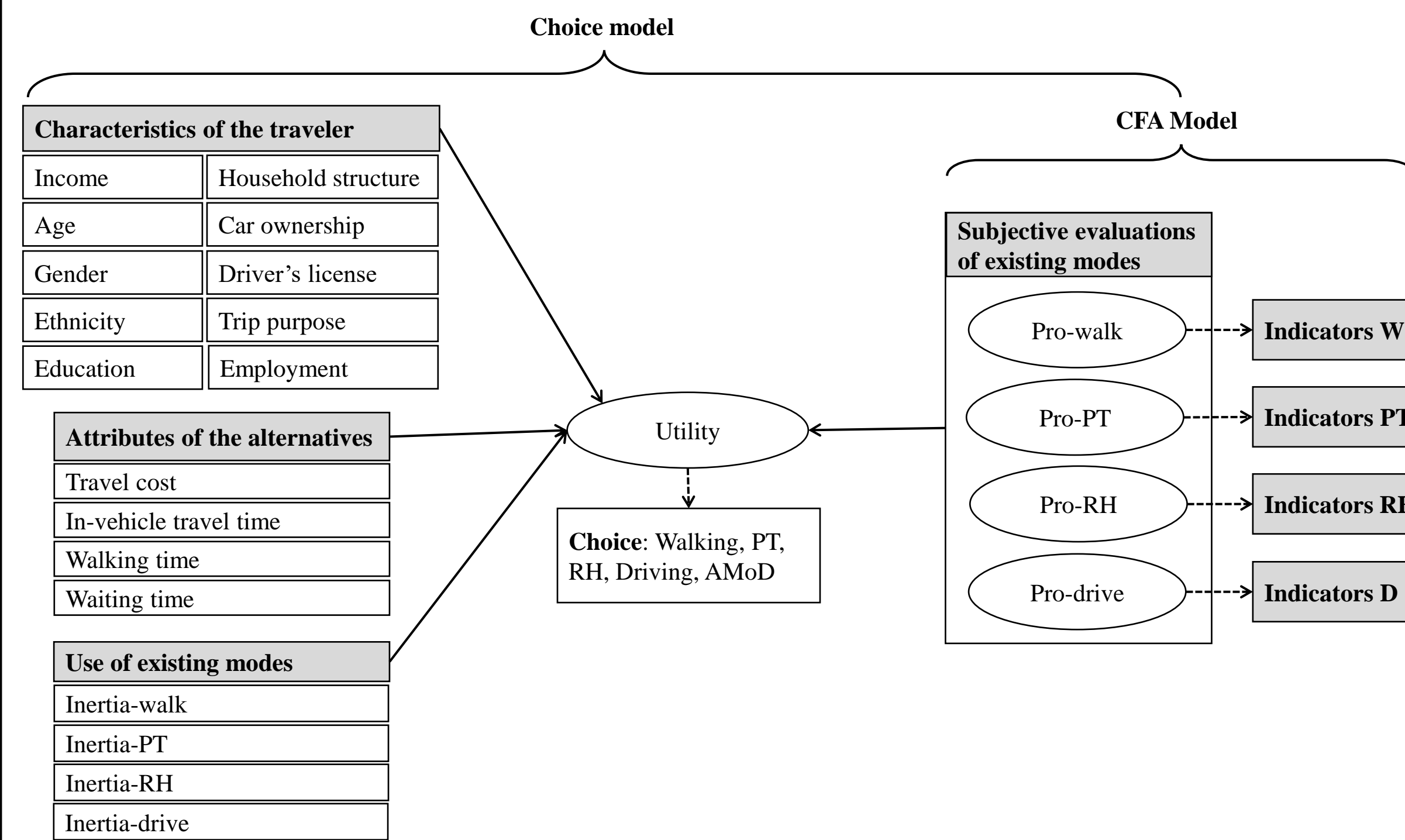
In order to evaluate whether subjective evaluations and use of existing modes affect mode choice independently or jointly, we estimate a base model with only sociodemographic and mode-specific variables, one model with only subjective evaluations, one model with only the use of existing modes, and one with both included for comparison. A latent variable mixed logit model is developed to estimate mode choice.

