PREFERENCE HETEROGENEITY IN COMMERCIAL VEHICLE PASSENGER CHOICE: A DISCRETE CHOICE EXPERIMENT

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Abstract

The study sought to identify the knowledge of passengers about the characteristics of commercial vehicles that influence passenger's choice and makes it attractive to private car users. It therefore presents the preference estimates for various attributes that affect commercial vehicles choice, with reference to students in University of Ghana who patronize commercial vehicles from Circle bus station in Accra to Kumasi with the main objective of understanding more about the factors that influence passenger's choice of commercial vehicles. A discrete choice experiment was designed to capture the responses for estimating passenger's commercial vehicles choice for various attributes specific to vehicles in the study area, that are loading passengers simultaneously. The main model was generated using the binary probit in STATA which was further segmented according to gender. The magnitude of estimates fromthe probit model indicated that, generally, passengers prefer commercial vehicles with entertainment, very new and almost full with passengers. This was generally supported by the segmented model by gender. Also, passengers will generally trade the size and brand off for very new and commercial vehicles with reduced loading/waiting period.

Keywords: Commercial vehicles, discrete choice experiment, passengers, stated preference

Introduction

In Ghana, road transport is the predominant means of commuting, which enhances high passenger travels and carting of goods and services. It provides essential role by linking the country to others in the entire West

African sub-region. Transportation has developed rapidly in Ghanaian societies, but there is competition betweenprivately owned cars and commercial vehicles. He said a report by the World Bank shows that the competition between passenger cars and other vehicles is very keen in many countries. It indicated that the patronage of passenger cars is less than the use of other vehicles in countries like Germany and India (Afful, 2011).

Furthermore, travel needs in developing countries are largely served by public transportation systems, especially bus transportation systems. But poor quality of travel in bus transportation systems has increased, with a resulting declining trend in commercial vehicle patronage. However, policy-makers and practitioners are constantly in search of solutions for improving commercial vehicle patronage, especially in urban areas of developing countries. For this reason, it is essential to improve commercial vehicle patronage in urban areas like Accra, not only for minimizing the usage of private cars and resulting road congestion, but also to safeguard the environment for greater community benefit (Panikumar & Maitra, 2006).

In Ghana, commercial vehicles are procured by individuals through personal savings, loans from relations, or a privately or publicly arranged higher-purchase system. A properly certified and licensed commercial vehicle in Accra is operated by a professional driver who chooses a route and may apply for membership of a local branch union. On admission, the applicant's vehicle is added to the pool of vehicles operating on a particular route like the Accra to Kumasi road (Addo, 2002). Normally, queues of vehicles that are loading simultaneously are formed at the terminal of origin and passengers are at liberty to patronize their preferred commercial vehicles to their various destinations across the country.

Informal commercial bus transport companies have over the years played a major role in the Ghanaian economy. The companies have been created with the aim of achieving profit, but unfortunately, many of these informal companies have suffered major decline in performance, resulting from high operating cost, low liquidity and significant decline in patronage. Notably among the transport operators in the private sector in the 1980s was King of Kings Limited. It is obvious that there is competition as the transportation sector is not regulated like the industrialized countries and hence the need for these companies as well as individual operators to upgrade their fleet to offer quality and reliable services to passengers. However, due to lack of expertise, use of wrong type of vehicles, mismanagement and poor vehicle maintenance practices, transport operators are far from achieving their desire growth (Afful, 2011). According to Damaraju, James and Pallavi (2011), in real life situation, people reveal their preferences through choices and that the aggregate of choices constitute the

demand for goods and services, the vote for political leaders and many other phenomena of interest.

Furthermore, Afful (2011) identification of lack of expertise, the usage of wrong type of vehicles, mismanagement, among others, as the major challenges confronting transport operators in Ghana,is a clear indication that the private transport companies operate in a highly competitive environment. However, he has failed to address customer (passenger) preferences with regards to the attributes of the commercial vehicles (utilities) that attract or influence passenger's choice. In this light, the author is of the view that transport operators have to make changes to the vehicles used for commercial purposes based on utilities that influence passenger's choice in order to remain competitive, and not to only minimize the usage of private cars and resulting road congestion, but also to safe guard the environment for greater community benefit. Also, an observation by Lancaster (1966) that individuals valuation of goods depend on its composing characteristics is a basis to assert that passengers have preferences with regard to choosing a commercial vehicle from a bus station, which is determined by a range of influencing attributes. But as which of the attributes and attribute levels of the vehicles that actually influence passenger's choice have to be explored using discrete choice experiment. The main objective of this study is to understand factors that influence passengers choice of commercial vehicles that are loading simultaneously, and specificallydesign a discrete choice experiment on commercial vehicles and assess the effect of the attributes on choice; Assess the attribute/level which contribute most in determining passenger's choice of a commercial vehicle; Come out with the characteristics of commercial vehicles that is attractive to private car users and passengers; assess the trade-offs between the attribute levels; and finally determine gender differences in the choice of a commercial vehicle.

