

Full Length Research Paper

Sustainable travel behaviour in Saudi Arabia and gender differences: An investigation of car sharing feasibility

Attiyah M Al-Atawi

Faculty of Engineering, University of Tabuk, Saudi Arabia.

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In order to increase efficiency and sustainability, it is of crucial importance to have an in depth understanding and investigation of travellers' behaviour, preferences, attitudes and choices. In this context, this paper investigates car-sharing as a mode for travel for work trips in Tabuk city for both male and female travellers. Tabuk is one of the regional capitals situated in north-western Saudi Arabia, which has recently generated enormous intra- and inter-city transportation demand due its rapid economic growth and due to recent oil and gas based growth economy in recent years. Investigation of the characteristics of trip makers which impact on the decision of selecting car-sharing as a mode of travel is presented for each of the males and females. In this context, this paper investigates the feasibility of car sharing schemes in Saudi Arabia and the impacts of gender on the use of this mode of travel for work trips in Tabuk city. The analysis presented in the paper provide an addition to practice and academic work in the area of investigations of choices of modes of travel and factors which contribute to it in Saudi Arabia (SA). In addition, SA is a developing country with unique cultural and traffic characteristics, to encourage further enhancement and utilization of this mode. Further investigations in these areas are still needed.

Key words: Car sharing, travel behaviour, sustainable travel modes, Saudi Arabia.

INTRODUCTION

Car sharing is a very interesting policy measure which can influence car users' behaviour. Car sharing schemes are often constructed with the aim of encouraging car users to reduce their use of the private car and increase the use of shared modes of transport. Typically, car sharing refers to a membership-based, shared-use access to an automobile fleet for as little as an hour at a

time (Scott et al., 2003; Buehler, 2011). In this case, vehicles are located in reserved parking spaces in neighbourhoods close to where members live and work. Carsharing or car sharing (US) or car clubs (UK) is a model of car rental. In these schemes, the users rent cars for periods of time to use them for various travel. They are mainly used by occasional users and those who

E-mail: aalatawi@ut.edu.sa.

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would like occasional access to a vehicle of a different type than they use day-to-day. The organization renting the cars may be a commercial business or the users may be organized as a company, public agency, cooperative, or ad hoc grouping. In the United Kingdom, where it is a recent development, the term "car clubs" is used to describe "carsharing", "car sharing" or "car-sharing". In the UK, "car sharing" refers to what is called "carpooling" or "ride sharing" in the US, namely the shared use of a car for a specific journey, in particular for commuting to work, often by users who each have a car but travel together to save costs. By having more people using one vehicle, carpooling reduces each person's travel costs such as fuel costs as well as other operating costs. Carpooling is also seen as a more environmentally friendly and sustainable way to travel as sharing journeys reduces carbon emissions, traffic congestion on the roads, and the need for parking spaces. Authorities and local councils aim at encouraging carpooling, especially during high pollution periods and high fuel prices.

In car sharing schemes, individuals have access to the cars on an agreed basis (Scott et al., 2003). Car sharing popularity has increased in particular in the USA. Such popularity is revealed by the continuous increase in the interest and use in car sharing clubs. Scott et al. (2003) reviewed car sharing schemes in more than 30 North American cities and 50 organizations throughout Europe. The authors showed that once car sharing is available, it is much more heavily used than the private automobile when available. This could well be an indication that only travellers who do not travel a lot would opt to car sharing. In addition, the car sharing concept would encourage a reduction in car ownership and usage. In terms of the social factors such as gender, age, income and occupation and their impacts on car sharing choice and usage, there are still gaps in such areas. Some studies for example showed that car sharing is similar for men and women (87%) in the USA. In Germany, on the other hand, statistics showed that while 65% of car sharing trips are made by males, only 57% of these trips are made by women (Buehler 2011). There are still huge gaps in the literature in these areas and in the investigations of the characteristics of users of car.

