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Captivity to car use in Saudi Arabia: A Mixed logit model analysis

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Abstract
A shortcoming with regard to current mode choice models in developing countries includes for example, the role of subjective factors in mode choice, which could vary significantly from developed countries; this is an issue which is not well understood. Captivity effects and the reluctance of personal vehicle users to use other travel modes remain to be better understood for demand forecasting applications. In specific, it is well known that only men are allowed to drive in Saudi Arabia. However, the state of captivity to the private car has not been investigated. This paper investigates captivity to the private car in Saudi Arabia. Survey questionnaires were designed for data collection in Tabuk city of Saudi Arabia. Data has been collected on a number of characteristics including information relating to current travel modes and patterns, characteristics and opinions and ratings of alternative travel modes in relation to a number of different criteria. Also, personal data which included age, marital status and family positioning have also been collected. In total 1200 surveys were distributed throughout the city of Tabuk.
From the investigations carried out in this study it has been observed that although almost all males have access to the private car, captivity is still a significant issue in the country. In this case, the captivity is in the context of lack of alternatives and confinement to a fewer number of modes. Results show that 66% of all male respondents' males choose "drive only" option which means that they are completely dependent on the car as the mode of travel, while about 16% of total male respondents in the sample using two different modes to travel to work" represent. The rest of male respondents have reported that they use three or more options to travel to their work. Modelling of captivity in terms of male travel in Saudi Arabia has also been investigated. Results show that income, number of private cars in the household and as well as costs of filling petrol have impacts on the choice of mode of travel for male members of the Saudi family. Further work is definitely required in this area.
Keywords: Car-captivity, travel behaviour, mode choice, Saudi Arabia.

I. Introduction

Mode choice models play an important role in supporting transportation planning decisions, transport policies and the cities and have been extensively investigated by several researchers. Travel choice decisions may vary considerably between developed and developing countries because of the difference in vehicle ownership levels, mobility needs, travel, and activity characteristics. In particular, several context-specific features of travel and mode choice behaviour in developing countries (e.g., predominance of two wheelers, captivity, lower value of time) remain to be understood [1]. In developing countries however, there is a growing interest in a better understanding of how people make their travel decisions in order to facilitate the

planning and design of transport policies to reduce congestion, improve the environment and the level of service of travel [1]. Travel choice studies which are carried out in developed countries could provide guidance and a useful source of information for those involved with transportation engineering and planning in developing countries. However, in most cases, there are major cultural differences between developing and developed countries, which are not catered for in those studies in developed countries. In this paper, a further investigation of mode choice for work trips in Tabuk city in Saudi Arabia is presented.

In Saudi Arabia, there is a huge phenomena of car users who are captives to the car. This is mainly because SA (Saudi Arabia), which has the largest reserves of petroleum in the world, has witnessed

rapid socio-economic transformation, and thus has helped to improve the status of travel by car due to cheap oil prices.The recent and past travel patterns show that the growing mobility needs and simultaneous reduction in public transportation use will no doubt lead to increases in congestion and worsening air quality. To meet the growing mobility needs on such a massive scale, several cities are considering various types of policies to manage the demand for travel which are appropriate to travel and traffic conditions for each city [1].

Saudi Arabia is an Islamic kingdom where most Saudis practice Islamic religion and this doctrine's religious beliefs are reflected in all aspects of Saudi public life, including social and economic development ([2], [3] &[4]).. From a travel point of view women are not allowed to self drive traditionally, in spite of their increased involvement in Saudi work force. That makes them captive riders. [5]have investigated gender differences in the context of travel choices and behaviour in Tabuk city of Saudi Arabia. The male travellers however, have an increased access to the car. There have been increasing claims that "*The males use only car as a travel option",* so in this paper, this claim has also been investigated.