Overview of Earlier Studies and Approaches

According to Afful (2011) many studies in developing countries have focused on the quality of transportation services. To him, poor quality of services have led generally to the decline in patronage, and ushering the demise of bus operating companies. However, Thornburn Colquhoun Int. (1996) observed that travelling conditions in Ghana for passengers on most public transport services are poor; vehicles are generally old, poorly maintained, uncomfortable and normally overcrowded. The vehicles are often overloaded and in poor condition.

Beale (2004) examined the effects of replacement of a relatively modern fleet of single-decker buses with luxury double-decker buses upon patronage and modal shift. The survey data demonstrated that the new buses

increased patronage through both generated journeys and modal shift.Existing and previous users gave positive responses to the new buses and respondents who had used both the old buses and the new buses, preferred the new buses.

Also, Litman (2011) argued that passengers highly value the time spent or waiting for a vehicle than in-vehicle travel time, especially, under congested conditions. In addition, public transport competes with other modes of transport and will be used only if it can satisfy the expectations of passengers, that is, if it can offer an attractive, reliable, affordable, and safer service (Stradling, Carreno, Rye, & Noble, 2007; Currie, 2005).

Van der Waerden, Borgers, Timmermans, and Berenos (2007) used MNL logit models to examine the choice between car, bus and bicycle for different journey purposes. They argued that the cost and time attributes dominate, obtaining a seat is significant across journey purposes, whereas the type of stop only showed up in the leisure model.

Pavlyuk and Gromule (2010) in their study of a preferred transportation mode considered Riga-Daugavpils two-way journeys with three possible transport options; car, coach, and train. A nested discrete choice model was used to analyze factors that influence passenger's choice. The authors concluded that departure time had a significant influence on bus/train choice.

Alpizar and Carlsson (2001) examined mode choice between bus and car, with improved bus quality as one of the attributes. Multinomial logitand random parameter logit models were employed, the RPL performed better than the MNL. The authors concluded that the best means of attracting passengers is to decrease the bus journey time.

Also, Streeting and Barlow (2007) report an analysis of patronage growth in South East Queensland across bus, rail and ferry. The analysis focused on identifying the drivers of demand both exogenous and endogenous. It was clear that service quality attributes appear to be contributing to patronage frequency.

Several works have shown that the quality of each of the public transport service attributes is related to the importance each passenger places on it (Dell'Olio, Ibeas, & Cecin, 2010; Foote, Stuart, & Elmore-Yalch, 2001).

Many studies in developed countries have focused on the assessment of public transport level of service (Mfinanga & Ochieng, 2006; Too & Earl, 2010), while others evaluate public transport service quality from the perspective of passengers satisfaction. For example, Ji and Gao (2010) identified significant factors of satisfaction from the analysis of passenger's satisfaction with public transportation as well as accessibility factors and personal attributes with a multi-level logistic regression model.

Furthermore, Dell'Olio et al. (2010) used ordered probit model to evaluate how bus users perceive the quality of their public transport service. In addition, Stradling et al. (2007) characterized the dimensions of bus service acceptability by examining what bus passengers disliked and liked about travelling by bus in Edinburgh using factor analysis.

Eboli and Mazzula (2008) carried out a stated preference experiment to identify the importance of service quality attributes on global customer satisfaction and calculated a service quality index that provides an operationally-appealing measure of current or potential service effectiveness using a multinomial logit model. Also, Tyrinopoulos and Antoniou (2008) combined factor analysis and ordered logit model to assess the quality implications of the variability of user perceived satisfaction across operators. The analysis showed that a well-coordinated transportation environment should be the primary aim of policy makers in Athens.