There is also further need therefore for research and investigation of demand prediction and travel behaviour issues related to car share and the parties which are more likely to use it. Some other countries are lacking such statistics in terms of who uses car sharing, including Saudi Arabia.

Tabuk city has typical travel characteristics of a medium size Saudi Arabian city. Women do not drive in the Saudi Arabia because of cultural and religious reasons. As part of the culture, there are separate work and education places for men and women in the country. The social factors are therefore strongly influencing when it comes to choice of mode of travel (Attayah and Wafaa, 2014). Female travellers depend on using car sharing

(sharing a ride with a male member of the family, having a private driver (usually available to the whole family) or hiring a contracted driver (who would drive her mainly from home to work on a contracted basis). Male travellers on the other hand drive cars (if they have access to a car and driving licence or could also share a ride with another male member of the family who has access to a car) as appropriate. Car sharing is defined in this context therefore as where any member of the family shares a ride with a male member of the same family who has access to a car and a driving license. Car sharing is therefore a very common concept in the country although the definitions of this mode, the operation and the related issues vary significantly from other western countries. The aim of this paper is to investigate and model the factors which affect the decisions of car sharing in the Kingdom of Saudi Arabia, specifically from both male and female travellers' point of view. The data has been collected in 2012 using a household survey in Tabuk city (Attayah and Wafaa, 2014). Modelling decision making in terms of car sharing for males and females have been carried out using discrete choice modelling techniques (Habib et al., 2011; Cervero et al., 2007; Fallon et al., 2004). There are two discrete choice models for both male and female travellers in Tabuk.

Past and recent research on car sharing

Car sharing age started in the late 1980s, where new schemes emerged to market and operate car sharing schemes [see for example Sefage project in Zurich, which started in 1948 and was the first implementation of the concept of car sharing (Harms and Truffer, 1998)]. Most of other car sharing schemes was then implemented mainly on a small scale. While the Sefage project is still in operation, majority of other schemes are no longer in operation although the principle of car sharing has since evolved (Shaheen et al., 1998; Barth and Shaheen, 2002; Tingting and Cynthia, 2012; Shaheen and Elliot, 2006). The argument of the principles of car sharing has always been the reduction of ownership and use of cars, reduced fuel consumption and environmental emissions.

Fallon et al. (2004) examined impacts of various factors on the potential of car sharing. They investigated the influence of distance, level and intensity of public transport options as well as the possibility of walking and cycling. They used a nested logit model to analyse their data (Louviere et al., 2000). They found that as distance increased, the probability of using car sharing decreased. Also, they reported that it is more likely to use car sharing where less public transport exists. Another investigation for the factors which determine the choice of car sharing using the simulation was reported by Ciari and Axhausen (2012). Fatmi and Habib (2014) recommend the urgency for implementing programs and policies that aim at

educating people and raising awareness about the influence and the importance of encouraging the shared modes of transport as well as the economic, environmental and social benefits of such scheme. They adopted structure equations modelling (SEM) to investigate mode choice, behaviour and attitudes towards car sharing.

The aforementioned review has essentially looked at very broad definitions and operations of car sharing schemes and their assessment. However, there are still a number of research gap areas where there has not been much investigations [see for example further discussions in Fatmi and Habib (2014), Saleh and Al-Atawi (2015) and Kunieda and Gauthier (2007)]. Some other gap areas include car sharing investigations in unique cultures such as the Middle East where there could be opportunities for car sharing for both male and females.

