

Research Article

Modeling of Intercity Travel Mode Choice Behavior for Non-Business Trips within Libya

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Abstract: This study is pioneer in investigating mode-choice behavior of inter-city traveler for non-business trips in Libya, for this we have successfully developed and validated disaggregate behavioral inter-city non-business travel mode choice model, based on a binary logit structure. Four major inter-city corridors in Libya were the source of the data required for the development of the model. Data was collected based on interviews with 576 respondents. Majority of these data (nearly two-thirds) were used for calibrating the model, whereas, the remaining data were used for validating the model. This study, which is the first of its kind in Libya, investigates the intercity traveler's mode-choice behavior for non-business trips. The proposed model elucidates car/air transport users' behavior and investigates their responses to the scenario of enhancing intercity transport. We have also investigated the prospect of car drivers shifting to air transport, based on a case of a diminution in airplane out-of-vehicle travel time (access time to airport, waiting time at airport and egress time from airport). We deem that the findings of this study will facilitate all the levels of decision-makers to sensibly allocate resources for the enhancement of air transportation.

Keywords: Binary logit model, disaggregate analysis, improved air transports, intercity mode choice behavior, modal shift

INTRODUCTION

The chaotic conditions of urban transport issues in a lot of countries, including Libya, needs immediate attention, for which the concept of travel demand management comes into helping hand. For the purpose of effectively managing demands of urban travel, it is essential to plan a suitable transport system, in addition to dealing with the issues of traffic jam, accidents and environmental pollution, as a result of overflowing number of vehicles. Understanding the urgency of addressing the scenario, the Libyan government has been trying to enhance the intercity transport with different approaches (Manssour and Rahmat, 2011, 2012; Manssour *et al.*, 2012, 2013).

Majority of the Libyan inter-city transports are dominated by automobiles, since the 1970s, however, in recent times, air traffic has also started to be a crucial part of the channels, where traffic is also heavier, to demand recurrent services. It is noteworthy that, even though bus service constitutes a small part towards the total trips, still they are considered as a significant option to cars particularly in rural areas.

According to Ortuzar and Willumsem (1994), transport mode is considered as a significant traditional model for planning transport, due to the primary role

played by public transport in policy making. In most developed countries, transport modeling is effectively employed to administer sustainable development, in terms of transport management. For the purpose of observing the behavior of travel and estimating the future demand of travel, substantial investments have been made in transport planning and policymaking. However, it is crucial that the estimations, integrates the designing of transport systems based on the following aspects:

- Global infrastructure
- Understanding the travel behavior of the local residents of
- Developing a system, which can effectively address the accommodate the future travel demands

In order to predict the preferences of travelers, quite a number of inter-city mode choice models have been developed. These models are crucial for planning, because generally, transportation systems require enormous investments (Ben-Akiva and Lerman, 1985). However, majority of these inter-city travel models, which were developed prior to the 1970's, were based on deterministic, aggregate methods of analysis.

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Therefore, these models were more descriptive, rather than causal and recognized by extensive confidence limits and therefore had large errors in predicting. They also comprise skeptical attributes of adaptability and constrained usefulness for policy evaluation. Consequently, modeling enhancements were accomplished with the escalation of behavioral-based probabilistic and disaggregate methods, which have resulted in the development of exceptional features. According to Atherton and Ben-Akiva (1976), the new models are competent enough for acquiring the causal associations among transport level of service, domestic socio-economic features and travel behavior. Consequently, they have presented a more substantial investigation of numerous transportation policy alternatives. The benefits and shortcomings of disaggregate and aggregate models have also been widely studied and documented (Watson, 1972, 1974).

The disaggregate approach are the 2nd generation of modeling strategy, which had succeeded aggregate approach (Koppelman *et al.*, 1984). Disaggregate models are capable enough of effectively forecast the behavior of an individual, in choosing a mode from various choice of available modes. The disadvantage of reduced informative power of the aggregate models based on the data aggregation has been eliminated in the disaggregate models (Kanafani, 1983), which significantly enhances the disaggregate models' prediction power. For example, Watson (1972, 1974) has developed and analyzed aggregate and disaggregate binary (rail versus car) mode choice models in the Edinburgh-Glasgow channel. The outcomes of his study has suggested that, the miscalculation in mode choice forecast for the identical specification is 12 to 15 times higher in an aggregate model, than the disaggregate model. Consequently, the utilization of disaggregate, behavioral, stochastic models in a predictive structure is considered more advantageous than the aggregate approach, due to the fact that the forecasts of disaggregate models are incredibly appealing. Eventually, a great number of researches have centered on disaggregate mode choice in the context of the inter-city mode choice behavior (Grayson, 1981; Banai-Kashani, 1984; Wilson *et al.*, 1990; Lyles and Mallick, 1990; Koppelman, 1990; Abdelwahab *et al.*, 1992; Forinash and Koppelman, 1993; Algarad, 1993; Al-Sughaiyer, 1994; Bhat, 1997; Mehndiratta and Hansen, 1997; Mandel and Rothengatter, 1997; Vovsha, 1998; Al-Ahmadi, 2006; Ashiabor *et al.*, 2007a, b; Praveen and Mallikarjuna, 2011). Of which, the studies that consist of probabilistic models have focused only on producing a particular decision, as soon as the traveler has determined to make a trip. Most of the studies have progressed from a binary logit model to a multinomial logit model and to the nested logit model. However, so far none of the studies have been conducted in Libya on the intercity mode choice behavior, therefore, this present research has focused on the development of a binary logit model, using disaggregate mode choice data and has