Although there is much work on public transport, in other areas, there is however, paucity of information on commercial vehicle choice in the study area in particular and Ghana in general. Knowledge on factors passengers consider before they patronize a particular commercial vehicle out of several vehicles that are loading passengers simultaneously would benefit transportation planners, policy makers, and commercial vehicle operators to adopt strategies to meet passenger's needs (service). This would help to design factors passengers value before patronizing a commercial vehicle or service quality interventions that would minimize the usage of private cars to reduce road congestion while eliminating subjectivity in the decision making of transport operators in Ghana. This study aims to address this gap in knowledge and reports on the results of a discrete choice experiment based on attributes that are the characteristics of commercial vehicles in the study area

Methods and Materials

Survey Design and Data Collection Procedure

The data were collected during the month of November, 2013 by the researcher. The data were collected using face-to-face/self-administered questionnaire in the various halls of residence, which explain a large response rate for a discrete choice experiment (DCE). Respondents were sampled using systematic sampling techniques for the study. Passengers who patronize commercial vehicles from the Circle bus station to Kumasi (the second largest city in Ghana) were targeted since the study sought to analyze the hypothetical choice of a commercial vehicle by these people.Also, a sample size of 150 respondents was chosen for the study, which according to Hensher et al. (2005) a total sample of fifty (50) individuals each with 16

choice sets and fully generic parameter specification for design attributes and covariate effects might just be acceptable for choice experiment.

Stated Choice Design

Stated/discrete choice experiment has been widely used in transportation. In this study, respondents were asked to choose between pairs of hypothetical commercial vehicles resulting from the combination of both attributes and attribute levels. This method requires respondents to trade-off the different aspects of the commercial vehicles thereby identifying important attributes in the study.The characteristics or attributes contained in each description were considered to be the main factors influencing commercial vehicle choice in the Circle bus station.

Determining Attributes and Attribute Levels

According to Hensher et al. (2005) after the problem of the study has been refined, the second stage in designing a discrete choice experiment is the identification of the attributes and levels. The attributes and their levels employed for this study were established through information gathered from commercial vehicle operators and passengers in the study area, supervisors, passengers at the Madina bus station and students from University of Ghana. According to Adamowvic et al. (1998), attributes are commonly identified from prior experience, primary or secondary research. However, focus group discussion with students and local experts in bus transport was used to reduce the initial list of potential attributes to five. The attributes and their levels are shown in Table 3.1.

Table 1: Attributes and attribute levels for commercial vehicles

Attributes	Attribute Levels	Description
Remaining passenger(s) to full	More than half full Less than half full	Reduced loading/waiting period Long loading/waiting period
Brand of vehicle	Yutong Sprinter KIA	Brand names of the vehicles
Size of vehicle	Small Large	Less than 24 seater capacity More than 24 seater capacity
Entertainment	Present Absent	Video/music in vehicle No video/music in vehicle
Registration number of vehicle	09-13 A-Z	New vehicles Old vehicles

The research questionnaire was tested in a pilot with students at the department of statistics-University of Ghana.The aim of the pilot was to assess as whether the passengers understand the definition of attributes and attribute levels, cope with the number of attributes and choice sets in the questionnaire and passenger's reasons for making specific choices. After the

attributes and their levels have been determined, the experiment was designed to elicit the stated choices to be presented to the respondents. A formal statistical design (main effect fractional factorial design) was used before translating into a survey form, taking into account the condition of optimality. According to Kuhfeld (2010) a design that is optimal is both balanced and orthogonal. Using the orthogonal design facility in SPSS, the full factorial design that consists of ($2^4 * 3^1$) combination of the attributes was stripped down to eight profiles for the experiment. The eight profiles were combined to generate 28 choice pairs with different sets of alternatives to form the choice options in the survey questionnaire. Respondents were asked to compare each of the 28 choice pairs and indicate which commercial vehicle they will choose or patronize, taking into consideration the attributes and their levels. An example of one of the 28 choice sets presented in the stated preference survey is shown in Table 2.

Table 2: Choice set Which of these two commercial vehicles would you prefer to choose or patronize?

Attribute	Vehicle 1	Vehicle 2
Remaining passenger(s) to full	More than half full	Less than half full
Brand of vehicle	Yutong	Yutong
Size of vehicle	Small	Large
Entertainment	Present	Absent
Registration Number of Vehicle	09-13	A-Z
Which vehicle would you choose?	**Vehicle 1 [ ]**	**Vehicle 2 [ ]**

Source: Study questionnaire, 2013

Model Structure and Explanatory Variable Specification

The random utility models as well as the economic consumer theory, which is based on the assumption that the decision-maker has a perfect discrimination capability. However, the researcher is assumed to have incomplete information and, therefore, uncertainty must be taken into account (Ben-Akiva & Bierlaire, 1999).