In the case of Saudi Arabia for example, the formal operation of car sharing is not recognised as such, instead there are informal arrangements of car sharing, mainly within each household. In Kingdom of Saudi Arabia, Tabuk city has typical travel characteristics of a medium size Saudi city. It should be noted here that for cultural reasons women do not drive in the Saudi Arabia. Moreover, workplaces as well as schools for men are separate than work places for women. Travel behaviour research indicates that travel decisions are usually influenced by accessibility as well as characteristics of the transport systems. Factors such as travel times, travel costs, waiting times, walking times have the most significant contributions in mode choice and travel decisions. In the case of developing countries however, most influencing factors for travel behaviour and decisions are the social factors (Srinivasan and Rogers, 2005). Because of the social factors in Saudi Arabia, most male members of the family drive cars, while the female mainly rely on car sharing, hiring a private driver or using a taxi. The aim of this paper is to investigate the factors which affect the decisions of car sharing in the Kingdom of Saudi Arabia. The data has been collected using a household survey in Tabuk city (Srinivasan and Rogers, 2005) for a detailed description of the survey.

The suitability of and attitudes for car sharing as well as alternatives in relation to different trip purposes were also investigated by (Fatmi and Habib, 2014). A number of socio-economic characteristics, travel attributes, and neighbourhood characteristics have been investigated as independent variables. Attiyah and Wafaa (2014) and Saleh and Al-Atawi (2015) investigated the modal share and the extent of car sharing in Tabuk city. Cultural and religious factors also contribute to travel behaviour characteristics. Srinivasan (2008) described that men in certain ages and in certain cultures (usually Islamic) travelled more than women. The authors also reported that in Nigeria, more than 70% of the women use public transport as their main mode of transport while about a similar percentage of men use private modes of presented similar statistics on walking trips for males

and females. In Pune, Al-Atawi and Saleh (2013) showed that female walking trip shares were 52% higher than men's, 61% higher in Bamako, and a 100% higher in Ashgabat (Al-Atawi and Saleh, 2013). In Tabuk, women tend to have a lower proportion of trips involving personal vehicles like bicycles or personalised motorized modes as it was found in Saleh and Al-Atawi (2015), Train (2003) and Adetunji (2013).

MATERIALS AND METHODS

Data collection

The data presented in this paper was collected from a household survey in Tabuk city in 2012. In total, 516 completed surveys forms were obtained from a total of 1226 distributed surveys throughout the city of Tabuk, which is an overall response rate of 42.0% for the study. Questionnaires were distributed in different sectors covering broad spectrum of characteristics of different workplaces in Tabuk city (health services, educational services, military services, security, private, Tabuk Municipality and the water Authority). The questionnaire comprised of five separate sections; the current travel patterns of the respondents including the mode of transportation which they use to reach their place of work as well as modes' characteristics, respondents' attitudes and preferences on alternate modes of transport, preferences and attitudes related to the times which individuals travelled to their place of work, information of respondents' preferences and attitudes to a number of traffic and travel transport policies and socio economic and household structure of respondents.

From the household data, it has been reported that 55.1% of all responders were male. It was also reported that the car drive was the most common mode of travel to work. A total of 233 males indicated that they held a valid driving licence which was 45.2% of total responders to the questionnaire. In terms of mode of travel to work, there was in total 221 male responders who indicated that they drove 4 to 5 times per week to reach their place of work. Interestingly, however, some of the male members of the households have specified more than two modes to be chosen including the private car as the preferred option while others indicated that they prefer informal car sharing and/or being a passenger with a contracted driver. Bus, taxi and other combinations have not shown significance in the modes chosen for male member. Therefore, there is a large percentage of travellers who are captive to the car as a mode of travel, while another large percentage are choosers.

The most popular mode of transportation which was used 2 to 3 times per week by males was an informal car share which accounted for 15.1% of all male responders. For the seldom (one or less times per week) option, it was seen that the informal car share was the most common option selected by the male responders; selecting this option accounted for 23.2% of all male responses within this questionnaire. Driving was seen to have the lowest response rate in the never category, with only 5.9% males who indicated that they never drove to work. The most common response in this category was that of the use of public buses of which 62.6% individuals indicated that they never used buses in their commuter journey.