incorporated more socioeconomic variables, characterizing intercity travelers, for the purpose of improving our knowledge of intercity travel behavior.

MATERIALS AND METHODS

The data used in the present study has been extracted from intercity passenger research conducted in 2010, to develop travel demand models for the purpose of predicting future intercity travel and estimating changes in mode split, due to a wide range of prospective air transport service developments. We have conducted travel surveys in the passages between major cities, to gather data related to intercity travel by the means of car and aircrafts, including socio-demographic and general trip-making characteristics of the traveler and detailed information on the current trip (purpose, origin and destination cities, etc.). The collection of modes offered to passengers for their inter-city travel has been established centered on the topographical location of the trip. The degree of service data were produced for every single accessible mode and all the trips depending on the starting point/destination information of the journey.

We have obtained the data for this study by revealed and stated choices. The queries that deal with airplane users were included only in the Revealed Preference (RP) survey and pertained to demographic and socio-economic features and mode attributes. We have asked the respondents to describe their present travel situation, by answering a collection of questions. For the respondents who use cars, the questionnaire has addressed both, Revealed Preferences (RP) and Stated Preferences (SP). A lot of studies have focused on Stated Preference (SP) and Revealed Preference (RP) for intercity transport. Traditionally, logit or binary probit models have used only SP data (Hensher, 1994; Polak and Jones, 1997) or have used both, SP and RP data (Ben-Akiva and Morikawa, 1990; Bradley and Daly, 1997). In this study, the survey information included the following aspects:

- Socioeconomic aspects of individuals
- Their trip information
- Attitudes and perceptions on travel and policy measures

In the year 2010, a total of 576 respondents were interviewed in a period of three months for the purpose of collecting the data, of which two-thirds of was used for calibrating the model and the remaining part was used for model validation. The revealed and stated preferences survey was designed to fulfill the needs for the development of an inter-city mode choice behavior model and to examine the main aspects, which impact the selection of intercity travel mode.

Libya get a lot of foreign inter-city tourists and the most common languages among tourists are Arabic and English. For that reason, we have designed bi-lingual the questionnaires (Arabic and English). Furthermore,

two sets of questionnaires were used for two modes of transports such as, private car and airplane for non-business trips. We have conducted the survey in airport terminals and natural journey break points, such as, service areas and petrol stations located between the cities. However, proper care was taken so that the survey process does not create any sort of traffic jam.

We have conducted the study in all main cities in Libya, due to the existence of huge number of cars, accessibility of inter-city public transport, airports and the adequate reflection of travelers. Especially, we have arbitrarily selected respondents from Tripoli, Benghazi, Sirt, Sabha and Al-Kufrah, depending on a stratified sampling technique, to accomplish a representative sample, which demonstrates demographic and socio-economic information. Therefore due to the reasons mentioned above, these cities are envisioned to be an exceptional case study, which represents Libya.

Nevertheless, it is worth to mention that, it is essential to test the questionnaires with actual respondents, for the purpose of ensuring their usefulness. For this reason, we have conducted a pilot study preceding the formal data collection, this pilot test was carried out to check items used in the main survey instrument. We have meticulously reviewed the random samples of 100 observations collected from intercity drivers during the course of this study. The outcomes of the pilot test has revealed that, some questions ought to be removed from the questionnaire, because the respondents had either ignored them or answered them incorrectly and also we realized that, few other questions have to be modified or rewritten. Therefore, the questionnaire was amended based on the pilot test and was used for collecting the actual data for this study. For this we have randomly selected the respondents based on a stratified sampling approach, to acquire a reflective sample, which demonstrates demographic and socioeconomic information.

The logit function is a vital component of discrete choice and logistic regression (Allison, 1999; Cox, 1972). Logit models were employed by using SPSS software version 20 and R Statistical Software version 2.15.2, for regression analysis, due to their capability to signify the intricate features of travel decisions of individuals, by integrating significant demographic and policy-sensitive explanatory variables. They never presume linearity in the associations between the independent and dependent variables and tend not to need the variables being typically distributed. The possibility of the occurrence of a specific event, depending on the independent variables, will be estimated by logistic regression.