A shortcoming with regard to current mode choice models in developing countries includes for example, the role of subjective factors in mode choice, which could vary significantly from developed countries; this is an issue which is not well understood. Captivity effects and the reluctance of personal vehicle users to use other travel modes remain to be better understood for demand forecasting applications. In addition, three strong assumptions are often made in mode choice analysis practiced in developing countries. Firstly, the choice set is usually assumed to be fixed and pre-specified for all users (this is relaxed partially by including variables such as vehicle availability). Secondly, it is often assumed that the coefficients of independent variables affecting mode choice utility are the same across different user groups. And lastly, the utility specification is assumed to belinearly related to the independent variables in most of the applications. Given the wide variability in socio demographic characteristics and vehicle ownership in developing countries, these assumptions are unlikely to hold in practice. Because of these limitations, there is a

substantial discrepancy between actual and projected ridership levels in some public transport facilities [1]. The aim of this paper is to investigate and report on results on the characteristics of car users in Saudi Arabia as a main mode of travel to work and characteristics of the users. Captivity to the car is also investigated and analysed in terms of socio economic characteristics, characteristics of the transport system and those of the journey.

The specific objectives of the paper are:
1. Investigate a number of socioeconomic characteristics of the "captive" travellers in comparison with those of "choosers" riders.
2. Investigate the proportion of captive riders for various modes, and their travel characteristics within Tabuk city in Saudi Arabia.
3. Investigate the differences in attitudes and perceptions between captive and choice travellers.

This paper consists of six parts, firstly the background of the paper and its goal and the concept of captivity are described. The second part is a literature review of captivity and captivity modelling, the third part describes the methodology, the general characteristics and historical developments of travel in Saudi Arabia and Tabuk, the data collection, fourth part contains the analysis of the characteristics of captive travellers in Tabuk, choice and captive. The fifth part compares the results of the models and finally, a summary of the research conclusions is presented.

II. Literature review of captivity

Miskeenet al. [6] used a calibrated Multinomial Logit Model for intercity trips to examine the national-level intercity transportation in Libya using nationwide revealed preferences (RP) and stated preferences (SP) survey. The model was developed to examine deference purposes of intercity trips (work, social and recreational) and model used for prediction based on the maximum likelihood method [4]. The final sample size consisted of 1300 interviews were obtained from all major intercity corridors in Libya for model development. About two-thirds of this data was used for model calibration, and the remaining parts were used for model validation. The intercity travel mode-choice model was successfully calibrated and validated. The outcomes indicated that, the overall model is effective and yields higher precision

of estimation. The proposed model by [6] is beneficial, due to the fact that, it is receptive to a lot of variables, and can be employed to determine the impact of modifications in the numerous characteristics on the need for various travel modes. Estimations of the model are useful to planners to estimate market shares for various modes and determine the impact of unique policy modifications on the need for intercity travel.

Khanet al. [7] reported a statistical framework to analyse the degree of mode captivity in a multi-modal travel environment to find its influence on the forecasted travel behaviour. They conducted computer-based stated preference (SP) surveys in Southern Redland Shire, Queensland, presenting the respondents with eight randomly generated SP mode choice games. Based on these responses, an individual was determined to be a mode captive or mode choice user. The set of mode captive users was further split into car captive and public transport captive users. From the result they found approximately 60% were determined to be car captive users; i.e. not perceiving to switch to any travelling alternative of car, shown to them in the SP survey. Nested logit models were then estimated, using the mode choice data only, for four trip purposes of work, shopping, education and other trips. The trip purposes were further categorised on the basis of two trip lengths (regional and local trips) resulting in the estimation of eight unique mode choice models to forecast the mode shares of the targeted population. The model specification developed for the mode choice model comprised the hypothetical travelling alternatives to car, namely bus on bus way, walk on walkway and cycle to cycleway. The bus on bus way mode further associated a set of five transit access modes of feeder bus, walking and cycling to bus way, park and ride, and kiss and ride.

Degree of car captivity in the travel behaviour of the region, were analysed by multinomial logistic regression equations, based on the three socio-demographic characteristics of household size, number of vehicles per household and age-group of the individuals, along with the level-of-service parameter of trip lengthusing Logistic regression by software SPSS 15.0. They determined the significant parameters influencing the three possible outcomes of an individual; being a mode chooser, car captive or PT captive user for each trip purpose. Their analysis showed that the attribute of number of vehicles per household served as the driving determinant for the traveller type outcome of an individual for each trip purpose.The likelihood of the traveller being a mode chooser or PT captive user was found to reduce substantially for each trip purpose with a unit increase in the number of vehicles in the household. They also tested various probability functions with varying values of parameters, in order to observe the possible changes in the outcomes of traveller type.

