Analysis of Students' Travel Mode Choice Behaviour: A Case Study in Oman

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ABSTRACT

The objective of this study is to identify the key factors affecting the student's mode choice behavior in the context of Oman using the results of a questionnaire survey. A questionnaire survey was developed and conducted among students of the University of Nizwa, Oman. The total number of collected samples was 157. The binary logistic regression revealed that gender, personal car ownership, and trip distance are significant attributes in explaining the mode choice behavior of students. The increase in trip distance and female students have a negative influence on their choice of the car whereas personal car ownership has a negative impact on student's choice of university bus. The Omani students have a positive correlation with car choice behavior. The findings of this study will help in deriving appropriate transport policies considering various significant factors of the mode choice behavior of the students.

KEYWORDS: Travel behaviour, Mode choice, Private car, Public transport, Transport Satisfaction Assessment.

1   INTRODUCTION

The increase in urban population increases travel demand on the road network. Private vehicle ownership and usage are also increasing as the main travel option for most people are private cars or taxis. There is a need to develop and promote alternative transport modes such as public transport to ensure the mobility needs and social and economic development of society. The local people have recognized the importance of the public transport system, but their preference for the use of their cars is more apparent as it provides more flexibility, privacy, and freedom in traveling [1], [2]. Only 1.3% of the population uses buses, while the rest depend on private transport or taxis [2].

People prefer public transport for long-distance travel and desire large buses or trains for this purpose. Public transport is acceptable to those residents, who currently spend less than 20 OMR per month on transportation. The relationship between the use of public transport and income is

evident. Almost a quarter of residents need public transportation daily and see it as well comfortable and economical. However, hot climate, safety, females' hesitation to share rides with males, status consciousness, and addiction to cars are the major barriers to the promotion of public transportation. Belwal reports that public transport infrastructure, priority transport for working-class and females, accessible public transport services for people belonging to different socio-economic groups, awareness, and promotion, and marketing and behavior modification programs are the main elements of improvement [2].

The mode choice behavior of students differs from other segments of the travel market. The analysis of the travel behavior of university students found a significant variation in travel patterns for the students who are generally residents on campus and off-campus [3]. Those students who own a private car mostly prefer to drive, while those who do not have a car rely on other modes of travel. For example, they may travel as a passenger with friends or may take a campus bus [4]. Availability of car, trip duration, day of travel, and trip purpose are good predictors of students' mode choice [5], [6]. The level of service quality of transport modes [7], trip distance, cost and time, comfort in traveling, age, gender, and vehicle ownership are significant factors in the mode choice of students [8]–[10]. It is reported that the home-to-school distances are negatively related to daily trips occurring with public transport modes [11].

Several characteristics of travelers affect their mode choice behavior as mentioned earlier. There is a need to assess factors influencing the mode choice behavior of commuters in the social and local context of Oman. Therefore, this study aims to identify the significant factors concerning the mode choice behavior of university students. A questionnaire survey was designed and conducted with the students of the University of Nizwa (UoN) and significant factors of mode choice were identified. The remaining paper is organized in the following manner. The research methods are presented in section 2. The survey and analysis results are discussed in section 3. Conclusions and recommendations are presented in the last section.

2　RESEARCH METHODS

2.1　Data Collection

A questionnaire was designed consisting of two parts. The first part included questions related to the personal and travel characteristics of the students. The personal characteristics included age, gender, marital status, nationality, personal income, car ownership, and possession of a driving license. The travel characteristics included travel time and cost and distance of a one-way commuting trip from home to the university. The second part of the questionnaire consisted of attitudinal dimensions of service quality of buses and private cars. The selected attributes of service quality were designed using opposite adjectives and were evaluated using five-point semantic differential scales i.e., strongly, somewhat, neutral, and strongly. The semantic differential scale is also referred to as an attitudinal scale and it has compatibility with the Likert scale data. The selected attributes included slow-fast, late–punctual, risky – safe, uncomfortable – comfortable,

expensive – cheap, environment damaging – environment friendly, unreliable – reliable, unattractive – attractive, and noisy – quiet.

This survey was conducted with the students of the University of Nizwa. The questionnaires were distributed randomly to the students and collected back after their completion. Sufficient time was given to the respondents to record responses. During the survey, it was assured that the collected information is correct and reliable. Many students refused to fill out the survey citing personal, privacy, and other concerns. Therefore, a total of 157 samples were obtained.