The mode choice models play a critical role in many transport applications. A discrete choice model is a mathematical function, which predicts an individual's choice, based on utility or relative attractiveness (Ben-Akiva and Lerman, 1985). According to the aim of this study, the binary logit model under discrete choice methods is analytically convenient and suitable

modeling method. For the binary models, i and j are the two alternatives in the choice set of each individual:

$$U_{in} = V_{in} + \varepsilon_{in}$$

$$U_{jn} = V_{jn} + \varepsilon_{jn}$$

Hence,

$$P_{in} = \text{Prob} [U_{in} \geq U_{jn}]$$

$$= \text{Prob} [V_{in} + \varepsilon_{in} \geq V_{jn} + \varepsilon_{jn}]$$

$$= \text{Prob} [V_{in} - V_{jn} \geq \varepsilon_{jn} - \varepsilon_{in}]$$

$$= \text{Prob} [V_{in} - V_{jn} \geq \varepsilon_n], \varepsilon_n = (\varepsilon_{jn} - \varepsilon_{in})$$

The probability that individual n chooses alternative i (P_{in}) as proposed by Ben-Akiva and Lerman (1985) is as follows:

$$P_{in} = \frac{1}{1 + e^{-V_n}} = \frac{e^{V_{in}}}{e^{V_{in}} + e^{V_{jn}}}$$

where,

- P_{in} = The probability that individual n chooses alternative i
- V_{in} = The utility of alternative mode i to individual $n = (X_i, S_n)$
- X_i = A row vector of characteristics of alternative mode i
- S_n = A row vector of socioeconomic characteristics of individual i

The probability that an individual will choose the airplane can be written as:

$$P_{airplane} = \frac{e^{V_{in}}}{e^{V_{in}} + e^{V_{jn}}} = \frac{e^{V_{airplane}}}{e^{V_{airplane}} + e^{V_{car}}} = \frac{e^{\beta X_{airplane}}}{e^{\beta X_{airplane}} + e^{\beta X_{car}}}$$

where,

- $P_{airplane}$ = The probability that individual n chooses the airplane

$$V_{car} = \beta_0 + \beta_{1car} X_{age car} + \beta_2 X_{G car} + \beta_3 X_{N car} + \beta_4 X_{EL car} + \beta_5 X_{HINC car} + \beta_6 X_{HCOSHP car} + \beta_7 X_{FT car} + \beta_9 X_{DIST car} + \beta_{10} X_{TTC car} = (\text{Fuel cost} + \text{oil cost} + \text{parking fees}) + \beta_{11} X_{IVTT car} + \beta_{12} X_{OOVTT car} = (\text{time at rest areas \& gas stations}) + \beta_{13} X_{DOS car} + \beta_{14} X_{PRIV car} + \beta_{15} X_{CONV car} + \beta_{16} X_{COMF car} + \beta_{17} X_{RELIAB car} + \beta_{18} X_{SAFE car} + \beta_{19} X_{WETHC car} + \varepsilon_i$$

$$V_{air} = \beta_0 + \beta_1 X_{age air} + \beta_2 X_{G air} + \beta_3 X_{N air} + \beta_4 X_{EL air} + \beta_5 X_{HINC air} + \beta_6 X_{HCOSHP air} + \beta_7 X_{FT air} + \beta_9 X_{DIST air} + \beta_9 X_{AEDISTA air} + \beta_{10} X_{TTC air} = (\text{LHTC} + \text{ACESC} + \text{EGRSC}) + \beta_{11} X_{IVTT air} + \beta_{12} X_{OOVTT air} = (\text{ACEST} + \text{WAITT} + \text{EGRST}) +$$

$$\beta_{13} X_{\text{DOS air}} + \beta_{14} X_{\text{PRIV air}} + \beta_{15} X_{\text{CONV air}} + \beta_{16} X_{\text{COMF air}} + \beta_{17} X_{\text{RELIAB air}} + \beta_{18} X_{\text{SAFE air}} + \beta_{19} X_{\text{WETHC air}} + \varepsilon_i$$

where,

- G : Gender
- N : Nationality
- EL : Educational level
- HINC : The household monthly income in Libyan dinar
- HCOSHP : The household car ownership
- FT : The family trip
- DIST : The distance of travel in kilometers
- AEDISTA : The access/egress distance to airports in kilometers
- TTC : Total travel cost = for airplane is the sum of - Line Hole Travel Cost (LHTC) + Access Cost (ACESC) to airports + Egress Cost (EGRSC) from airports terminals to final destination - and for private car is the sum of fuel cost + oil cost + parking fees in Libyan Dinar (LYD)
- IVTT : In-vehicle travel time in hours
- OOVTT : Out-of-vehicle travel time in hours for airplane, which is the sum of - Access Time (ACEST) to airports + Waiting Time (WAITT) at airports + Egress Time (EGRST) from airports terminals to final destination - and for private car is the time at rest areas and gasoline stations
- DOS : The duration of stay at destination
- PRIV : Privacy
- CONV : Convenience
- COMF : Comfort
- RELIAB : Reliability
- SAFE : Safety
- WETHC : Weather conditions, (β_0) is constant and $\beta_1, \beta_2, \beta_3 \dots \beta_{19}$ are the coefficients of variables x_i