The responses of males in relation to using two modes of transportation during the week was a combination of driving and being a passenger in an informal car share which accounted for 44.4% of all male responders to the questionnaire. This was followed by utilising both walking and driving as was selected by 25.4% male respondents. The lowest combination which was a passenger in a car driven by a contracted driver and used another means of transportation accounted for 2.1% of all male responders

to the questionnaire. Male (18%) responses in relation to their income levels and the mode they used in reaching their place of work was seen in an income level between 8001 and 12000 SAR and drove to work. The pay bracket which received the highest overall response rate from males was that of the 4000 to 8000 SAR pay range.

For males, with respect to their place of work and mode used to reach their destination for all frequencies throughout the week, it can be seen that the highest response rate was from individuals with some form of education, who drove to work. This accounted for 19.8% of all male responses to the questionnaire. The second most popular 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 (Attiyah and Wafaa, 2014; Saleh and Al-Atawi, 2015).

From the data collected from the surveys conducted, it was found out that a total of 55.7% (287) of respondents indicated that they regularly drove to work, with 43 individuals who indicated that they sometimes or seldom drove to work, while a further 14.5% indicated that they never drove to work. The second most common mode of transportation utilized was through informal carshare schemes, with 17% (88) of the respondents indicating that they utilized this method while formally organised car sharing schemes accounted for a further 3% (16) of regular work journeys. With regards to commuter journeys, using a private vehicle in which the individual was a passenger with some form of professional driver in place, it was seen that a total of 42 (8.1%) individuals utilized a private driver on a regular basis while 46 (8.93%) individuals employed a contracted driver regularly.

Private bus and cycling accounted for 20% (107) journeys combined, with 3.5 and 6.4% of respondents indicating that they utilized each mode on a regular basis. 54% of respondents indicated that they never used private buses, with a further 55% of individuals never choosing to cycle to their destination. Within the private bus option, it was seen that 2.7 and 5% of respondents chose to sometimes and seldom utilize this mode, while these frequency of use accounted for 1.4 and 1.7% of journeys through cycling.

When the use of a private driver was further examined, it was seen that 32 (6.2%) and 39 (7.57%) individuals used these services on a less regular basis under the sometimes and seldom options, respectively. It was seen that the use of contracted drivers was identical in the seldom and regular categories at a level of uptake of 46 (8.39%) in each instance with 27 (5.24%) individuals indicating that they sometimes utilised these services. The use of taxis as a mode of transportation was seen to increase as the frequency of use decreased with 29 (5.6%) individuals indicating that they would sometimes use this means of transportation with this level rising to 53 (10.3%) on a seldom basis. A total of 235 (45.6%) individuals indicated that they never use taxis as a means of transportation to their place of work.

On the other hand, a total of 25 (4.85%) individuals indicated that they regularly walked to their place of employment with these levels rising to 32 (6.21 %) and 42 (8.16 %), respectively for the sometimes and seldom choices. A total of 244 or 47% of respondents indicated that they never walked to their place of work while a further 10 (2%) individuals indicated that they took a taxi to work on a regular basis. A further 18 (3.44%) individuals indicated that they commuted to their workplace by another means not mentioned within the questionnaire however these respondents failed to specify the specific mode by which they travelled.

Attiyah and Wafaa (2014) and Saleh and Al-Atawi (2015) provided further discussions on the distribution of questionnaires and their characteristics.

General data statistics

From the household data, initial statistics showed interesting

results. Initially, respondents to the survey were asked "how often they used all of the available modes of transportation". From the data collected it was seen that driving was the most popular mode being used by 49.38% of the respondents more than once a week followed by the "informal car share option" with 17.63% responses. This was then followed by walking with 10.17% respondents indicating that they chose this mode more than once a week and in turn the "use of contracted drivers and chauffeurs" with 9.96 and 9.54% responses, respectively. At the lower end of the scale came bus users with 7.05% respondents indicating that they used these services more than once a week followed by formal car shares with 5.60% responses and cycling and taxis with 4.15 and 2.49% users each. When respondents were asked to indicate the modes which they use once or less per year it was seen that taxis were the most common mode of transport on such a rare occasion, with 13.49% responses.