2.2 Analysis Methods

The collected data were analyzed using component analysis and binary logistic regression. Initially, factor analyses were conducted using the principal component analysis method (PCA) and varimax rotation. The rotation of components was done to obtain interpretable results. The components were extracted for an eigenvalue greater than 1.0. The binary logistic regression was done as there were only two travel alternatives i.e., the university bus and the private car. In logistic regression, the student's use of university buses and private car represents the dependent or objective variable. The independent variables included students' socioeconomic characteristics that were coded as binary variables or nominal variables (1, 0). The extracted components of attitudinal attributes of the private car and the university bus were also introduced as the independent variable in the logistic regression.

Logit models have well-known applications in mode choice behavior such as Binary Logit (BL) model, Multinomial Logit (MNL) Model, and Nested Logit (NL) Models. The choice of a particular logit depends on the number of available travel alternatives. The logit choice model is derived through the application of the utility maximization principle where everyone chooses an alternative from a set of alternatives that maximize his utility. According to this definition, the probability of choosing alternative i by an individual n is expressed as (Eq. 1).

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_{i=1}^{j} e^{V_{ni}}} \tag{1}$$

Where:

P_{ni} = the probability that alternative *i* is chosen by individual *n*

e = Euler's number

V_{ni} = the estimate of systematic utility of alternative *i* for individual *n*

j = number of available alternatives

The systematic utility of alternative i for individual n is expressed as a linear function of explanatory variables (X_{ni}) as shown in Eq. (2). The random utility function is given in Eq. (3).

$$V_{ni} = \sum_{n} \beta_i * X_{ni} \tag{2}$$

$$U_{ni}^{j} = V_{ni}^{j} + \varepsilon_{ni}^{i} \tag{3}$$

Eq. (3), ε_{ni}^{j} is the random error that represents the deviation of systematic utility from the actual utility. This study attempts to apply a binary logit model as the data set has only two alternatives i.e., private car and university bus in the present case. Several explanatory variables were identified from the questionnaire survey and included in the logistic regression for possible correlation with the mode choice behaviour. All explanatory variables were coded purposefully as 1 or 0 and their significance was estimated.

3 ANALYSIS OF RESULTS

3.1 Descriptive Statistics of SEDs

The descriptive statistics of respondents of SEDs are shown in Table 1. About 82% of the students are Omani which is consistent with the actual number of local and expat students at the University of Nizwa. The females made up around 64% share of the sample and most of the respondents are unmarried. Around half of the students have no personal income or driving license. Almost 56% of the respondents use university buses for commuting. The cross-distribution in Figure 1 of students' responses on mode choice shows that the female, single status, and Omani students and students with no income have more preferences with the university bus. Whereas, students who are male, own a personal car, and possess a driving license to have more selection for a car while commuting to the university.
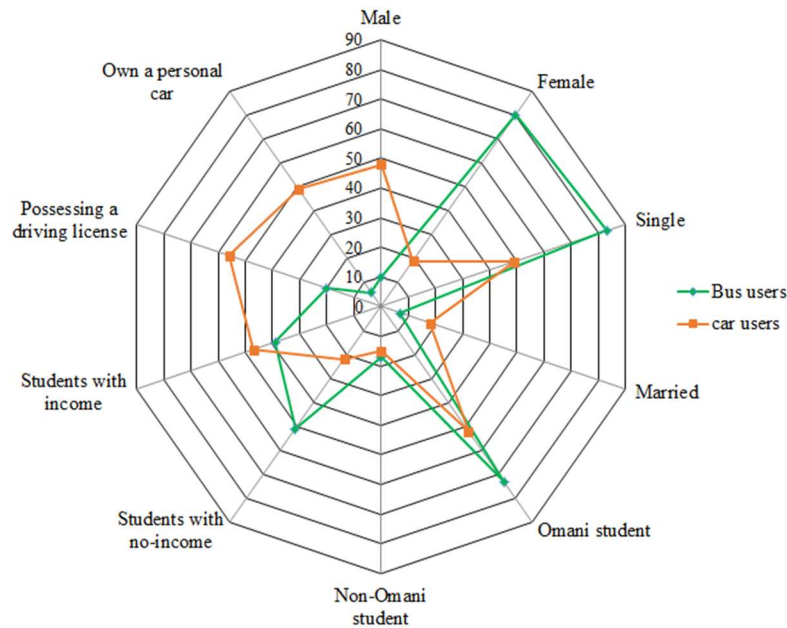
Figure 1: Cross distribution of student's mode choice preference