According to earlier studies, the data required for indicating, calibrating and examining transferability can be categorized as:

- Socioeconomic variables
- Degree of service or supply variables
- Data about the trip

A number of these variables are qualitative, whilst others are quantitative. However, it is not possible to predetermine the variables, which appropriately depict the behavior driver, during model calibration, until the impact of the other variables is examined in the initial modeling stage. A few of the models tested have revealed inadequate statistical goodness-of-fit and/or weird signs, consequently they all were invalidated. For instance, some models have generated a very good fit, however had a unproductive indicators in the variable total travel time. Precisely, the ideas applied to shift from one option to another are:

- Minimizing of variables with trivial coefficients
- Minimizing variables with “inappropriate” signs

We have developed a binary logit model for intercity non-business trips for two options, such as, airplane and car, for the purpose of assessing the application of these travel modes and determining the factors, which would impact car users to switch from traveling by car to selecting airplane. In this model, the dependent variable has been set to “1”, if the commuters’ traveled by airplane and “0” for using car (Allison, 1999; Kleinbaum *et al.*, 2007). Right after the variables with trivial coefficients were removed from the model, the informative variables were gender, nationality, monthly income of family, out-of-vehicle travel time and family trip, duration of stay at destination, car ownership, comfort and weather conditions. Some of the explanatory variables such as, age, household monthly income and gender were categorized. For instance, the income was categorized as, <LYD 300, LYD 30-400, LYD 40-500, LYD 50-600, LYD 60-700 and >701 (1 US Dollar = LYD 1.27) and gender was categorized as 1 for male and 0 for female. Age was categorized as, <20, 21-30, 3-40, 4-50, 5-60 and >60. A Duration of Stay (DOS) variable was measured on an ordinal scale from one to four (1 = one-3 days, 2 = 4-7 days, 3 = 7-30 days and 4 = more than 30 days).

The coefficients are approximated by fitting the data to the model (s). The maximum likelihood estimation technique is a widely employed fitting approach, which includes the selection of values for the coefficients, to optimize the probability, which the model will estimate similar to the possibilities produced by the observed individuals. Moreover, the method produces extremely precise estimations.

After completion of the calibration process, the credibility of the succeeding models was tested, by employing the calibrated models, to estimate model-split for data, other than that used for model calibration; we have used 120 observations for validating non-business trips model. The survey data gathered was bifurcated, of which the first part was used for model calibration, whereas the other part was used for validating the model. The validation of models was carried out by comparing the observed options and the estimated option, by employing the calibrated models.

RESULTS AND DISCUSSION

In this present study, some specific variables are estimated to impact behavior of travelers, when they are exposed to various transportation modes. A number of the variables (e.g., travel cost and travel time) identified in the literature, are significant, whereas other variables are proposed exclusively to address this research problem.

The Table 1 summarizes the estimates from the binary logit model for non-business trips by car vs. aircraft. A number of variables, found in earlier studies,

Table 1: Estimations from the binary mode-choice model (car versus airplane) for non-business trips

Variable code	B	S.E.	Sig.	Odd ratio	95% C.I.	
					Lower	Upper
N	4.179	1.367	0.002	65.294	4.481	951.438
Age	2.121	0.636	0.001	8.341	2.396	29.040
EL	4.643	1.219	0.000	103.808	9.514	1132.605
HINC	-3.023	0.655	0.000	0.049	0.013	0.176
HCOSHP	1.290	0.308	0.000	3.632	1.987	6.637
DOS	-0.189	0.418	0.004	0.916	0.816	1.002
AEDISTA	-0.401	0.097	0.000	0.670	0.553	0.811
OOVTT	-0.145	0.029	0.000	0.865	0.817	0.916
FT	-2.907	0.842	0.001	0.055	0.010	0.285
TTC	0.006	0.003	0.047	1.006	0.999	1.012
COMF	2.343	0.581	0.000	10.413	3.332	32.538
WETHC	-3.581	0.743	0.000	0.028	0.006	0.120
Constant	23.629	5.413	0.000	1.827E10		
Summary of statistics						
(-2) log likelihood						110.314
Model chi-square						340.204
Cox and Snell's R ²						0.664
Nagelkerke value						0.885
Number of observations						335
Explanation of variables included in the selected model						
N	= Nationality			AEDISTA	= Access/egress distance from/to airports	
Age	= Age			HINC	= Household monthly income in (LYD)	
EL	= Education level			HCOSHP	= Household car ownership	
FT	= Family trip			DOS	= Duration of stay at destination	
COMF	= Comfort			OOVTT	= Out-of-vehicle travel time (hour)	
WETHC	= Weather conditions			TTC	= Total travel cost	

have been attempted in the course of the calibration process. Some of the models, which were tested have demonstrated inadequate statistical goodness-of-fit and/or unproductive signs and hence were denied. Among all the model specifications tested, the most acceptable model for inter-city non-business trips is that presented in Table 1. A number of other variables have been employed in the course of the calibration process; however these studies are not presented here due to space constraints. All the variables presented in Table 1 have considerable parameter estimates and logical signs.