When individuals were asked to indicate which modes of transportation they never used in their commute to their place of work it was seen that "cycling" was the least used option with a total of 74.90% respondents indicating that they never cycled to work. This was followed by the use of formal car shared which 58.09% individuals indicated they never took part in.

Next respondents were asked to identify the mode which they could avail of as a means of reaching their place of work should the mode which they currently use become unavailable to them. The use of an "informal car share" was identified by the majority of responders as being an available option to them with 62.41% of the responders selecting this option. This was followed by the use of a "contracted driver" as was selected by 38.50% and the use of taxis as selected by 38.23% individuals. Cycling was seen to be the most unpopular option available with only 2.28 % individuals indicating that they could cycle should their current mode of transportation become unavailable to them. No one has indicated that the bus has been a feasible option.

Following on from the previous question where respondents were required to indicate the alternative modes of travel available to them, they were then asked to rate these available modes in the order in which they would utilize them if their current mode became unavailable for use. From the data provided in relation to first choice options it was seen that an "informal car share" was the mode which most respondents would choose to take, with 35.59% of the respondents choosing this option. The use of a "taxi" was the mode which gained the second most responses within the first choice category being selected by a total of 14.29% individuals. This was followed by the option to drive which was selected by 13.21% respondents and the option to be a passenger driven by a chauffeur, which was selected by 12.98% respondents as their first choice. Walking and the use of a formal car share were selected by 3.63 and 3.39% respondents, respectively. 0.97% respondents indicated that they would choose to use another mode of transportation.

Survey results showed that about 17.63% of all male respondents indicated that they found that the most popular mode of transport for them for about 2 to 3 times a week was car sharing. On the other hand, about 23.2% of all male respondents indicated that they seldom (one or less times per week) use car sharing as a mode of travel. While driving a car was the most popular mode of transport, it represents the lowest percentage in terms of the category "never" with only 5.9% indicating that as their choice option. The option of "never used public transport" was the highest option in this category as 62.6% of individuals specified that they never used buses in their commuter journeys. Hirschl (2003) offered further detailed discussions on the analysis of the results.

In the case of Tabuk, the main factor in selection of mode of the transport mode is the social role, and specifically the role inside the family. From the results obtained it was clear that majority at times, the car was the main mode for most family heads, the private driver and car sharing were the most used modes of transport for women

Table 1. Choice of travel options should current mode becomes unavailable.

Choice	1st	2nd	3rd	4th	5th	6th
Walk	15	14	14	12	16	23
Private Bus	22	17	14	29	21	13
Cycle	0	0	1	2	5	5
Drive	55	7	10	8	4	6
Chauffeur	53	40	31	16	8	5
Contracted driver	44	85	62	17	8	3
Formal car share	14	12	19	11	13	7
Informal car share	147	101	41	19	7	4
Taxi	59	85	54	28	14	9
Other	4	2	2	2	0	2
Totals	413	363	248	144	96	77

Table 2. How respondents usually reach their place of work.

Mode	Never	Seldom (1 or less times per week)	Sometimes (2-3 times per week)	Regularly (4-5 times per week)	Total
Passenger Informal Car sharing	0.2	0.2	0.1	0.17	0.69
Passenger car sharing	0.5	0.1	0.0	0.03	0.63
Contractor driver	0.5	0.1	0.1	0.09	0.69
Private driver	0.5	0.1	0.1	0.08	0.68
Drive	0.1	0.0	0.0	0.54	0.75
Total	1.78	0.44	0.31	0.91	3.43

Source: Attiyah and Wafaa (2014).

(Attiyah and Wafaa, 2014).