Choice set generation has received considerable attention in the realm of route choice behaviour, where the number of possible alternatives can virtually number to infinity. Notable among these studies is the implicit availability and perception (IAP) model developed by [8], which penalises the utility of an alternative based on its perceived availability. [9]proposed an ideologically similar model form where the utility of an alternative is specified as a continuous probability density function with one or two mass points, the mass points allowing for an alternative to be either extremely unattractive or entirely dominant. [10]for instance, presented a specification in which the individual is either captive to an alternative or is free to choose from the full choice set according to a Multinomial Logit (MNL) model; they called this the "dogit" model [11].

However none of the above addresses the typical complex captive condition of travel which exist in Tabuk city of Saudi Arabia due to strict cultural norms and cheapest oil price. Therefore the study has been undertaken using the following approach.

III.   Survey design and Data collection
Situated in north-western Saudi Arabia, Tabuk is the provincial capital and headquarters of the Governor of the Tabuk region, local councils and branches of various governmental departments. It is the northern gateway to the Kingdom, close to the Jordanian border. It is the largest city in North Western Saudi Arabia and is mainly a military town. It has a population of 441,351 (2004 data) and is spread over an area of 104,000 square kilometres.

Survey questionnaires were designed for data collection in Tabuk city of Saudi Arabia.The survey questionnaire as a whole comprised of five separate sections which included the information such as current travel modes and patterns with some characteristics of modes, opinions on alternate modes of transport and ratings of these modes in relation to

a number of different criteria and personal data which included age, marital status and family positioning along with others. For further details of survey structure see[4]. In total 1200 surveys were distributed throughout the city of Tabuk.

A total of 515 completed surveys were returned which gave an overall response rate of 42.9 % for the study as a whole. Questionnaires were distributed in different sectors in order to cover all workplaces in Tabuk. This includes: Health services (Hospitals, Health care centres, Military's hospital), Educational services (Boys' Schools, Girls' schools, University of Tabuk, Prince Fahad bin Sultan University), Military sector (King Faisal Airbase, King Abdulaziz Military City), Security Sector (Police, Traffic Department, Border Guard, Civil Defence), Private sector (Banks, Consultants, Saudi Electricity Company, Saudi Telecom Company), Tabuk Municipality and Water Authority.

IV.   Descriptive analysis

Al-Atawi and Saleh[5]report on the socio economic factors from the data collected and their effect on the choice of mode of transport. The results show that cultural and gender factors are fundamental. In this paper, the aim is to further investigate the factors which lead to the choice of mode of travel, the extent of captivity of the private car and the potential of other modes in travel to work trips. It should be mentioned here that in Saudi Arabia only male members of the family have access to car driving while female members are not allowed todrive. They have to be driven by a male member of the family, use a contracted driver, private driver or a hired driver. Therefore, the female travellers are completely captive in terms of driving a car. The rest of the analysis in this paper is based on the modes used by male travellers to work trips and their reported mode of travel for these trips.

The householdsurvey data has been assessed and analysed using a number of statistical software. The preliminary analysis of the data show that just over 50% of the survey respondents were male (55.1%) while the rest are female. From a total 233 males respondent, about 45.2 % of them specified that they have access to a private car and have valid driving licences. When asked about the main mode to travel to work 66% of male respondents reported that they use the car on daily basis or at least 4-5 times a week as the main travel option. Another 16% reported they

have a choice of one of two possible modes of travel. Another 10% of male respondents reported that they have a choice of two other modes as well as the private car to consider for the journey to work.

The rest of the male population of the sample reported as choices of modes of travel than the reported above. From the results, it seems that bus, taxi and other combinations have not shown significance in the modes chosen for male member. For further discussions of the results see [4]. For the respondents who show that they use other modes of travel than the private car, car sharing was the most popular option. About 15% of all male respondents expressed that they use informal car sharing as their mode of travel to work. In addition, for those male respondents who reported that they use more than one option to travel to work, the private car and the informal car sharing were the most popular options there.

Income data, family position, having a driving license and mode of travel were also collected and analysed. From the results with respect to family position, it was seen that 91.4 % of family heads indicted that they hold a licence and 98.9 % of wives indicated that they did not hold a licence. 87.5 % and 71.1 % of eldest sons and sons respectively indicated that they held a driving licence while 84.1 % of daughters indicated that they did not hold a licence.