In the model, a demographic variable such as age has been identified to substantially explain the choice of mode of transports, where the elders prefer cars to aircraft. The variation is that, the probability ratio for the young being 8.341 as against the old. These outcomes confirms with European results. Mackett and Ahen (2000) have also identified that, the younger generation drive less, where they prefer to take public transport, rather than the elderly.

The Nationality (N) variable has showed a difference in travel behavior for intercity mode choice between Libyan and non-Libyan citizens. The coefficient of nationality has significantly affects the choice of the traveler for non-business trips. The probability of choosing the airplane by Europeans and other Arabs is greater, because Nationality (N) has a positive coefficient.

The Household Income (HINC) coefficients for the airplane were negative; consequently, the increase in their incomes would decrease their choice of airplane, use, where household with higher incomes and more vehicles per capita, might less probably use airplane, than to take a car. This outcome is in line with Reid

et al. (2004). Kumar and Mallikarjuna (2011) and Proussaloglou included income in their models. Kumar *et al.* (2004) have also included age, gender, education and profession coefficients. Socioeconomic factors can impact the sensitivity of travelers towards travel time and cost. For example, Ashiabor *et al.* (2007a, b) have found that, high-income travelers are less sensitive to travel cost and they are more likely to cars for intercity travels.

As expected the Out-of-Vehicle Time (OOVTT) variable had negative coefficients, which is statistically crucial towards the choice of the air mode. This indicates that, the probability of choosing the air mode decreases, when the out-of-vehicle time to total travel time increases. In other words, other variables being equal as the travelers' out-of-vehicle time increases, the probability of switching to the private car mode increases significantly. The in-vehicle travel time with respect to choice of the air mode was not significant, because airplane in-vehicle travel time is short and fixed, as against car. Therefore, the out-of-vehicle travel time (access, egress and wait time) is more time-consuming than in-vehicle travel time. This result confirms with the spontaneous expectation, where the travelers consider that, the time spent in waiting for travel services, as more annoying, than the time spent on travelling.

A number of studies have agreed that, out-of-vehicle time (access, egress and waiting time) are more time-consuming than line-haul time. Their estimates range from 1.5 times to 10 times as onerous. Algarad (1993) has found that, the travelers put more value on the out-of-vehicle time than the in-vehicle time. Furthermore Hensher (1997) has assumed that, access and egress time to be approximately valued at 1.5 times

in-vehicle time and considered this as a “generally accepted ratio.” Stopher *et al.* (1999) have obtained ratio of in-vehicle to access time, they have identified a ratio to be between a low of 2 and a high of 10. Forinash and Koppelman (1993) have estimated the ratio of out-of-vehicle time to in-vehicle time, where the out-of-vehicle time is four times onerous as the in-vehicle time.

Travelers are found to be very sensitive to out-of-vehicle time and among various types of out-of-vehicle time, the waiting time is the most onerous factor, to users who prefer aircraft. In practice, the rule of thumb is that, waiting time is valued twice as against the in-vehicle time for non-business trips. This rule of thumb (or slightly higher values of waiting time) is supported by several studies reviewed by Wardman *et al.* (2001), while the relative value of waiting and in-vehicle time varies by conditions (MVA Consultancy *et al.*, 1987; Bruzelius, 1979; Transport and Road Research Laboratory, 1980). The perceived waiting time a traveler can be much more time-consuming, than his actual waiting time (Moreau, 1992; Hess *et al.*, 2005). Nevertheless, travelers perceive less amount of waiting time, when they feel less stressed, due to the information on expected waiting time (Evans, 2004). The value of waiting time also varies if the people are forced to wait, or decide to wait.

Access/egress service of airports directly affect mode choice decisions. Access/Egress Distance from/to Airports (AEDISTA) variable is expected to have negative coefficients, which are statistically significant with respect to choice of the air mode. This indicates that, the probability of choosing the air mode decreases, as airports access/egress distance increases. The people residing near to an intercity transport terminal are more likely to choose those modes operating from the terminal; and people located far away from the terminal, may use other modes.

