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Modeling of Transport Mode in Libya: a Binary Logit Model for Government Transportation Encouragement

Massuod Ali Ahmed Abuhamoud, Riza Atiq O.K. Rahmat and Amiruddin Ismail

Department of Civil and Structural Engineering, Faculty of Engineering, University Kebangsaan, Malaysia, 43600 UKM Bangi, Selangor Darul Ehsan, Malaysia.

Abstract: Libya is a rich developing country which suffers the consequences of explosions in both human and motorization. This has been accompanied by a heavy toll of deaths and economic cost. Road accidents were the cause of I0% of all deaths. Therefore, this research foresee in contributing greater extra details on car users mode choice behavior to better understand the likely measures that would have to be taken to encourage greater public transport use. The survey was carried in Tripoli where there is high car ownership and use, and government bus available. To model the transport mode behavior of car use vs. government bus, binary logistic model was used to explore the factors affecting car/government bus and to predict the probability of changing from private car to government bus. The results obtained have shown that some measures have to be taken to encourage car users to use other forms of public transport. The current study is the first of its kind to explore the Libyan scenario in the matter investigated.

Key words: Libya, government travel, travel demand, legit model mode choice.

INTRODUCTION

The planet has representationally contracted as transport has developed to encounter the demands of the populous. Worldwide contribution in this enlargement has been unbalanced as the driving force for transport demand is ultimately economic growth, which in itself results in an increased need for travel. A never-ending programme of road building is not the answer (Chapman, 2007; Newbery, 2005), but subtle junction improvements, active traffic management systems and intervention in travel behaviors can significantly reduce congestion. Policies are required to encourage the shift to other transport modes. A commonly used tactic to encourage the use of public transport is to offset the affordability of car ownership with various forms of indirect taxation. This could be in the form of increased parking charges at destination or fuel tax levies. For example, congestion charging schemes in Singapore and London have resulted in a reduction in traffic congestion of 40% and 30%, respectively, offset by increased bus usage. For example, Ryley (2006) describes the dependence of young families on the motor car who would be disproportionately affected by indirect taxation. Ultimately, successful policies need to be sustainable both socially and environmentally (Headicar, 2009; Weir and McCabe, 2009).

The bus is extensively used as a mode of transport in low income areas and is often the only alternative to using a car locally. Buses are flexible and can be deployed quickly in response to changing demand and do not need specialist infrastructure as is the case for trains. A double-decker bus is a sustainable mode of transport and can replace up to 50 other motorised vehicles. Traffic and congestion are also reduced as a bus takes up a fraction of the roadspace.

Policy makers need to encourage car users, where possible, to switch to buses. The bus is the most viable form of urban transport and has a major role to play in the delivery of sustainable transport objectives. Higher levels of priority are required to encourage this modal shift. This could form part of a bigger sustainable development policy reallocating roadspace to public transport, cyclists and pedestrians, thus providing viable alternatives to the car (Marshall and Banister, 2000).

Libya is a rich developing country which suffers the consequences of explosions in both human and motorization. This has been accompanied by a heavy toll of deaths and economic cost. Road accidents were the cause of I0% of all deaths. Compared to European countries and USA, Arab Countries have a very high road accident fatality rate. In 2001, 22.3 persons, 14.8 persons, and 7.3 persons per 10.000 vehicles were killed

Corresponding Author: Massuod Ali Ahmed Abuhamoud, Department of Civil and Structural Engineering, Faculty of Engineering, University Kebangsaan, Malaysia, 43600 UKM Bangi, Selangor Darul Ehsan, Malaysia.

in Libyan, Saudi, and Qatari road traffic, respectively. Moreover, one of the major modes of personal transport in Libya is the private car, mainly because it is affordable and more dependable than the other transport available. Thus, about 73% of the registered vehicles in the country are private cars, which numbers have increased tremendously recently – from 578924 in 2001 to 1343422 in 2007. As a result, private car accidents have also increased from 10855 to 13165 (Abuhamoud and Rahmat, 2010; Mekky, 1985).

Many metropolitan areas are experiencing urgent problems associated with the increasing worldwide trend in car ownership and use that pose a serious threat to the quality of human environments on many levels (Loukopoulosa *et al*., 2005). The travel demand management in many countries, including Libya has been receiving an increasing attention for its prospective to reorganize urban transport problems. Managing urban travel demand is not only planning the transport system but also tackling the issues of traffic congestion, motor accidents and environmental pollution from the increasing use of vehicles. In the local situation, the government has always been trying to improve public transport with different approaches. Thus, there is improvement in the country's public transport, especially in the Tripoli area (Abuhamoud and Rahmat, 2010).