Table 1: Distribution of respondents' personal and travel characteristics

Characteristics	Distribution (%)
Nationality	Omani (82%), Expats (18%)
Gender	Male (36%), Female (64%)
Age (years)	Under 20 (20%), 20-25 (61%), 26-30 (12%), above 30 (7%)
Marital status	Single (83%), Married (17%)
Personal income	No income (47%), Have an income (53%)
Personal car ownership	Yes (33%), No (65%)
Driving license	Yes (49%), No (51%)
Traveling mode	Car/taxi (44%), university bus (56%)

3.2   Principal Component Analysis of Students' Attitudes

The PCA was conducted to extract the components as this method is compatible with the attitudinal data. Both component analyses resulted in three components. The components of private car service quality included service attributes (SA), attractiveness and reliability attributes (ARA), and environment and affordability attributes (EAA) as presented in Table 2. These components were named seeking the nature of associated observed variables and practice in previous studies [12], [13]. The % of variance explained by SA, ARA, and EAA are 27.391, 21.667, and 19.116, respectively. The estimated values of Cronbach's alpha are more than 0.6 which shows an acceptable level of reliability of the extracted components and internal consistency. The first component of SA included dimensions of service comfort, punctuality, safety, speed, and calmness, and the factor of ARA consisted of reliability and attractiveness attributes. The third factor of EAA is comprised of service attributes related to the environment and users' affordability. The value of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy is more than 0.6 and near 0.8 which shows that the sample is adequate and Bartlett's Test of Sphericity is also significant in extracting the components [14].

Table 3 shows the results of PCA of bus service quality dimensions. The three components are service attributes (SA), speed and punctuality attributes (SPA), and aesthetic attributes (AA). The values of % variance explained by three factors are also presented in Table 3. The values of Cronbach's alpha of all three components are more than 0.6 and the value of the Kaiser-Meyer-Olkin Measure of Sampling Adequacy is more than 0.6 and near 0.8 [14]. These values show that the sample size is adequate and extracted components are reliable. The internal consistency among respondents is also high. The first component of SA included service dimensions relate to the environment, affordability, comfort, safety, and reliability of the bus service. The SPA component

included attributes of speed and punctuality, and the AA component included attributes of service attractiveness and calmness.

Table 2: Rotated components of private car service quality

Observed variables	Mean	Components		
		SA	ARA	EAA
Uncomfortable – comfortable	3.172	0.744		
Late – punctual	3.268	0.715		
Risky – safe	3.159	0.715		
Slow – fast	3.261	0.622		
Noisy – quite	2.822	0.509		
Unattractive – attractive	2.873		0.792	
Unreliable – reliable	3.032		0.711	
Environment damaging – environment friendly	3.261			0.783
Expensive – cheap	3.229			0.765
Cronbach's alpha (α)		0.756	0.625	0.618
% of variance explained		27.391	21.667	19.116
KMO and Bartlett's Test				
Kaiser-Meyer-Olkin Measure of Sampling Adequacy				0.779
Bartlett's Test of Sphericity		Approx. Chi-Square		298.441
		Degrees of freedom (df)		36
		Significance		0.000

Note: SA: service attributes, ARA: attractiveness and reliability attributes, EAA: environment and affordability attributes

Table 3: Rotated components of bus service quality

Observed variables	Mean	Components		
		EASA	SPA	AA
Environment damaging – environment friendly	3.089	0.772		
Expensive – cheap	3.191	0.733		
Uncomfortable – comfortable	2.949	0.724		
Risky – safe	2.987	0.682		
Unreliable – reliable	2.841	0.672		
Slow – fast	3.185		0.818	
Late – punctual	3.248		0.792	
Unattractive – attractive	2.879			0.879

Noisy – quite	3.108			0.721
Cronbach's alpha (α)		0.782	0.686	0.652
% of variance explained		29.547	23.396	21.020
KMO and Bartlett's Test				
Kaiser-Meyer-Olkin Measure of Sampling Adequacy				0.769
Bartlett's Test of Sphericity		Approx. Chi-Square		317.168
		Degrees of freedom (df)		36
		Significance		0.000

Note: EASA: environment, affordability, and service attributes, SPA: speed and punctuality attributes, AA: aesthetic attributes

3.3 Logistic Analysis Regression

The student's mode choice behavior was analyzed using binary logistic regression. The explanatory variables were defined on a nominal scale i.e., 1, 0, or scale variables in SPSS. Variables specifications are presented below.