Beimborn (1968) has developed a general model, to investigate the degree, to which local access or terminal locations affect the choice of an intercity mode. He has exercised his model to analyze travel between Washington, DC and Philadelphia. Nevertheless it had been already shown by Beimborn that, accessibility to intercity line-haul termini has a significant influence on modal choice behavior, Leake and Underwood (1977) have proposed an intercity terminal access modal choice model. This was undertaken as part of a detailed analysis of the bi-modal choice between air and rail in Great Britain. Later, Lunsford and Gosling (1994) have reviewed the most important airport choice and airport ground access mode choice models to that date. They have also identified that, travel time does not provide a comprehensive representation of ground access quality at an airport. Moreover, in his airport choice models (Harvey, 1988) has included ground access quality with a variable that represented the expected utility, from his ground access mode choice model. Spear (1984) has recommended that, models should be calibrated with

data on passenger awareness of ground access modes. This would facilitate researchers to determine, how better marketing could increase ridership.

Generally, cost is regarded as one of the main factors affecting intercity mode choice. The total cost of traveling by automobile primarily includes the price of fuel, oil and parking fees, whereas, the total cost of traveling by air is represented by the fares paid for each included access and egress cost for these modes. Total travel cost as independent variable affects the choice of Libyan car users, which unexpectedly has positive coefficient, due to the fact that, car users do not consider travel cost of using their car, as significant, even though the cost of air transport is significantly smaller than the user expense of car (Sen *et al.*, 2010). There is no justification for the minor role of total travel cost variable, except that, most of the non-business travelers go for recreation, so that, they might consider the transportation costs to be trivial, compared with other expenses. This also confirms the expectation that, increasing the cost of driving is likely to be an effective deterrent of the use of car, unless a convenient alternative mode of transport is provided. Kain and Zhi (1996) have conducted an econometric analysis of the factors influencing transit ridership. Their findings have implied that, transit use will increase less by reducing fares than by improving the service, even 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 the acceptance of air transport usage. Litman (2004), Hanly and Dargay (1999) and Goodwin (1992) have focused more on municipal transit systems, rather than intercity travel. Normally, increase in fares, has a negative impact on ridership, but the response is generally found to be somewhat unrealistic. Studies show that, commuters tend to be less responsive to changes in travel costs, than leisure travelers.

The size of the Family that Travels (FT) variable was used to determine, if the members of the group that travel together, are related. The size of the family and the age of the family members traveling between cities, often reflects the actual cost of the trip. The number of family members traveling together (family trip) is significant in influencing the car users' mode-choice behavior. The probability of selecting the airplane decreases, as the family size increases, because the variable family trip coefficient has a negative sign. Family travelers are expected to choose the private car mode, for at least two reasons. First, the private car mode is superior to air, in terms of travel privacy. Second, for a family trip, travel party size is more likely to be larger than two and because travel costs are usually paid by the head of the family, the use of an economical mode is expected. Algarad (1993) and Al-

Ahmadi (2006) have conducted a study in Saudi Arabia; they have found that, the size of the family traveling together, had statistical significance on intercity mode choice behavior. The size of the travel party is also an important variable, which is commonly ignored in mode-choice studies (Miller, 2004). As the size of the travel party increases, the automobile becomes more cost effective.

The Education Level (EL) is statistically significant in explaining the mode-choice behavior. The positive coefficient sign implies that, people with higher education level are more likely to use air transport for their non-business travel.

The coefficient of Household Car Ownership (HCOSHP) in the model is significant; if the traveler has no cars, the likelihood of selecting airplane increases, based on the positive coefficient of car ownership. Car ownership of the household is also a major factor that determines the choice of the mode of transport. Additionally, if the household have one car, the use of a car for intercity trips usually means that, the car will be used for a long time period. Thus, the car will be unavailable for other household members during that time, in this situation the traveler prefers to choose airplane. The results from the survey have indicated that, an increase in car ownership in the household is likely to decrease the resistance to a mode change. Resistance to switching was found to be higher among respondents, whose household vehicle ownership is one, whereas, respondents from households that owned two to three or more vehicles and are less resistant to the mode change (Riza, 2004):

Model:

$$\ln \frac{P}{1-P} = 23.629 + 4.179 (N) + 2.121 (Age) + 4.643 (EL) - 3.023 (HINC) + 1.290 (HCOSHP) + 1.189 (DOS) - 0.401 (AEDISTA) - 0.145 (OOVTT) + 0.006 (TTC) - 2.907 (FT) + 2.343 (COMF) - 3.581 (WETHC)$$

Perceptual variables were introduced during the calibration to investigate the effect of incorporating these variables on the mode choice behavior of the traveler. The perceptions of mode comfort have

significantly affected the choice of the traveler for non-business trips. Liu and Li (2004) have noted that, factors, such as, comfort/convenience, security/safety and reliability may affect mode choice, but observed that, only a few studies have analyzed these factors, due to data limitations and modeling difficulties. Liu and Li (2004) have developed a mode choice model, which includes safety and reliability. Kumar *et al.* (2004) have included comfort in their model.