The utility is modeled as:

$$U_{in} = V_{in} + \varepsilon_{in} \quad (1)$$

Where V_{in} is the deterministic term of the utility and ε_{in} is the random term, taking care of the uncertainty.The deterministic term V_{in} of each alternative is a function of the attributes of the alternative itself and the characteristics of the decision-maker.A linear in the parameters function is denoted as follows;

$$V_{in} = \sum_k \beta_k x_{ink} \quad (2)$$

Where, V_{in} = the systematic utility component of the commercial vehicle; β_k= the utility coefficient associated with attribute X_{ink} of the commercial vehicle; X_{ink} = represents a vector of explanatory variables specific to vehicle *i* and

individual n; and k = the k[th] attribute of the vehicle. The probit model employed for the study based on random utility theory was therefore stated as:

$$\Pr ob(Y = 1/X) = \Pr ob(U_{vehicle1} > U_{vehicle2}) \quad (3)$$

$$Y = \beta_o + \beta_1 M_{hf} + \beta_2 L_{hf} + \beta_3 Y_u + \beta_4 S_p + \beta_5 K + \beta_6 S + \beta_7 L + \beta_8 P + \beta_9 A + \beta_{10} N_{09-13} + \beta_{11} N_{A-Z} + \varepsilon \quad (4)$$

Where; Y = Choice; the dependent variable and equal 1 if vehicle 1 was chosen and 0, if vehicle 2 was chosen; β_i = the alternative specific constant; M_{hf} = Vehicle is more than half full; L_{hf} = Vehicle is less than half full; Y_u = Brand of vehicle (Yutong); S_p = Brand of vehicle (Sprinter); K = Brand of vehicle (KIA); S= Small vehicle; L= Large vehicle; P = Present of entertainment in vehicle; A =Absent of entertainment in vehicle; N_{09-13} = Vehicles' registration number from 2009 to 2013; N_{A-Z} = Vehicles' registration number from A to Z; ε = error term.

Model Results and Discussion

The results reveal that there is goodness-of-fit of the model from the data. The likelihood ratio chi-square of 498.41 with a p-value of 0.000 tells us that the model as a whole is statistically significant, that is, it fits significantly better than a model with no predictors. All estimated coefficients have the expected sign and are significant at the 95% confidence level and therefore have influence on the probability of choosing an alternative. However, yutong and small commercial vehicles are not significant. Respondents prefer commercial vehicles that are almost full with passengers (reduced loading/waiting period), which increase the utility of the individual and thereby increase the probability of uptake of commercial vehicles by 0.102499. In addition, commercial vehicles with entertainment and are registered within five years (very new), increase the utility of the individual and thereby increase the probability of commercial vehicles uptake by 0.504689 and 0.344877 respectively. In other words, passengers prefer commercial vehicles that are very new and having entertainment to those without. The brand of commercial vehicles which is sprinter decreases the utility associated with vehicle choice, though it is significant. Passengers will trade this attribute off.

Table 3: Overall Model Based on Total Sample

Attributes	Coefficient	Z Value	P>|Z|	[95% Conf. Interval]
Vehicle more than half full (Reduced loading/waiting period)	0.102499	3.68	0.000	0.047897 0.157100
Brand of vehicle (Yutong)	-0.014088	-0.42	0.677	-0.08032 0.052145
Brand of vehicle (Sprinter)	-0.078997	-2.04	0.041	-0.154766 -0.003228
Size of vehicle (Small)	-0.046717	-1.68	0.094	-0.101319 0.007884
Entertainment (Present)	0.504689	18.12	0.000	0.450087 0.559292
Veh. registration # (09-13)	0.344877	12.38	0.000	0.290275 0.399480
Constant	-0.425306	-7.49	0.000	-0.536670 -0.313942
Number of observations	8396			
Prob> χ^2	0.000			
Likelihood χ^2	498.41			
Rho-square	0.0428			

Segmented Model Depending on Males

The results show that commercial vehicles with reduced loading/waiting periodincrease the utility as well as the uptake probability of male passenger's commercial vehicle patronage by 0.187351 to those without. Moreover, commercial vehicles with entertainment and are registered within five years (09-13/very new) improve the utility and uptake probability associated with the choice of commercial vehicles by 0.455366 and 0.364328 respectively. Furthermore, these attributes have the same effects as those estimated in the main model. However, the size and brand of commercial vehicles will be traded off.