- Gender (female = 1, otherwise 0)
- Car ownership (1 if a student owns a personal car, otherwise 0)
- Nationality (1 if a student is Omani, otherwise 0)
- Trip distance (in Km)

3.4 Results of Car Choice Model

The modeling results in Table 4 show that the student's gender, possession of a driving license, personal car ownership, trip distance, nationality, and car travel cost are significant in determining their car choice behavior. Also, their perceived attitudes on service dimensions of service quality are significant in defining their preferences towards the car. The coefficient of gender as females is negative which shows that female students have a low probability to choose a private car. This is because some female students do not possess a driving license. The students who own a personal car have a high probability to choose a car as the estimate is positive. Similarly, Omani students have a high likelihood to choose a car for commuting. However, the increase in the trip distance has a negative influence on their utility to consider a car. This is true as an increase in distance increases driving load and stress which makes traveling a little difficult, especially on the home trip (university to home). The service dimensions of the private car such as comfort, safety, speed, punctuality, and calmness have a positive and significant relationship with the student's intentions to use a car. It means that the students who have positive attitudes toward these attributes of service quality would have more likelihood to use a private car.

Table 4: Regression estimates of car choice model

Explanatory variables	B	S.E.	Wald	Sig.	Exp(B)	95% C.I. for EXP(B)	
						Lower	Upper
Gender (female)	*-3.749*	0.999	14.086	*0.000*	0.024	0.003	0.167
Own a personal car	*2.625*	0.825	10.130	*0.001*	13.804	2.741	69.507
Trip distance	*-0.151*	0.044	11.839	*0.001*	0.860	0.789	0.937
Omani student	*2.290*	1.148	3.977	*0.046*	9.871	1.040	93.686
SA	*1.017*	0.390	6.820	*0.009*	0.362	0.168	0.776
ARA	0.098	0.311	.099	0.753	1.103	0.599	2.029
EAA	-0.238	0.278	.730	0.393	0.788	0.457	1.360
Constant	-0.410	0.902	.207	0.649	0.664		

	Model Summary			Hosmer and Leme show Test		
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square	Chi-square	df	Significance (p-value)
1	76.343	0.585	0.785	13.289	8	0.002

3.5 Results of Bus Choice Model

The logistic regression analysis in Table 6 shows that female students have a positive association with their likelihood to use the university bus. This relationship is highly significant. Students who own a personal car have a negative probability to use the university bus. The increase in trip distance increases the likelihood of students using the university bus. For long-distance, bus traveling is comfortable and relaxes the passengers. The Omani students have a low probability to use the university bus. The coefficients of SPA and AA factors are negative and significant with students' bus choices. The negative coefficient shows that the students who have low beliefs in speed, punctuality, and aesthetic attributes of bus service would have a low probability to choose the university bus. The goodness of fit parameters predicts the good reliability of modeling results.

Table 5: Regression estimates of bus choice model

Explanatory variables	B	S.E.	Wald	Sig.	Exp(B)	95% C.I. for EXP(B)	
						Lower	Upper
Gender (female)	***3.285***	0.791	17.233	***0.000***	26.718	5.664	126.023
Own a personal car	***-2.153***	0.748	8.277	***0.004***	0.116	0.027	0.504
Trip distance	***0.024***	0.016	2.093	***0.048***	1.024	0.992	1.058
Omani student	***-1.768***	0.953	3.440	***0.064***	0.171	0.026	1.105
EASA	-0.217	0.326	0.443	0.506	0.805	0.425	1.525
SPA	***-0.479***	0.312	2.350	***0.025***	0.620	0.336	1.143
AA	***0.766***	0.339	5.101	***0.024***	2.152	1.107	4.185
Constant	0.587	0.853	0.473	0.492	1.799		

	Model Summary			Hosmer and Leme show Test		
Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square	Chi-square	df	Significance (p-value)
1	84.780	.562	.754	9.449	8	.006

4   CONCLUSIONS

This paper evaluated the student's mode choice behavior using the results of a questionnaire survey. Logistics regression was conducted to identify the utility function between the personal and trip characteristics of students and their mode choice. This regression analysis revealed that gender, personal car ownership, and trip distance are significant in explaining the mode choice behavior of students. The increase in trip distance and female students have a negative influence on their choice of the car whereas personal car ownership has a negative impact on student's choice of the university bus. The Omani students have a positive correlation with car choice behavior. These findings implicate that students would prefer to the university for a longer trip, however, once they have a private car and possess a driving license, they may change their preferences. The female students would continue to use the bus service as long as they feel safe, comfortable, and attractive. These findings have significant implications for the transport planner in making policies related to the mode choice behavior of students.

5   ACKNOWLEDGEMENTS

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