The preference rankings of alternatives and perception indicators (such as, comfort, convenience and reliability, etc.) had been considered and the preference index computed from the estimation using the multinomial logit model (Algers *et al.*, 1975; Manheim, 1979; Neveu *et al.*, 1979; Al-Ahmadi, 1989; Al-Sughaiyer, 1994; Byung *et al.*, 1995). The results have showed that, most parameters had the correct signs and the goodness-of-fit measure of the model with the preference index, was significantly better than that of the model without it. It was confirmed that, preference rankings and perception indicators had a large effect on travel choice behavior. A study by Algers *et al.* (1975) have emphasized variables related to comfort and convenience that are measured by variables, such as, waiting time, the number of transfers and seat availability (Guo and Wilson, 2004).

The weather conditions have influenced the intercity travel mode choice behavior; the Weather (WETHC) variable is found to be significant and negatively affects the choice of the air mode. This could be due to fact that the intercity travelers like to travel by their car in summer, because the weather, especially, hot and humid summer does not encourage the travelers to use air transport, because of the long waiting time at airports, sometimes the waiting time will exceed more than three hours. Moreover, the poor quality of service at waiting lounges of airports and the absence of air conditioners and also the poor quality and lack of public transportation at Libyan cities.

The influence of weather conditions on individual intercity travel behavior had received comparatively less attention than urban travel. Some studies have specifically focused on the impact of weather on urban mode choice decisions under normal and unexpected travel conditions (Khattak and De Palma, 1996). The

Table 2: Hosmer and Lemeshow test for the (car versus airplane) model

		Airplane		Car		Total
		Observed	Expected	Observed	Expected	
Step 1	1	0	0.000	33	33.000	33
	2	0	0.000	33	33.000	33
	3	0	0.001	33	32.999	33
	4	0	0.007	32	31.993	32
	5	0	0.105	33	32.895	33
	6	9	8.329	25	25.671	34
	7	33	33.561	1	0.439	34
	8	33	32.997	0	0.003	33
	9	34	34.000	0	0.000	34
	10	32	32.000	0	0.000	32
Chi-square			df		Sig.	
0.912			8		0.999	

study has indicated that, adverse weather causes changes in mode choice, route choice and departure time of automobile commuters. De Palma and Rochat (1999) have conducted a similar survey among Geneva commuters and have found a similar pattern as Khattak and De Palma (1996). Adverse weather leads to changes in mode choice, route choice and departure time, with the latter being the most important. Aaheim and Hauge (2005) have used micro-level information on individual transport behavior in Bergen (Norway), to study the impact of weather conditions on mode choice decisions at an individual level, using a quintal response model. They have observed that, increases in precipitation and wind, have increased the likelihood of the use of public transportation, as compared to walking and biking. However, their analysis has showed that, weather conditions did not induce a switch between public and private transport.

In terms of the explanatory power of the model, the two R-squared values indicate the model's strong explanatory power. Table 1, shows that, the model for non-business trips has a Nagelkerke value of 0.885, indicating that, it can explain 89% of the variations in the dependent variable, whereas, the Cox and Snell value can explain 67% of the variations. -2 Log likelihood, Cox and Snell R Square and Nagelkerke R² values showed that, the model use to predict the travel mode is acceptable.

Chi-square omnibus tests of model coefficients have given the value of 340.204 on 12 df, significant beyond 0.000. This is a test of the null hypothesis, which states that, addition of the independent variables to the model, does not significantly increase its ability to predict the decisions made by the study subjects. Therefore, the coefficients of the present model are statistically significant. With probability $p < 0.000$, at least one of the population coefficients differs from zero.

To assess how well the model fitted the data, the Hosmer and Lemeshow's goodness-of-fit test statistics was calculated and the chi-square test for the significance of the relationship between the observed and expected frequencies was run. We have found slight differences between the observed and the predicted values for both modes of transport, as evidenced by the significant chi-square value.

The Hosmer-Lemshow statistics has evaluated the goodness-of-fit, by creating 10 ordered groups of subjects and comparing the number in each group (observed), with the number predicted by the logistic regression model (predicted). Thus, the test statistics is the chi-square statistics with a desirable outcome of non-significance, indicating that, the model predictions did not significantly differ from the observations (Table 2).

The observed and predicted values were very close, indicating the good fit of the models (Fig. 1 and 2). The classification matrices for the predicted versus observed outcome have showed that, the model for non-business trips have correctly classified 98.4% of the car cases

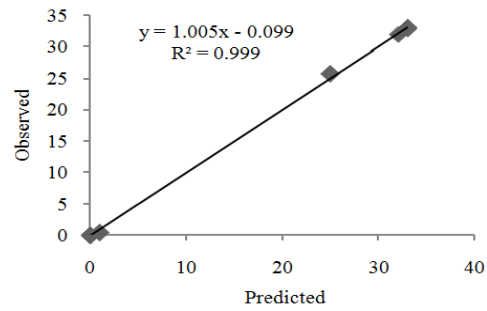


Fig. 1: Relationship between predicted and observed car (business trips) model

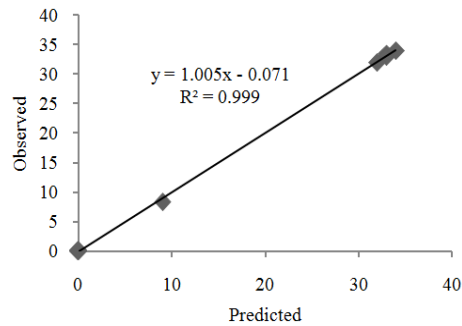


Fig. 2: Relationships between predicted and observed airplane (business trips) model

