How Expectation and Perception Affects Public's Use Intention of Automated Buses for Different Journey Purposes

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Abstract

This paper examines how public's expectation and perception towards the automated bus system would impact the adoption of this system for different trip purposes. Previous studies have contributed based on the hypothetical perceive but not the real observation. In contributing to this gap, based a data dataset collected at Barkarbystaden, Stockholm, we examines how public's expectation and perception from the real, fully operated automated public transport service operate in the mixed traffic environment on the public road would affect people willingness to take automated buses for work, shopping, leisure and family journeys. The results of the estimated multivariate probit model indicate that 1) Expectation of frequency, perception of travel time, safety and the informative are found significantly influencing people take the bus ride to commute. 2) For shopping and family journeys, increasing the frequency of the bus service, improving public's perception of safety and providing a pleasant experience during the journey are found may increase travellers' willingness to use the automated buses for shopping and family trips. 3) Most perception and expectation variables are found have no significant effects increasing or decreasing people's willingness to take the bus ride for leisure journeys. 4) People who intent to take the automated bus ride for shopping trip may use the bus for family and leisure trips.

Keywords:

Automated buses, expectation and perception, trip purposes

1. Introduction

Automation technology is expected to change the human behaviors and travel demands radically in the future (Fagnant and Kockelman, 2015; Ge et al., 2018; Gelauff et al., 2019). Introducing automation technology into public transport system may benefit transport system in different ways. For example, automation technology has the potential to substantially improve road safety (Litman, 2015; Haboucha et al., 2017; Konig and Neumayr, 2017). Similar benefits may apply to public transport system. In addition, automated buses will remove driver costs of vehicle operation. Not only bus operators may benefit from reduced operating costs, but users benefit from reduced travel fares as well (Piao et al., 2016; Abe, 2019; Cao and Ceder, 2019; Dong et al., 2019).

Although vehicle automation holds the potential to benefit public transport systems, implementation of the automation technology will not be successful without understanding public acceptance of such public transport systems (Becker and Axhausen, 2017). For instance, as a part of the CityMobil2 project, Madigan et al. (2016) explored public's acceptance of automated road transport systems as a transport system. Their study revealed that performance expectancy has an impact on behavioural intentions to use such a

system. Similarly, applied qualitative content analysis, Salonen and Havvisto (2019) studied what kind of experiences, perceptions and feelings passengers have when they travel in self-driving shuttle bus. Their findings revealed that ride experience may change public's perception of the automated buses.

Users' willingness to choose certain transportation mode may also depends on the trip purposes. Individuals and households' daily lives consist of various activities such as work, shopping, leisure, as well as family interaction. Providing accessible transport services for all is important to ensure people not excluded from reaching workplaces, daily and non-daily products, and leisure services, and it is also important to ensure qualified life opportunities for our diverse communities. While some studies have discussed how public expectation and perception towards automated buses would impact on passengers' behavioral intentions, few have examined how these factors would affect public's intention of automated buses for different trip purposes. This research gap is particular important for the public transport operator to understand the market preference and behaviour in order to seek the most suitable business case to deliver the service. Therefore, in this research we compare the automated buses adaptation on working, shopping, leisure and family trips. We are interested in knowing how public's expectation and perception would affect people use automated buses for different trip purposes.

2. Survey and data collection

The data were collected in Barkabystaden, Stockholm, Sweden. Barkabystaden is one of the largest city development project in the northern Europe, and plans for 18,000 new homes, 140 blocks and 10,000 new workplaces until 2030. Barkarbystaden is developed with the most sustainable public transport system, and will become the new travel node in western Stockholm.

In order to understand how expectation and perception affect users' perceived value of the automated bus service, three waves of panel survey of about 500 residents and local workers was conducted in July, October and December 2019. The data were collected via online questionnaires. In this study, we focus on the first wave data. To ensure that respondents have some knowledge of the bus service, the survey targeted at people who live, work or study in or around Barkabystaden.

The first wave data was collected by the end of March, 2019. The questionnaire has three sections. The first section of the questionnaire included a series of Likert-scale questions related to respondents' expectation and perception towards automated bus service, including attitudes about reliability, safety, informative, informative, and comfortability towards automated buses. Next, respondents were asked whether they would like to take automated buses for working, shopping, leisure or family trips or not. To our knowledge, this is the first study which aims to investigate user acceptance of automated bus service for different trip purpose. The final section assessed the characteristics of survey participants. Socio-demographic characteristics were reported by respondents. As a result, a total of 491 valid responses were collected in the first wave. Only first wave data are reported in this study.

3. Methodology

This paper aims to shed light on how perception and expectation influence people taking automated buses for different trip purposes. As shown in section 4.3, respondents consider taking the bus ride more than one trip purpose simultaneously; it would be more realistic to consider multiple choices than a single choice. Four binary trip purposes are considered: work trip, shopping trip, leisure trip and family trip, respectively.

Moreover, the unobserved error terms are allowed to be correlated across different choices, which results in more efficient estimation (i.e., smaller standard errors of estimators). Thus, a multivariate probit model was selected for this study. In the multivariate probit model, some variables could be found significant which did not achieve significance in an isolated binary model (Yun et al., 2011).