It was also seen that 69.4 % of those individuals, whom indicated that their income was below 4000 SAR did not hold a valid driving licence, while 58.5 % of those in the 4000-8000 SAR income bracket indicated that they hold a valid driving licence. For the 8001-12000 and 12001-18000 SAR income brackets it was seen that 71.9 % and 61.7 % of the respondents for these income brackets held valid driving licences. In the 18001-25000 SAR wage bracket, it was seen that 56.5 % of the respondents indicated that they did not hold a driving licence while likewise in the 25001-30000 SAR bracket it was seen that 60 % of the respondents did not hold a valid licence. For those whom indicated that they had an income greater than 30000 SAR it was seen that 53.8 % of these did not hold a driving licence either.

With regard to work place for the male respondents, statistics show that the highest response rate was from individuals in education whom drove to work.

This accounted for 19.8% of all male responses to the questionnaire. The second most popular

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combination was also seen to be from individuals in the education sector indicating that they used an informal car share at some stage during the working week.

V.   Investigation of captivity of car use

In this section, we investigate captivity of male work travellers to the car. Firstly,by analysing the perceived valuations of relevant attributes of the sub-sample of those being males and use the cars as their mode to travel to work (see for example [1] for a similar approach); then secondly by modelling the level of captivity of those males who travel to work by cars using mixed logit analysis.

5.1 Investigation of the perceived valuations of relevant attributes for captivity

In this section, the key factors considered to have an impact on captivity include: comfort, convenience, environment, flexibility, reliability, safety and cost. Table 1 shows the average value assigned by each subject to each of these attributes. It should be noted here that these values were reported regardless of whether or not the respondent use the mode. From the Table1, it appears that the means of the values assigned to each attribute are similar amongst captive individuals and non-captives. The lack of a clear difference in this case is clear; that is Captive subjects have preferences identical to non-captives.

Table1: Perceived average valuations of relevant attributes

Attributes	CAPTIVITY			
	0 (non captive)		1 (captive male)	
	Mean	Count	Mean	Count
Comfort	0.12	114	0.13	223
Convenience	0.11	114	0.11	223
Environment	0.09	114	0.10	223
Flexibility	0.11	114	0.11	223
Reliability	0.12	114	0.12	223
Safety	0.13	114	0.12	223
Cost	0.13	114	0.11	223
Time_	0.12	114	0.13	223
Total	0.95	114	0.95	223

Then respondents were asked about the importance of the different attributes to the choice of mode of travel. Table 2 shows that the average relative valuation of the different attributes which affect the choice of mode of travel varies between the captives and non-captives from 12% (for the travel cost) to 30% (for environmental impacts). In other words, referring to the mode of transport actually used, captive subjects tend to value some attributes higher than non-captives (assign a value higher than average). These attributes include environmental impacts, comfort, flexibility and travel time. Travel costs showed the least value in terms of its perceived importance between captives and non-captives as cheaper oil price in the region for captive male drive. For non captive driver travel time was most important attributes for mode choice.

Table 2: Importance of different criteria to the choice of mode of travel

Criteria	Valuation of attribute for captivity				
	0 (Non captive)	1 (Captive Male)	% difference	Chi-square statistic	p-value
Comfort	3.456	4.404	27%	90.208	.000*
Environmental	2.772	3.614	30%	60.987	.000*
Flexibility	3.272	4.040	23%	77.719	.000*
Reliability	3.509	4.251	21%	78.808	.000*
Travel Cost	3.544	3.969	12%	46.826	.000*
Travel Time	3.570	4.349	22%	79.827	.000*
* The Chi-square statistic is significant at the .05 level.					
Degrees of freedom	5				

In summary, the above investigation shows that *Captive* subjects are not characterised for having special preferences compared with the sample average (table 2); and they are in average significantly more satisfied than the sample with regard to comfort, environment impact, flexibility, reliability, transport costs and travel times.