Table 4: Model Depending on Male Passengers

Attributes	Coefficient	Z Value	P>|Z|	[95% Conf. Interval]
Vehicle more than half full	0.187351	4.82	0.000	0.111212 0.263492
Brand of vehicle (Yutong)	-0.027693	-0.59	0.558	-0.120349 0.064962
Brand of vehicle (Sprinter)	-0.023287	-0.43	0.667	-0.129239 0.082665
Size of vehicle (Small)	0.010425	0.27	0.788	-0.065715 0.086565
Entertainment (Present)	0.455366	11.72	0.000	0.379226 0.531506
Veh. registration # (09-13)	0.364328	9.38	0.000	0.288188 0.440467
Constant	-0.489101	-6.09	0.000	-0.64642 -0.33177
Number of respondents	77			
Number of observations	4312			
Log Likelihood	-2865.762			
Rho-square	0.0412			

Segmented Model Depending on Females

The results show that commercial vehicles with entertainment (television or music) and very new, are all significant, and increase the utility associated with the choice of commercial vehicles by 0.560875 and 0.328395

respectively. These attributes also have the same effect as those estimated in the main and the segmented model by males except vehicles with reduced loading/waiting period that have no significant effect on vehicle choice. This is an indication that there is no much difference in the choice of vehicles by gender. The brand of commercial vehicles which is sprinter reduces the utility associated with vehicle choice by 0.138168, eventhough it is significant. Also, yutong commercial vehicles are insignificant. Furthermore, small commercial vehicles are significant though it reduces the utility associated with commercial vehicle choice by 0.110343. Passengers who are females will therefore trade the size and brand of vehicles off for vehicles with entertainment and very new.

Table 5: Model Depending on Female Passengers

Attributes	Coefficient	Z Value	P>|Z|	[95% Conf. Interval]	
Vehicle more than half full	0.012053	0.30	0.764	-0.066485	0.090592
Brand of vehicle (Yutong)	0.000861	0.02	0.986	-0.093998	0.095721
Brand of vehicle (Sprinter)	-0.138168	-2.50	0.013	-0.24669	-0.02964
Size of vehicle (Small)	-0.110343	-2.75	0.006	-0.188877	-0.031808
Entertainment (Present)	0.560875	14	0.000	0.482336	0.639414
Veh. registration # (09-13)	0.328395	8.2	0.000	0.249857	0.406934
Constant	-0.360465	-4.57	0.000	-0.515125	-0.205805
Number of respondents	73				
Number of observations	4084				
Log Likelihood	-2693.368				
Rho-square	0.0486				

Conclusion

The main purpose of this study was to understand more about the factors influencing passenger's choice of commercial vehicles, and makes it attractive to private car users. Discrete choice experiment and the probit model were used to capture the responses of students in University of Ghana who patronize commercial vehicles that are loading simultaneously from the Circle bus station in Accra to Kumasi. The effects of certain attributes based on the findings from the study revealed that in choosing commercial vehicles, passengers took into consideration vehicles with entertainment, very new and almost full with passengers (thus reduced loading/waiting period) before making their choices.

The most important attribute that influence passenger's choice of commercial vehicles is entertainment which has the highest coefficient among all the attributes estimated in the various models. The high preference for new commercial vehicles was in line with the study by Beale (2004) that passengers gave positive responses to the new buses, and respondents who had used both the old and new buses, preferred the new buses. Also,

passenger's preference for commercial vehicles with reduced loading/waiting period was also in line with the observation by Litman (2011) that passengers highly value the time spent or waiting for a vehicle than in-vehicle travel time. It further confirms the shortfall in public policy identified by Afful (2011) that there have been lengthy waiting times for public transport both at and between bus terminals. Furthermore, the main and the segmented model indicated that commercial vehicles with characteristics like entertainment and very new (nice internal and external appearance) are highly significant and have positive impact on vehicle choice. However, these characteristics would attract private car users or minimize the usage of private cars to ease road congestion.

Passengers will generally trade the brand and size of vehicles off for vehicles that are very new and almost full with passengers. Confirming the observation by Dell'Olio et al. (2010) and Foote et al. (2001) that the quality of each of the public transport service attributes is related to the importance each passenger places on it. Also, there is no much difference in the choice of commercial vehicles by gender.

Policy Implications

The study results indicate that passengers highly prefer commercial vehicles with entertainment; very new; and almost full with passengers (reduced loading/waiting period). Moreover, in areas where revealed data are inadequate or absent, researchers can employ the use of discrete choice experiment because of its robustness. Much attention should be given to commercial vehicles with entertainment (especially for long distance travels) as a result of the large magnitude of its estimate. Also, very new commercial vehicles should be used. Moreover, maintenance works should be performed on the vehicles (thus to make both the external and internal to appear very nice) in order to attract passengers and private car users. This will not only help to minimize the usage of private cars and resulting road congestion, but also to safeguard the environment for greater community benefit. However, any size and brand of the vehicles could be used since they will be traded off. Operators should also pay much attention to the period vehicles leave the bus station since passengers prefer commercial vehicles leaving the bus terminal early (thus, reduced loading/waiting period).

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