Subjective Evaluation – CFA
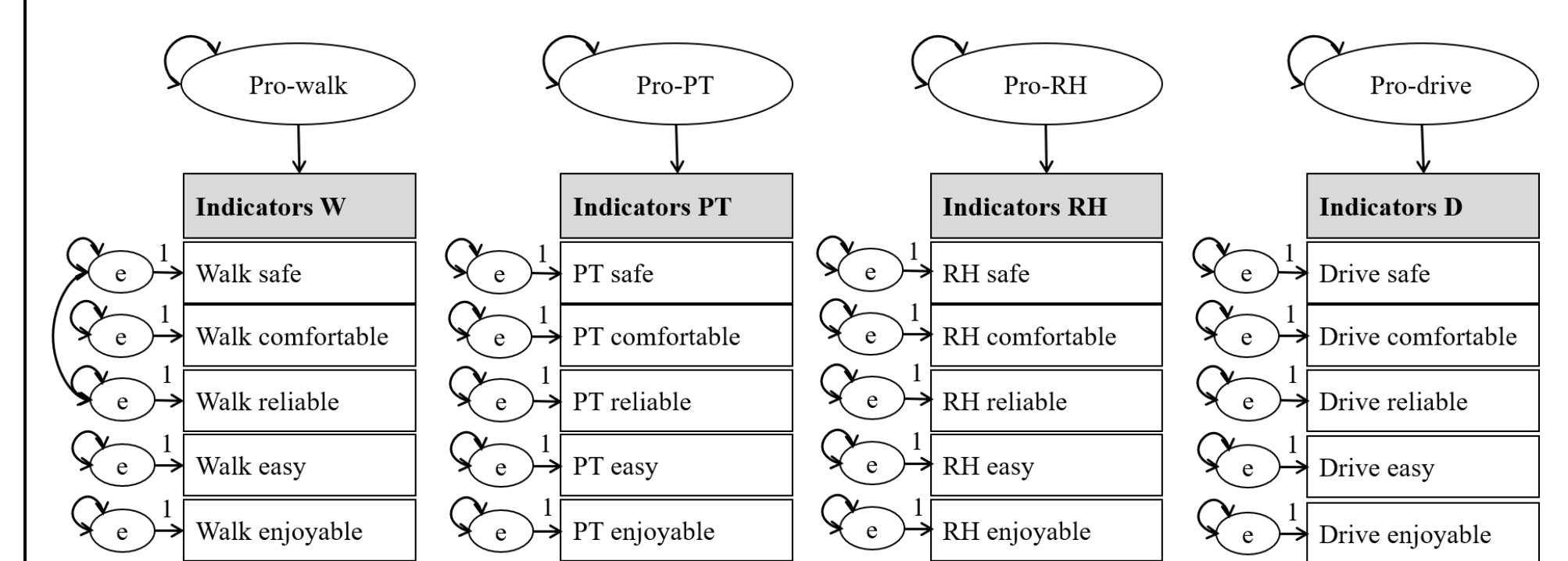
A confirmatory factor analysis model is formulated to identify a latent common factor (subjective evaluation) for each mode choice that influences the indicator questions' responses. Each latent variable is estimated separately.

Use of Existing Modes – Inertia

One weakness of stated preference is that stated choice does not always agree with revealed choice. Inertia represents the tendency to stick with the past choice; we use a dummy variable to indicate whether individual n has chosen mode m in the RP part and estimate its effect (inertia) on SP choices.

4 MODEL RESULTS AND DISCUSSION

- **Model Fit**: The inclusion of both subjective and objective (inertia) evaluations of existing modes is significant at a 95% confidence level using a likelihood test. The alternative-specific constants (ASC) from the benchmark model and the new model stayed almost the same except for those of AMoDs – more systematic variations in AMoD are captured via latent attitudes and inertia. RP responses contain more random noises than SP responses.
- **Subjective Evaluations**: Positive evaluation of a certain mode is correlated with the choice that mode in the survey. Subjective evaluations of walk, driving, and public transit do not significantly influence the choice to use AMoD; people with positive evaluations of ridehailing are more likely to choose AMoD.
- **Use of Existing Travel Modes (Inertia)**: Choices of car-based modes (driving and ridehailing) are positively predicted by existing use of these modes; but choice of public transit is negatively predicted by existing use of public transit and walking. With the introduction of AMoD, users of all existing modes switch to some extent. Individuals who are currently using ridehailing or driving are more likely to choose AMoD and people who are walking are the least likely to choose AMoD were this introduced as a new travel mode.

5 CONCLUSION

- The best model is achieved with the inclusion of both subjective evaluations and use of existing modes. Subjective evaluations and actual use of existing modes play different roles in the adoption of AMoDs.
- The study gives insights into how to identify the target audience of a new mode of travel using existing travel behavior. Future studies in understanding people's travel mode preference should consider people's attitudes and usage of existing modes. In this situation, we considered AVs in the form of a on-demand service, to follow up on the idea of possible cooperation between AV and public transit, more direct research could be done on the design characteristics and people's attitudes.