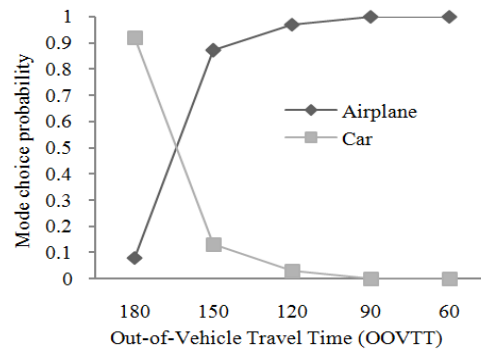


Fig. 3: Effect of reducing airplane out-of-vehicle travel time on car/airplane use for non-business trips

and 97.9% of the airplane users. The predictions were 98.2% accurate.

Probability prediction: One of the most important uses of the mode choice models is to predict the effects of policy measures. To promote the use of public transport, therefore, this study has examined the incentives of reducing the airplane out-of-vehicle travel time. This process was done by solving the binary logit equation by the R Statistical Software program for the probability, using a range of out-of-vehicle travel times (access time to airport, waiting time at airport and egress time from airport) while keeping the other variables constant (by assigning them with their mean values). The mode-choice probabilities for reducing the

airplane out-of-vehicle travel time were for a one-way trip. The modes share probabilities, categorized by various levels of out-of-vehicle travel time, as shown in Fig. 3. The mode-choice probabilities ranged from 91% likelihood of car use with the current airplane out-of-vehicle travel time per trip (180 min), to 2% likelihood of car use, with a reduction in the airplane out-of-vehicle travel time per trip (60 min). At the same time, the probability of airplane choice has increased from 9% with the current airplane out-of-vehicle travel time of 180 min, to 98% with the 60 min reduction in the airplane out-of-vehicle travel time for airplane travel for non-business trips:

$$P = \frac{1}{1 + \text{EXP} (23.629 + 4.179 (N) + 2.121 (\text{Age}) + 4.643 (\text{EL}) - 3.023 (\text{HINC}) + 1.290 (\text{HCOSHP}) + 1.189 (\text{DOS}) - 0.401 (\text{AEDISTA}) - 0.145 (\text{OOVTT}) + 0.006 (\text{TTC}) - 2.907 (\text{FT}) + 2.343 (\text{COMF}) - 3.581 (\text{WETHC}))}$$

where,

P : Probability that the intercity travelers choose airplane

CONCLUSION

This study had investigated the choice behavior of travelers between two modes of transport such as, car and airplane and had determined the trade-offs gained by travelers in making their choice. Preferences for the two modes were compared to determine the important reasons behind the choice of a particular mode and the circumstances that had prompted travelers to opt from the use of their cars for intercity transport. This study, which is the first of its kind in Libya, has investigated the mode-choice behavior for non-business trips by the intercity traveler. The general approach to calibrate the intercity mode-choice behavior model for non-business trips using private car and airplane in Libya was successfully built and validated. This model indicated that, age, traveler nationality, education level, household income, number of cars owned by the family, size of the family that travel together, duration of stay at destination, access/egress distance to/from airports, out-of-vehicle travel time and mode characteristics (comfort and weather conditions) played a role in the decisions related, to intercity travel mode choices for non-business trips in Libya. The coefficient estimates all possessed the expected signs and were statistically significant (at 5% level). Moreover, the most effective means of encouraging a switch from car to a safer mode of intercity transport is by, reducing the airplane out-of-vehicle travel time (access time to airport, waiting time at airport and egress time from airport). Precisely, this research has proven the hypothesis that; car is the premier mode of transport, due to it is a convenient and comfortable way to travel for large family and the poor service of air transport.

The explanatory power of the mode has been indicated by the two R-Square values. The factors included in the model account for 89% of the variation for the Nagelkerke, while Cox and Snell had achieved 67%. The overall accuracy of the prediction model was 95.4. Mcfadden (1979) has noted that, the values of 0.2 to 0.4 for R² represent an excellent fit, whereas, the values of R² in this study, are always greater than 0.8 for model. -2 Log likelihood, Cox and Snell R Square and Nagelkerke R² values had showed that, the model used to predict the travel mode is acceptable. Ultimately this model will be helpful in the intercity travel demand analysis for the Libyan local Airlines and the Ministry of Transportation and Communication. It might also help the government and public transportation agencies and private carriers to make marginal decisions and prevent under- or over-design of their facilities.

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