In our case, we estimate the following multivariate probit model for each commuter ''i'' choosing different dependent choice ''j'',

$$Y_{ij} = \beta_j X_{ij} + \varepsilon_{ij}, (\mathrm{i} = 1, \ldots, \mathrm{n};\ \mathrm{j} = \mathrm{W, S, F, L}) \quad (1)$$

Where Y_{ij} is a binary dependent variable indicating whether people prefer to take automated buses for work trip (W), shopping trip (S), family trip (F) and leisure trip (L), X_{ij} is the matrix of independent variables (i.e. social-demographic variables, attitudual variable, and travel habits) influencing commuters' behavior intention towards the automated bus ride. β_j is a vector of unknown coefficients to be estimated. ε_{ij} denote the correlated error terms which are are assumed to be drawn from a multivariate normal distribution with a mean of 0 and a variance of 1, and correlation coefficient cov [ε_{ij}] = Cov[ε_{ij}] = ρ_{ij}. If ρ_{ij} = 0, then there is no correlation between the errors. However, if q ≠ 0, then the bivariate probit is appropriate and parameter estimates in the equations will be unbiased.

4. Results

Many explanatory variables were considered for each model, including social-demographic variables (gender, age, income, car ownership), attitudinal variable, and travel habits. Table 1 shows the results of the multivariate probit model. The McFadden's $R^2$of the final model is 0.10. All correlations between the error terms are positive, which implies that if a person has a high (low) value in the distribution of unobserved effects in the first model, he or she is likely to have a high (low) value in the distribution of unobserved effects in the second model correspondingly. Specifically, as we expected, the results show that people who intent to take the automated bus ride for shopping trip may use the bus for family trip and leisure trip. Similarly, people intend to take the bus ride for family trip are found more likely to take the bus ride for leisure trip as well. As for the work trip, significant positive effects were found between work trip and family trip.

Our analysis pointed out that increasing the frequency of the bus service and the perception of safety may positively influence people taking the bus ride for work, shopping, and family trips. Furthermore, pleasant experience during the journey are found as have significant positive impact of users' concerns on their willingness to ride in automated buses for shopping and family trip. For leisure journeys, most perception and expectation variables are found have no significant effect increasing or decreasing their willingness to take the bus ride. With respect to the effects of travel habits on users' intention to commute to work by automated buses, the findings revealed that people who drive to work are less likely to take the bus ride to work, while the reverse effects are found on people who commute by train.

Considering the correlated effects across different trip purposes, error correlations between shopping, family and leisure trips are shown significantly. The results prove that people who intent to take the automated bus ride for shopping purpose are more likely to take the bus for leisure or family journey.

TABLE 1 Multivariate probit analysis of automated buses usage for different trip purposes

		Work trip		Shopping trip		Family trip		Leisure trip	
Variable		Value	S.E.	Value	S.E.	Value	S.E.	Value	S.E.
Attitudinal Variable									
Reliability									
Reliability		-.06	.08	.10	.07	.12	.08	.08	.07
Speed		.06	.11	.12	.10	.12	.10	**.16**	**.10**
Frequency		**.19**	**.07**	**.22**	**.07**	**.16**	**.07**	-.03	.07
Travel time than bus service		.11	.10	-.12	.10	**-.23**	**.10**	-.13	.10
Travel time than car		**.22**	**.10**	-.02	.09	.07	.09	-.00	.09
Safety									
Safety with No operator		**.20**	**.08**	.05	.07	.08	.07	-.06	.07
Safety with operator		.12	.08	**.16**	**.08**	**.19**	**.08**	.10	.07
Hacked		-.07	.07	.12	.07	.05	.07	-.07	.07
Informative		**-.28**	**.11**	-.06	.10	.10	.10	-.05	.10
Ride comfort									
Pleasant ride		.04	.11	**.20**	**.10**	**.17**	**.10**	.10	.10
Expectation of comfortability		.00	.10	.12	.10	.00	.10	.12	.09
Past travel mode									
Walk		-.05	.09						
Cycle		.01	.10						
Bus		-.05	.08						
Subway		.04	.09						
Train		**.15**	**.08**						
Car		**-.24**	**.09**						
Social demographic									
Gender	Male 1; Female -1	**.12**	**.07**	.04	.07	.05	.07	.04	.07
Age	Young (<35 years old) 1;								

	Old (≥35 years old) -1	**.15**	**.08**	**.27**	**.07**	**.15**	**.07**	**.15**	**.07**
Income	Low 1; High-1	-.03	.08	-.01	.07	-.05	.07	-.05	.08
Car ownership	Own cars 1;	.01	.10	-.03	.08	-.08	.08	-.04	.08
	Have no car -1								
Constant		**-1.34**	**.59**	-.71	.53	**-2.69**	**.09**	**-3.14**	**.59**
Error correlations									
ρ_{12} (work trip with shopping trip)		.09	.08						
ρ_{13} (work trip with family trip)		**.16**	**.08**						
ρ_{14} (work trip with leisure trip)		.09	.08						
ρ_{23} (shopping trip with family trip)		**. 43**	**.07**						
ρ_{24} (shopping trip with leisure trip)		**. 35**	**.07**						
ρ_{34} (family trip with leisure trip)		**. 50**	**.07**						
LL(β)		-1029.50							
LL(0)		-1138.59							
Rho-square		.10							

5. Conclusions and discussion

Despite growing body of studies show that public's expectation and perception are critical determinants of people using the automated public transport system, research on how these factors would influence people's willingness to take automated buses for different trip purposes are still limited. Thus, based on a dataset collected at Barkarbystaden, Stockholm, we examine how public's expectation and perception of reliability, safety, information provision, and comfortability towards the bus service would affect people take automated buses for different trip purposes. Moreover, as people tend to consider choose a transportation mode for more than one trip purpose, a multivariate probit model was used in this study. The unobserved error terms are allowed to be correlated across different trip purposes.

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