In terms of the share of other modes of travel in the commute trips in Tabuk, results showed interesting patterns. Only 4.85% of total individuals specified walking as the regular mode of commuting to their work place while 6.21% said that they sometimes would walk. A percentage of about 8% of total respondents indicated that they seldom walk to work. On the other hand, 47% of all respondents indicated that they never walked to work. The taxi as a mode of commuting was only specified by 2% of respondents as the regular mode of travel to work. In addition, there was a further 3.44% of respondents who indicated "others" as their main commuting mode of transport although they did not specify those modes. Table 1 gives a summary of statistics of modes of commute trips in Tabuk.

Although the private car is seen to be the most used mode of travel for male travellers, most of them indicated that they use other modes than the private cars in their commute journeys to work. Table 2 shows how respondents usually reach their place of work and the frequency by which they do so. From the table it appears that while 91% of respondents indicated that they use private cars 4 to 5 times a week for their commute travel, there was a 31% of commuters who indicated that they use other modes of travel as well as the private car. Attiyah and Wafaa (2014) showed that the social role is a major factor for the selection of mode of travel. The male head of the family mainly uses the private car while the wives and the daughters in the family use car sharing or a private driver (Attiyah and Wafaa, 2014).

MODELLING OUTLINE AND RESULTS

Two binary mixed logit models were calibrated; one for

each of the travel options "Male CAR_USER" and "FEMALE INFORMAL CAR SHARING". The present study estimates the two models to explore the effects of various characteristics which affect the choice and use of the car as the most preferred option for male travellers and the car sharing as the most preferred mode of transport for female travellers. In this research, each 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 characteristics. Therefore, binary mixed logit specifications have been assumed to be appropriate to model this choice. In addition, different parameter such as education, cost of petrol and attitudes and preferences have also been used. The dependent variable represents the choice of car for male and car sharing for female, such that 1 is yes and 0 no. The function of the logit model that determines travellers' choice of the mode of travel is represented by the utility function and is written (Belk, 2010; Louviere et al., 2000) as shown in Equation 1:

$$U_{in} = \beta_n^i X_{in} + \varepsilon_{in} \quad (1)$$

Where U_{in} is the propensity function that determines the probability of car sharing option selected by an individual traveller i ; X_{in} is a vector of observed variables such as rider attributes, system characteristics, β_n is a vector of

Table 3. List of variables used in the models.

Variable	Question
Family Head	What is your status in your Household? Head
Wife	What is your status in your Household? Wife
Place of work in education sector	What is your place of work? Education
Place of work in health sector	What is your place of work? Health
Place of work in government sector	What is your place of work? Government
Place of work in Internal affairs & security	What is your place of work? Internal affairs and security
Place of work in Military	What is your place of work? Military
Place of work in in Private Company	What is your place of work? Private Company
Place of work in Other sector	What is your place of work? Others
Indicator variable for "Journey time"	A variable that indicates the importance of value of time
OFT_PETR	How often do you fill petrol in your car?

parameters associated with X_{in} ; and ε_{in} is error term. A number of models have been tried and there have been no evidence of superiority of any other model form over the logit model. For determining whether a mixing distribution is appropriate for specific variables within the utility function, a mixed logit specification was further investigated.

Table 3 presents the list of variables used in the models and their indications. Tables 4 and 5 present the results of the two models, respectively. The definitions of variable used are listed in Table 3. From Table 4, it appears that all the independent variables are statistically significant at 90% level of significance and are with the logical signs. As can be seen from the results in terms of the position in the family, as expected the male family head is the most likely to be driving a car while the wife is the most unlikely to be driving a car (negative sign of the coefficient and zero probability). In terms of work sector, the results show that a male worker in private company, military and health sector are the most likely to be driving cars to work, respectively with positive coefficients and probabilities of 0.0003, 0.000 and 0.0001, respectively. The variable "How often do you fill petrol in your car" is seen to be statistically significant at 95% level in the model and is uniformly distributed. It should be mentioned here also that the variable "level of education" is an important parameter in the decision of choice of car sharing, especially for females. The variable is statistically significant at 95% level. This variable has been only included in the female model. Further investigations of this variable are still needed however. Table 5 presents "FEMALE INFORMAL CAR SHARING" choice model. From the model it appears that the variables "Journey time", "level of education" and a constant are statistically significant non random variables in the model. The variable "alternative mode of travel is a contracted driver" is a negative, statistically significant random parameter which is uniformly distributed in this model. This might imply that the contracted driver, if were available, might have been the preferred option of travel.