5.2 Modelling Captivity

The analysis of the data collected as a result of the questionnaires has been modelled using a mixed logit model. The details of this model and the results achieved shall now be discussed.The formulation of the mixed logit model begins by specifying a function that determines traveller choice, it is written as (see also [12], [13] and [14]) equation 1:

$$U_{jt} = \acute{\beta}_t X_{jt} + \varepsilon_{jt}$$ -------------------- *Equation (1)*

where U_{jt} is the propensity function that determines the probability of discrete choice option j for an individual t ; X_{jt} is a vector of observed variables such as traveller attributes, travelling characteristics etc, the alternatives, socio-economic characteristics of the respondent and descriptors of the decision context and choice task itself (eg task complexity in stated choice experiments) in choice situation t; β_t and ε_{jt} are not observed by the analyst and are treated as stochastic influences. Within a logit context we impose the condition that ε_{jt} is independent and identically distributed (iid) extreme value type.

β_t is a vector of parameters associated with X_{jt} ; and ε_{jt} is error term. Instead of assuming that β_t does not vary over observations as in the standard logit formulation, the mixed logit model has β_n as a vector of estimable parameters for discrete outcome n, which varies across the observed individuals. The variation is with density $f(\beta\theta)$, where θ is a vector of parameters of the density distribution. In most applications, mixed models specify the density f to be continuously distributed, such as normal, log-normal (which restricts the impact of the estimated parameter to be strictly positive or negative), triangular and uniform function (see [14] for a thorough discussion on the selection of the distribution of the random parameters).

The mixed logit model can be estimated by two different ways, although both will lead to the same results. The first way, known as random parameter specification, involves specifying each β_t associated with an attribute of an alternative as having both a mean and a standard deviation (i.e. it is treated as a random parameter instead of a fixed parameter). The second way, known as the error components approach, treats the unobserved information as a separate error component in the random component. Since the standard deviation of a random parameter is essentially an additional error component, the estimation outcome is identical [14].

The presence of a standard deviation of a beta parameter accommodates the presence of preference heterogeneity in the sampled population. This is often referred to as unobserved heterogeneity. While one might handle this heterogeneity through data segmentation (eg a different models for each trip length range) and/or attribute segmentation (eg separate betas for different trip length ranges), the challenge of these segmentation strategies is in picking the right segmentation criteria and range cut-offs and indeed being confident that one has accounted for the unobserved heterogeneity by observed effects. A random parameter representation of preference heterogeneity is more general; however such a specification carries a challenge in that these parameters have a distribution that is unknown. Selecting such a distribution has plenty of empirical challenges (see below). As shown below the concern that one might not know the location of each individual's preferences on the distribution can be accommodated by retrieving individual-specific preferences by deriving the individual's conditional distribution based (within-sample) on their choices (ie prior knowledge)

After model estimation, there are many outputs for interpretation. An early warning – parameter estimates typically obtained from a random parameter or error components specification should not be interpreted as stand-alone parameters but must be assessed jointly with other linked parameter estimates. For example, the mean parameter estimate for travel time, its associated heterogeneity in mean parameter (eg. for trip length) and the standard deviation parameter estimate for travel time represent the marginal utility of travel time associated with a specific alternative and individual.

Maximum likelihood estimation of mixed logit models is computationally cumbersome as a result of the required numerical integration of the logit formula over the distribution of the random and unobserved parameters[13]. Therefore, the parameter vector is estimated by maximising the simulated log-likelihood function. Random draws and Halton draws

have been typically employed in literature, of which the latter has been reported (see for instance, [13]) to provide a more efficient distribution of draws for numerical integration and involve far fewer draws to achieve convergence. Halton sequences that are more generally used in existing empirical studies are thus adopted in the present case study.

In this case, the dependent variable takes a value "1"for those captive male subjects (223) who always drive to work and "Zero" is the value assigned to other subjects. Figure 1below shows the percentages of males drivers in terms of mode captivity. From the figure, those choosing "drive only", "using two different modes to travel to work", "using three different modes to travel to work during a typical week", and "others".

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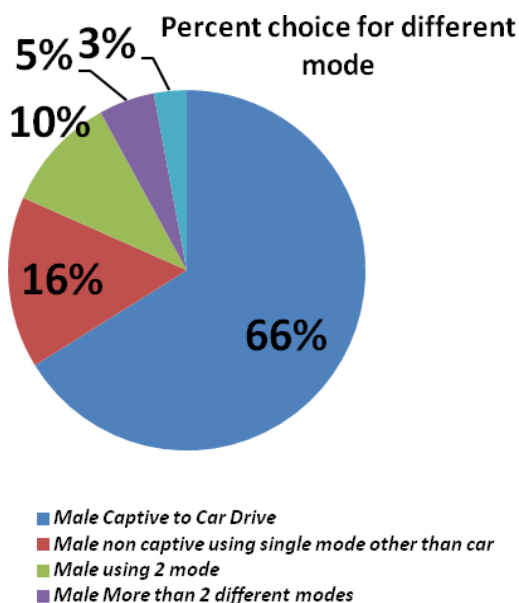

