Behavioral Modelling of Public Transport Passengers Participating in Last-Mile Freight Delivery

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Abstract

An emerging stream of Crowd-Shipping (CS) solutions focuses on existing momentum in Public Transportation (PT) to ship viable delivery packages by PT passengers. Few studies have explored the package delivery acceptance behavior of passengers engaged in PT-based CS initiatives while passengers' behavioral intention to participate (i.e., engage) is not studied. It is requisite that newly introduced CS platforms explore their potential crowdshippers' behavior on intention to participate and set efficient marketing strategies. Given a survey data collected from 2208 PT passengers in Sydney metropolitan area, this study explores the intention of PT passengers as crowd-shippers to participate in PT-based CS initiatives, as well as prohibiting factors in way of participation.

Introduction

This study contributes to the literature on CS with PT passengers by estimating the probability of intention to participate using a binomial logit model developed using survey data collected from the Sydney metropolitan area in 2022. Results of the model can estimate the initial attractiveness of the initiative for PT passengers and be used in approximating the expected number of registered crowd-shippers. The data collected also includes the reasons for passengers rejecting the initiative, collected through an open-ended question in the survey.

Methodology

In order to model the intention of PT passengers to participate in the PT-based CS initiative, this research relies on discrete choice models based on random utility maximization (Train, 2009).

Using an inductive thematic analysis, 917 reasons (text responses) for not participating are scrutinized, and the prohibiting factors are identified and categorized. Considering demographic and socio-economic characteristics of the respondents, the study reveals to what degree passengers with different characteristics are sensitive to prohibiting factors.

Discussion

This research provides several practical insights that can assist in successfully defining, launching, and advertising a new PT-based CS initiative. As a key finding, it is observed that women, full-time employees, elderly, retirees, and low-income PT passengers hardly participate, while the youth, individuals with a positive attitude towards sustainable freight initiatives, and those who experienced working with parcel lockers would participate with a higher probability. Moreover, it is observed that factors relating to time availability/flexibility and physical health condition of passengers are much more important than the compensation level for passengers to accept to participate in PT-based CS initiatives.
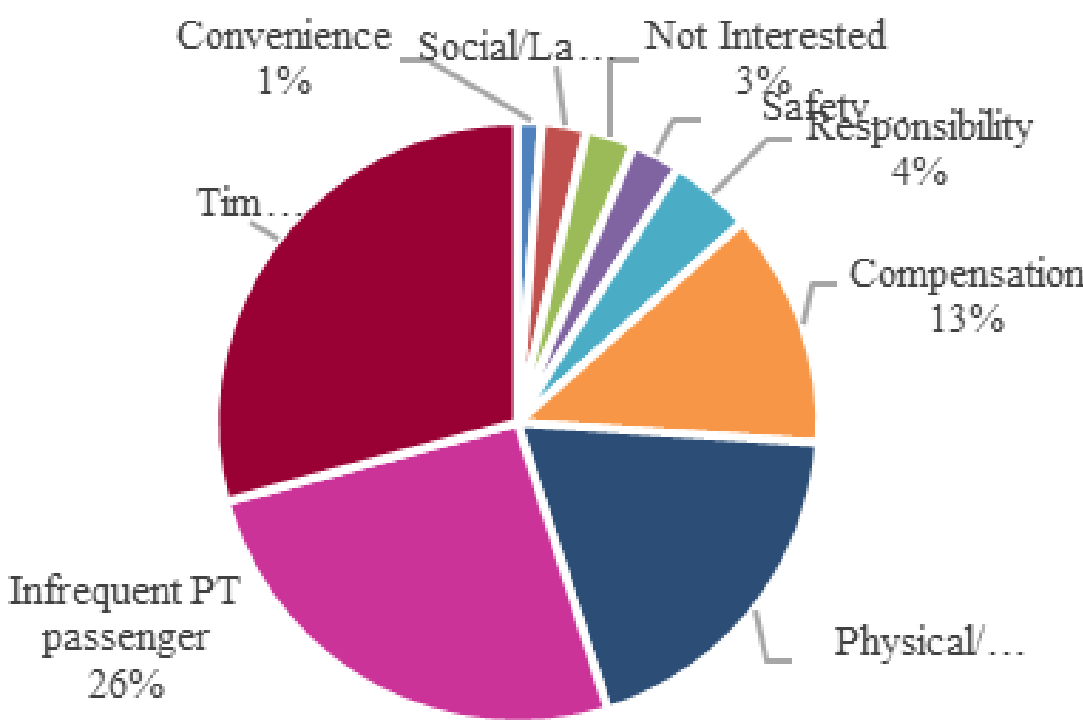
Variable name (units)	Units	Parameters estimated	Z (P>|Z|)	95% confidence interval
Female (yes:1, no:0)	1,0	-0.418**	-4.28 (0.000)	-0.610 to -0.227
Young adults (yes:1, no:0)	1,0	0.268**	2.60 (0.027)	0.066 to 0.470
Senior adults (yes:1, no:0)	1,0	-0.403**	-2.27 (0.030)	-0.751 to -0.055
High-income (yes:1, no:0)	1,0	-0.347**	-2.62 (0.014)	-0.607 to -0.870
Full-time employee (yes:1, no:0)	1,0	-0.230**	-1.89 (0.037)	-0.469 to 0.008
Retired (yes:1, no:0)	1,0	-0.527**	-2.71 (0.030)	-0.907 to -0.146
Large household size (yes:1, no:0)	1,0	0.165	1.67 (0.137)	-0.290 to 0.360
PT trip frequency per month	Continuous	-0.012**	-3.20 (0.000)	-0.201 to -0.004
Sustainable role (yes:1, no:0)	1,0	0.537**	3.95 (0.000)	0.270 to 0.804
Locker preference (yes:1, no:0)	1,0	0.793**	6.80 (0.000)	0.565 to 1.021
Locker experience (yes:1, no:0)	1,0	0.514**	4.41 (0.000)	0.286 to 0.742
Medium-volume delivery (yes:1, no:0)	1,0	-0.990**	-5.71 (0.000)	-1.328 to -0.650
High-volume delivery (yes:1, no:0)	1,0	-1.007**	-5.55 (0.002)	-1.363 to -0.652
Constant		0.486*0	2.03 (0.082)	0.016 to 0.956
Model fit statistics				
Number of observations	1589			
Log-likelihood at zero betas	-1623.37			
Log-likelihood at convergence	-1283.91			
Pseudo R^2	0.234			