Therefore, this research foresee in contributing greater extra details on car users mode choice behavior to better understand the likely measures that would have to be taken to encourage greater public transport use. The urgent need for this study is to develop more accommodating models to evaluate commuter's behavior. In addition, the current traffic problems in Libya should be alleviated by encouraging the community to use public transport. However, despite assumption, there has been no authoritative identification of the real factors influencing car use.

2. Methodology:

2.1 Study Area:

The survey was carried in selected areas of Tripoli where there is high car ownership and use, and government bus available. Respondents were randomly selected based on a stratified sampling approach in order to achieve a representative sample reflecting demographic and socio-economic profiles. The demographic details, such as income, age, gender, and educational level and trip characteristics were also collected. A total of 350 respondents were questioned over two month.

The questionnaire was translated into the Arabic language through iterative forward-backward procedures by two translators with similar education, background and language proficiency and printed in both languages. The validity of studies using translated instruments may be questioned when there is a lack of attention to and/or minimal explanation of the procedures used for determining the equivalence between the primary and secondary language tool. Ensuring equivalence of a translated Arabic version of the current study questionnaire is an important prerequisite for identifying specific expressions of concepts under investigation and for cross-linguistic comparisons.

After determining the mode choice variables, and subsequent data collection and specification of the mode choice models for the two modes of transport (car and government transport), the next step was to run the models to assess how much of the travel choice behavior can be explained by the socioeconomic characteristics and trip variables, such as travel time and travel cost.

The logit function is an important part of discrete choice and logistic regression (Allison, 1999; Cox, 1972). Logit models were employed using SPSS software for regression analysis because of their ability to represent complex aspects of travel decisions by individuals by incorporating important demographic and policy-sensitive explanatory variables. They do not assume linearity in the relationships between the independent and dependent variables, and do not require the variables to be normally distributed. The logistic regression estimates the probability of a certain event occurring based on the independent variables. The logit model is represented by Equation 1 below:

$$\text{logit (Model)} = \beta_0 + \beta_1 x_{age} + \beta_2 x_{gender} + \beta_3 x_{carownership} + \beta_4 x_{travel\ time} + \beta_5 x_{education} + \beta_6 x_{travel\ cost} + \beta_7 x_{distance} + \varepsilon \quad (1)$$

where tan β_0= constant

β_i = coefficient of x_i

Statistical significance of model coefficients has been tested using Wald chi-squared test. The process of developing travel models is commonly called "calibration." Given the basic form of a travel forecasting model, such as gravity or logit model, calibration involves estimating the various constants and parameters for the model.

The coefficients are estimated by fitting the data to the model(s). The Maximum Likelihood Estimation method is the fitting technique usually used in practice. This consists of choosing values for the coefficients so as to maximize the likelihood (or probability) of the model predicting the same choices made by individuals as observed. It has been shown that the method yields estimates that have great possible accuracy.

RESULTS AND DISCUSSION

To model the transport mode behavior of car use vs. government bus, binary logistic model was used to explore the factors affecting car/government bus and to predict the probability of changing from private car to government bus. The model examined the characteristics of government bus and car trips such as travel time, travel cost, demographic and socioeconomic characteristics to determine their influence in the choice of transport mode. The dependent variable in logistic regression is usually binomial, that is, the dependent variable can take the value 1 with a probability of success q, or the value 0 with probability of failure 1-q (Allison, 1999). In the models, the dependent variable was "0" for government bus use and "1" for car use (Allison, 1999; Kleinbaum *et al*., 2007). The explanatory variables were: age, gender, times, cost and distance. These variables are continuous and nominal. A summary of the estimations from the model are presented in Tables 1. The coefficients for the explanatory variables were travel time; cost and occupation are clearly significant, while the other factors are not significant at $P > 0.05$. Logistic regression coefficients for Age, household, occupation, license, cost, distance are positive, implying that an increase in them would increase car use. On the other hand, coefficients for other independent variables are negative.