Figure 1: Percentage of male travellers and mode captivity

5.3 Modelling Captivity using mixed logit model

The present study estimates the mixed logit model to explore the effects of various characteristics which affect captivity of the mode of transport. In this research, the respondent was asked to report on the mode chosen, the reasons for the choice by him/herself as well as reporting on other household and travel characterises. The responses taken from each member of the family on behaviour of other members of his/her family could not be assumed to be independent and hence the errors of each respondent's responses are correlated. Therefore, a mixed logit specification could be more appropriate than other typical models such as logit/probit models. Moreover, the un-measured variables could result in unobserved heterogeneity, and therefore the mixed logit model would seem to be a more appropriate model to use.

Table 3 presents the model estimation results for the mixed logit model. For determining whether a mixing distribution is appropriate for specific variables within a mixed logit model, we compare when the estimated standard error for each random parameter is significantly different from zero. The parameter whose standard error is found to be significantly different from zero is assumed to be random across the observations. The highest likelihood was obtained with the uniform distribution hypothesis.

The Mixed Logit Model –as shown in Table 3 shows that the captivity of car is positively correlated with "salary level" of members of family while negatively correlated with the "number of cars in household" and "cost to fill the petrol". This is logically acceptable since as expected individuals with highest income level would be more likely to be captives to their cars and not showing interest in using other modes of travel. On the other hand as the number of vehicles in the household increases, it seems that it is more likely that an individual would be more willing to share a journey with other members of the family as a form or car sharing for example. When the perceived costs to fill the petrol are high, it was found that travellers' captivity to the car is lowered. There has been a negative relationship between captivity and costs of filling petrol. Moreover, the variable reflecting "How often you fill petrol in your car" was seen to be randomly distributed with a uniform distribution which is unlikely to be independent of systematic components and random component variances are unlikely to be constant between or within individuals, time periods and locations[15].

Table 3: Mixed logit model estimation results for captive driver

Variable	Parameter estimate	Standard Error	t- statistics	P-value
Fixed Parameters				
Constant	-0.952	0.516	-1.844	0.065
Indicator variable for How many cars does your Household have	-0.603	0.213	-2.829	0.005
Indicator variable for How much (approximately) does it cost you to fill your car	-0.051	0.021	-2.420	0.016
Indicator variable for What is your salary and in which level (1-7)	0.588	0.224	2.629	0.009
Random Effect Parameter				
Indicator variable for how often do you fill the petrol	1.332	0.558	2.388	0.017
Standard deviations of parameter distributions	1.490	0.684	2.178	0.029
Summary Statistics				
Number of Observations:337(Observation with Dep=0		(non captive) 114 and Observation with		
Dep=1 (Captivity to drive) 223case)				
Restricted log-likelihood (Constant only): -234.2837				
Log likelihood at convergence:-167.9520				

VI.   Conclusions

Mode choice models play an important role in supporting transportation planning decisions and have been extensively investigated by several researchers. Unlike in developed countries, fewer mode choice studies have been reported in developing countries. Travel choice decisions may vary considerably between developed and developing countries because of the difference in vehicle ownership levels, mobility needs, travel, and activity characteristics. In particular, several context-specific features of travel and mode choice behaviour in developing countries (e.g., predominance of two wheelers, captivity, lower value of time) remain to be understood[1]. Therefore the main goal of this paper is to investigate the issue of car captivity in Saudi Arabia and characteristic of captive travellers and its modelling in Tabuk city in Saudi Arabia, using data from a household survey which was carried out as part of the study.

While it is well recognised that Saudi women have been characterised and criticised of being captives in terms of their access to driving private cars, this study found that men also can be captives in terms of their total dependence on the private car.

Results show that almost all Saudi males have access to the private car. However, in this case, there is captivity in the context of lack of alternatives and confinement to a fewer number of modes.