Further investigations in this area would be recommended therefore. Again, the social factors seem to be important and relevant in this case (Holmberg and Robèrt, 2000; Attiyah and Wafaa, 2014; Saleh and Al-Atawi, 2015).

As discussed, the female members of the family indicated that mostly they use contracted driver, private driver or travel as a passenger with another male member of the family in an informal car sharing travel in Table 1. This could have potential impacts on policy aspects regarding planning and designing for females' travel modes. In this case, car sharing seem to provide a potential and adequate travel option which can be further encouraged as a formal mode of travel for this set of travellers. Car sharing might be more acceptable for female travellers than other non-car modes of travel. These type of models will hopefully assist decision makers to recognise interactions between people in more connected societies. In this case, the calibrated models help understanding the most important factors which affect choice of mode of travel and those which affect the preference of car sharing. For Saudi women, the level of education and income obviously has a role to play for the choice of mode of travel. Also, the cost of mode of travel is affecting the decision on which mode to use. These types of models help bridging the gap in the current and available economic models since there are a huge shortage of models and investigations in developing countries, especially for certain societies such as Saudi Arabia.

DISCUSSION

The data which has been used in the analysis in this research was collected during a household survey in Tabuk in Saudi Arabia, in 2012. A total of 1,226 questionnaires were distributed and around 515 completed questionnaires were obtained; with a response rate of over 40%. The survey covered a broad range of

Table 4. Mixed logit model estimation results for “Male CAR_USER”.

Variable	Coefficient	Standard Error	t-Value	P-Value
Non random parameter				
Constant	-1.6988	0.2962	-5.7360	0.0000
Family Head	0.6784	0.3227	2.1020	0.0356
Wife	-2.1692	0.4739	-4.5780	0.0000
Place of work in education sector	0.6164	0.3731	1.6520	0.0985
Place of work in health sector	1.5751	0.5452	2.8890	0.0039
Place of work in government sector	1.0002	0.4545	2.2010	0.0277
Place of work in Internal affairs & security	2.3930	1.2204	1.9610	0.0499
Place of work in Military	2.2133	0.7524	2.9420	0.0033
Place of work in Private Company	1.8129	0.5316	3.4100	0.0006
Place of work in other sector	1.5468	1.0039	1.5410	0.1234
	-1.6988	0.2962	-5.7360	0.0000
Random parameter				
OFT_PETR	0.5035	0.1092	4.6120	0.0000
Standard deviation of uniform distribution parameter	0.5758	0.1659	3.4720	0.0005

Statistics summary: Number of observation = 520. Restricted log-likelihood (constant only) = -360.4365. Log likelihood at convergence = -234.8393.

Table 5. Results for “Female informal car sharing”.

Variable	Parameter estimates	Standard error	t- Value	P- Value
Non random parameter				
Indicator variable for “Journey time“	0.096	0.027	3.585	0.0003
Indicator variable for continuous variable that represent “Level of education“ of the respondent. Low level of the variable are associated with low level of education	0.672	0.167	4.030	0.000
Constant	-5.978	1.020	-5.860	0.0001
Random parameters				
Indicator variable for How would you make your journey to work if your current mode (most regularly used mode) was not available to you? With passenger contractor drive	-0.612	0.992	-0.617	0.0537
Standard deviation of parameters	3.082	1.523	2.023	0.043

Statistics summary: Observations: 520. Restricted log-likelihood (constant only) = -360.4365. Log-likelihood at convergence = -183.7058

places of work including the education, health, military services, local authority, private sector and security services. In terms of the data collected from the surveys, these included mode of travel, characteristics of the selected modes, characteristics of alternative modes of travel, journey characteristics, respondents attitudes and preferences on various travel options as well as a number of transport policies.