Variable definition:
Female: Women
Young adults: Individuals aged less than 40
Middle-aged adults: Individuals aged between 40 to 60
Senior adults: Individuals aged more than 60
Low-income: Individuals with an income less than 30k AUD per year
Medium income: Individuals with an income between 30k AUD to 90k AUD per year
High income: Individuals with an income more than 90k AUD per year
Full-time employee: Individuals working full time
Part-time employee: Individuals working part time
Unemployed: Unemployed individuals
Retired: Individuals who are retired
Disable: Individuals with disability
Small household size: Individuals living in households with maximum 2 members
Medium household size: Individuals living in households with 3 or 4 members
Large household size: Individuals living in households more than 4 members
PT trip frequency per month: An average number of PT trips per month
Sustainable role: Individuals supporting sustainable urban freight initiatives
Locker preference: Individuals not having an opposition to contact with parcel locker facilities
Locker experience: Individuals having has working experience with parcel lockers
Low-volume delivery: Individuals having less than 5 deliveries per year
Medium-volume delivery: Individuals having between 5 to 20 deliveries per year
High-volume delivery: Individuals having more than 20 deliveries per year
Apartment dwellers: Individuals living in an apartment
House residents: Individuals living in a house

Managerial findings

Providing a large and balanced supply (i.e., crowdshippers) with demand (i.e., delivery tasks) in CS systems is of utmost importance, particularly in the initial phases of launching CS initiatives. If an oversupply or overdemand situation exists, a deadweight loss will occur which leads to market inefficiency. This study can help CS managers keep the demand and supply balanced. For example, once a surge demand situation is present, CS managers can focus on attracting PT passengers who participate with a higher probability by taking an optimal advertising strategy. For instance, young male passengers with high PT trip frequency and having experience in contacting parcel lockers can be prioritized for labor absorption. Once, CS managers decide to expand their market share and the rate of labor observation is declining, they can shift from generalized to personalized marketing strategies.

Future research

We recommend future studies extend this research by exploring the intention of other potential crowds to participate in CS initiatives in different scopes such as occasional drivers, cyclists, and passengers of ride-sourcing or ride-sharing systems. Specifically for launching PT-based CS initiatives, PT passengers' intention to participate can be modeled by advanced discrete choice models such as mixed or latent-class discrete choice methods. Moreover, exploring prohibiting factors for participation in the initiative can be collected through interview-based surveys rather than online surveys with open-ended questions. Therefore, the possibility of building richer models based on grounded theory would be attainable.