Chi-Square Omnibus tests of model coefficients give us a value of 119.101 on 14 df, significant beyond 0.001. This is a test of the null hypothesis that adding the independent variables to the model has not significantly increased our ability to predict the decisions made by our subjects. Therefore, it could be concluded our model coefficients are statistically significant. The probability $p < .000$, inferring that at least one of the population coefficients differs from zero. To assess how well the model fitted the data, Hosmer and Lemeshow's Goodness-of-Fit test statistic was calculated and a chi-square test between the observed and expected frequencies done. There was little difference between the observed and predicted values for both modes of transport as evidenced by the chi-square value not being significant. The Hosmer-Lemshow statistic evaluates the goodness-of-fit by creating 10 ordered groups of subjects and then compares the number actually in the each group (observed) to the number predicted by the logistic regression model (predicted). Thus, the test statistic is a chi-square statistic with a desirable outcome of non-significance, indicating that the model prediction does not significantly differ from the observed (Table 2).

Logistic regression allows one to predict a discrete outcome, such as group membership, from a set of variables that may be continuous, discrete, dichotomous (dummy variable), or a mix of any of these (Allison, 1999; Kleinbaum *et al*., 2007). A dummy variable is a numerical variable used in regression analysis to represent subgroups of the sample in the study (Powers and Xie, 2008). One of the most important uses of mode choice models is to predict the effects of policy measures. To promote the use of government bus, the study examined the incentives of reducing the bus travel time and cost. This was done by solving the binary logit equation for probability using a range of travel times and costs, while keeping the other variables constant (by according them their mean values (Table 2). The model was tested for its validity. The same variables (travel time, travel cost, demographic and socioeconomic) were tested for their significant in clarifying the mode choice behavior. As the same results were obtained, this verified that the model yields sound results. -2 Log likelihood, Cox & Snell R Square, Model $\chi 2$ and Nagelkerke R^2 values showed that the model use to predict the travel mode is acceptable.

In relation to behavior there is also a distinction to be made between: situations where the individual accounts for the opportunity to use travel time in making their journey planning decisions and notably in their choice of travel mode; and situations where travel time use had no bearing on the journey planning decisions, albeit that the individual might then seek to make the best use of the travel time on the chosen mode (Lyons and Urry, 2005). Drivers can be shifted to taking the public transport if the traveling time can be reduced. This finding concurs with previous findings which found that travel time for both modes are the most important determinants of mode choice. He concluded that to reduce car use during peak hours, focus should be on increasing the cost of its use and providing faster and more reliable public transport (Alpizar and Carlsson, 2003; Amador *et al*., 2005; Fosgerau *et al*., 2010; Li *et al*., 2010; Morera *et al*., 2004).

Similarly, as reported earlier, travel cost as independent variable affecting the choice of Libyan car users was unexpectedly has positive coefficient and that could be due to car users not considering travel cost of using their car as significant even though the cost of public transport is significantly smaller than the user expense of car (Sen *et al*., 2010). This also confirms the expectation that increasing the cost of driving is that likely to be an effective deterrent the car use unless a convenient alternative mode of transport is provided. Kain & Liu (1996) did an econometric analysis of the factors influencing transit ridership. Their findings implied that transit use will increase less by reducing fares than by improving the service, though both changes will reduce private car use. Road users may respond in different ways to road pricing. In the short-term, road pricing may cause people to change their route choice, departure time, travel mode, destinations or trip frequencies (Tillema *et al*., 2010). It may be surprising that interest in the beneficial effects of car use reduction, for instance, concern about the travel cost, did not seem to affect acceptance of bus usage.

In the model used in this study, demographic variables such as age and gender contributed significantly to explain the mode choice behavior. Males were more likely to use public transport than drive. It is also noted that the B for gender is negative. Since the reference group is female (dummy variable coding female =0), this implies that male is less likely to shift to public transport. Gender and travel behavior in two Arab communities were studied previously (Elias *et al*., 2008). Their statistical analyses revealed that demographic factors, such gender, affect travel mode differently for women and men. Effective policy interventions must consider these gender distinctions to best address the travel needs of individuals in communities in the Arab world. Gender analysis needs to be incorporated into all transport planning, so that gender impacts are studied and considered before project implementation. Most importantly, gender analysis challenges the traditional, neoclassical analysis which looks at households as black boxes and assumes that household behavior reflects the preferences of all its individuals, regardless of the power structures and gender relations within these household units. In this sense, gender analysis is part of a general re-orientation of transport planning away from a focus on facilitating the movement of motorized vehicles to a people-centered perspective that starts with an analysis of the basic household mobility needs.