The results show that about 17.63% of all male

respondents indicated that about 2 to 3 times a week they use car sharing. On the other hand, about 23.2% of all male respondents indicated that they seldom (one or less times per week) use car sharing as a mode of travel. Public transport” was indicated as the highest option in this category of “never” for about 62.6% of all respondents.

Modelling results for two mixed logit models for male travellers and choice of a car and female traveller and

choice of car sharing were presented. The results show that all the coefficients are statistically significant at 90% level and with the expected signs. The positive signs associated with the dependent variables show that as the values of each of the independent variables increases, the likelihood of travellers using car sharing increases.

The results show that the family head, oldest son or son members of the family have influence on the choice of car as a main mode of transport for any male family member in the household. Also, the cost of travelling is a factor which contributes to the selection of the car sharing as a mode for travel. The female members of the family however indicated that mostly they use contracted driver, private driver or travel as a passenger with another male member of the family in an informal car sharing travel (see also Table 1). In this case, car sharing can provide a potential and very important travel option which can be encouraged as a formal mode of travel. This might encourage more female members to use it. University graduates are more likely to opt to car sharing as well as those who do not have access to another car or private drivers (University graduate coefficient has a positive and statistically significant factor in the model). Random parameters are those parameters with an error term of random distribution. Non random parameters are those variables where the error term is assumed to be fixed and unique for all individuals in the sample. In addition, it should be noted here that improving the operation and acceptability of car sharing in this community and in other similar communities and also applying this type of technology can lead to enhancing car sharing as a mode of travel and increase its modal share. In fact, car sharing in this type of culture (Saudi context) can well be more suitable and appropriate for Saudi women. Further investigations for different types of societies and cultures are urgently needed since there is a lack of research in these areas.

The results presented in this research offer useful information for policy and decision making process in Tabuk as well as in other similar Saudi cities. In order to promote public transport options as well as other sustainable options, it is important to understand the attitudes and characteristics of the decision makers and users of the system. Further specific research on car sharing options in Saudi Arabia and how can these be deployed to improve the transportation system in the country is urgently needed. Further utilizations of the results presented in this research can be useful to other Saudi cities and other similar cities in the world. In particular, female travel and choices of mode of travel is a very interesting topic and still hugely under researched. This researcher has been aiming at investigating the feasibility of car sharing schemes in Saudi Arabia and the impacts of gender on the use of this mode of travel for work trips in Tabuk city. The analysis presented in the paper show that there is a great potential of car sharing in Saudi Arabia for male as well as female users. Currently,

most car sharing is taking place on an informal basis. There is a potential however for proper design and operation of formal public schemes for female in order to encourage them to use public modes of travel in Saudi Arabia. These options provide an addition to practice and academic work in the area of investigations of choices of modes of travel and factors which contribute to it in Saudi Arabia (SA). Other developing country with unique cultural and traffic characteristics can also make use of such systems and benefit from this investigation. The ultimate aim is to increase efficiency and sustainability of the transport system.

In addition, it should be noted here that improving the operation and acceptability of car sharing in this community and in other similar communities and also applying this type of technology can lead to enhancing car sharing as a mode and increase its modal share. In fact, car sharing in this type of culture (Saudi context) can well be more suitable and appropriate for Saudi women. Further investigations for different types of societies and cultures are urgently needed since there is a lack of research in these areas.

Finally, these models are very useful for decision makers to have an appropriate understanding of factors and choices of mode of travel. It is hoped therefore that the model will provide important tools for the development of a more efficient transportation system in these type of society where female have different requirements than males in terms of the mode of travel. Further research and development in this area is still needed.

Conflict of interests

The author has not declared any conflict of interest

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