From the results, those males choosing "drive only" represent 66% of all respondents; these are assumed to be captive to the car. Those who are "using two different modes to travel to work" represent 16% of total male respondents in the sample. Another 10% of then stated that they are "using three different modes to travel to work during a typical week" while 8% reported different opinions.

The results obtained from the Mixed Logit Model show that the captivity of car is positively correlated with "salary level" of members of family while negatively correlated with the "number of cars in household" and "cost to fill the petrol". This is logically acceptable since as expected individuals with highest income level would be more likely to be captives to their cars and not showing interest in using other modes of travel. On the other hand as the number of vehicles in the household increases, it seems that it is more likely that an individual would be more willing to share a journey with other members of the family as a form or car sharing for

example. When the perceived costs to fill the petrol are high, it was found that travellers' captivity to the car is lowered. There has been a negative relationship between captivity and costs of filling petrol. Moreover, the variable reflecting "How often you fill petrol in your car" was seen to be randomly distributed with a uniform distribution which is unlikely to be independent of systematic components and random component variances are unlikely to be constant between or within individuals, time periods and locations.Further work on captivity in Saudi Arabia and future policies to increase the options available to travellers to choose from and reduce captivity is urgently needed.

References

[1] Srinivasan, K., Lakshmi, B. P. V., Ramadurai, G., Muthuram, V., Srinivasan, S., (2007) Determinants of Changes in Mobility and Travel Patterns in Developing Countries: Case Study of Chennai, India. *Journal of Transportation Research Record: Journal of the Transportation Research Board, pp.* 42-52.

[2] Aldossary, A., While, A. and Barriball, L. 2008. Health care & nursing in Saudi Arabia. *International Nursing Review, 55*, pp.125-128.

[3] Littlewood and Yousuf., 2000 Primary health cares for Saudi Arabia: Applying global aspect for all, locally. *Journal of advance nursing (32),* pp. 675-681.

[4] AL-ATAWIA AND SALEH W (2014): TRAVEL BEHAVIOUR IN SAUDI ARABIA AND THE ROLE OF SOCIAL FACTORS, TRANSPORT, PP 1-9, DOI: 10.3846/16484142.2014.91319.

[5] Al-Atawi A and Saleh W (2014): Travel behaviour in Saudi Arabia: Disaggregate approach. Final Report.

[6] Miskeen, A. B., Mohamed, , Ahmed, A, Alhodairi, and Rahmat,O K, Abdullah Bin, R (2013) Modeling a Multinomial Logit Model of Intercity Travel Mode Choice Behavior for All Trips in Libya, *World Academy of Science, Engineering and Technology* 81, 2013 pp.148-157.

[7] Khan, O A., Ferreira, L. and Bunker, J. M. (2007) Analyzing the Degree of Mode Captivity in Multi-modal travel Behavior Using Stated Preference Data. In *Morris, Jenny and Rose, Geoff, Eds. Proceedings the 30th Australasian Transport Research Forum*, pages pp. 1-16, Melbourne.

[8] Cascetta E and Papola (2001) Random utility models with implicit availability/perception of choice alternatives for the simulation of travel demand. *Transportation Research C,* No. 9, pp. 249-263.

[9] Swait, J. (2009), "Choice models based on mixed discrete/continuous PDFs," *Transportation Research Part B: Methodological,* Vol. 43, No. 7, pp. 766-783.

[10] Gaudry, M., and M. Dagenais 1979. "The Dogit Model," *Transportation Research Part B:Methodological,* Vol. 13, No. 2, pp. 105-111.

[11] Ben-Akiva, M. 1977. Choice models with simple choice set generating processes. , Department of Civil Engineering, MIT, Cambridge, MA.

[12] Louviere, J.J., Hensher, D.A. and Swait, J. (2000). Stated Choice Methods: Analysis and Applications in Marketing, Transportation and Environmental Valuation, Cambridge University Press, Cambridge.

[13] Train, K. (2003): Discrete choice methods with simulation. Cambridge University Press, New York.

[14] Hensher D, Rose JM and Green WH (2005) Applied choice analysis Cambridge University Press, Cambridge.

[15] Louviere, J, Street, D, Carson, R, Ainslie, A, DeshazoJ. R., Cameron, T, Hensher, D, Kohn, Rand Marley, T (2002) Dissecting the Random Component of Utility, *Marketing Letters,* Volume 13, Issue 3, pp. 177-193.