Seventy percent of the 1.3 billion people living in poverty worldwide are women, according to the UN 1995 Human Development Report. Transport-related issues such as access to jobs, markets and social/educational facilities play an important, but underappreciated role in perpetuating women's disadvantaged position in society. While there have been an increasing number of efforts to incorporate gender perspectives especially into the health, education and agricultural sectors, much fewer attempts have been made in the transport sector. This is particularly unfortunate since transport plays such a vital role in most women's daily routines (Patters and Men'S, 1999). Relatively few studies have examined gender differences in travel behavior outside the industrialized West, let alone within the Arab world. Turner and Fouracre cite research in Brazil, which revealed that women make only a third of work trips but half of non-work trips, and research in Kenya, which revealed that women's travel is mostly local and on foot (Turner and Fouracre, 1995). In the studies from both Brazil and Kenya, women reported a higher transit mode share than men. Srinivasan found that in Chennai (formerly Madras), India, men spend more time and money on travel than women, although women walk more, make more trips, and complete more shopping tours than men (Srinivasan, 2006). Srinivasan advocates improved transit to reduce travel times to improve access to opportunities. Peters reviewed case studies from cities in India, Mali, Bangladesh, Turkmenistan, and Peru and concluded that women have less access than men to individual mechanized modes of transit ranging from bicycles to automobiles and that women who do have access to public transit are more dependent on it than men with similar access. To the best of the authors' knowledge, the only study that considered gender differences in travel behavior and that included Libyan populations is this study.

The older one gets, the more likely he is to drive, so the elderly are more likely to drive than take a bus. The difference was, however, small - the odds ratio for the young being 1.263 that for the old. This finding agrees with European results. Mackett and Ahen (2000) also found that the young drive less, being more willing and able to cycle and take the bus than the elderly. Analysis show that when an individual passes the driving exam, the pattern of travel and attitudes towards public transport changes. He or she will statistically travel less by public transport. Access to car is significant for choice of transport mode as well.

Driving licence and access to a car traditionally have been among the most significant determinants for mode choice. In the 80's, driving licence rates among young people increased. OR for license is 1.834 (C.I. 95%: 0.341-9.865), which indicate that people with driving are less likely to shift to public transport as compared to non-licensed drivers. Household and distance are positively related to travel mode. Elias (2008) stated that the number of children is a negative predictor of making at least one tour for women and is never a significant predictor for men. If young people experience an inflexible and uncomfortable public transport supply not adjusted to their needs they will aquire a driving licence and buy a car as soon as they feel that their everyday trips are too complicated with public transport.

The results obtained have shown that some measures have to be taken to encourage car users to use other forms of public transport. The current study is the first of its kind to explore the Libyan scenario in the matter investigated.

Table 1: Model coefficients

Independent Variables	B	S.E.	Sig.	Odd Ratio	95% C.I.	
					Lower	Upper
Age	0.234	0.061	0.000	1.263	1.121	1.423
gender(1)	-3.190	0.652	0.000	.041	0.011	.148
household			0.524			
household(1)	0.499	0.788	0.526	1.647	0.352	7.717
household(2)	0.688	0.606	0.256	1.989	0.607	6.522
occupation(1)	0.310	1.136	0.785	1.363	0.147	12.636
car	-0.593	0.315	0.060	.553	0.298	1.024
license(1)	0.606	0.858	0.480	1.834	0.341	9.865
times	-0.272	0.056	0.000	.762	0.682	0.850
cost	3.595	0.674	0.000	36.413	9.720	136.406
distance			0.007			
distance(1)	16.713	40192.97	10.000	1.814	0.000	.
distance(2)	0.570	1.951	0.770	1.768	0.039	80.940
distance(3)	20.726	9093.349	0.998	1.003	0.000	.
distance(4)	3.452	1.276	0.007	31.569	2.589	384.871
distance(5)	3.078	0.945	0.001	21.720	3.405	138.539
Constant	-4.795	2.240	0.032	.008		
Summary of statistics						
-2 Log likelihood	124.401					
Cox & Snell R Square	0.422					
Model $\chi 2$	74.35					
Nagelkerke R Square	0.626					

Table 2: Hosmer and Lemeshow Test

	Government transport		Car		Total
	Observed	Expected	Observed	Expected	
1	21	19.922	1	2.078	22
2	14	15.004	8	6.996	22
3	10	9.672	12	12.328	22
4	6	5.296	16	16.704	22
5	1	2.183	22	20.817	23
6	0	1.132	22	20.868	22
7	0	.504	21	20.496	21
8	0	.230	22	21.770	22
9	2	.054	20	21.946	22
10	0	.003	19	18.997	19
Chi square		df	Sig		
0.655		8	0.864		

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