

Research Article

Switching Model for Private Vehicles to Public Transportation System in Case of Sana'a

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Abstract: The latest statistical information of rapid increase in the use of the personal transport generally in Yemen and especially in Sana'a illustrate that 80% of the registered vehicles in the country are own cars and taxis which numbers have increased tremendously recently which is the cause of the increasing of the traffic congestion, accidents, inadequate parking space and air pollution, among other problems. Earlier studies in this subject, however, focused primarily on car safety issues rather than identifying factors influencing car use and car user mode choice behavior. Due to these problems, the objective of this study is focused on shifting car users to public transport mode transport and discussed the factors to encourage the traveler to shift towards public transport in order to increase road safety and enhance road environment. The data collected and demographic details are analysed like age, gender, educational level and travel behavior in regard to the transportation mode. For a description of the survey data, SPSS is used and logit model is applied. The questionnaire distributed in Yemen which is designed based on social or economic preference, trip characteristics and probability of shifting from private vehicles to public transportation mode. The obtained results reveal that the time and cost and convenient has a momentous role in encouraging the private vehicle users to switch to public transport.

Keywords: Logit model, model shift, private vehicles, public transport

INTRODUCTION

Urban population growth determines the progress of transport sector in the concerned region (Region, 2006). The bigger the city or its growth, thus is the growth of transport infrastructure. Moreover, the income growth makes people prone travel much more (Ismail *et al.*, 2012; Shokri *et al.*, 2009a). Both in developed and developing countries, congestion is a major problem in many urban regions (Altef *et al.*, 2013; Shokri *et al.*, 2010). Traffic congestion occurs when the supply does not meet the demand. It is a barrier for the free movement and business in the urban regions. Urban cities in developing countries have several factors that creates problem to sustainable transport system. The population, high income, rapid growth of cities and urbanization has led increase in travel demand. Service of transport sector has not been up to the mark in developing countries and most transport facilities fail due to lack of proper planning and design. Besides, pedestrians and non-motorized vehicle users are less considered when planning urban

transport system that creates mixture in the roads and further complications. Most of the people afford to have private vehicles and hence the vehicle population has also boomed. Extremely congested roads with all types of vehicles and passengers, traveling different speed are the situation of Sana'a roads. This is further worsened by lack of public transport facilities and space. Air pollution and other environmental hazards are also yet another concern (Almselati *et al.*, 2011).

Due to these problems many cities have attempted to restrict the use of private cars in favour of public transport (Steg, 2003). Such polices exist in France (Harrison *et al.*, 1998), Germany (Shokri *et al.*, 2009b; FitzRoy and Smith, 1998), Britain (Altef *et al.*, 2013; Shokri *et al.*, 2012b; Sayed Sharafuddin and Ata Khan, 2000) Netherlands (Cheung and Hoen, 1996), Romania (Marshal and Mclellan, 1998), Australia (Black, 1996) Asian countries and Canada.

The case study of the current study is Yemen which is bounded by Sudia Arabia from the north, east by Oman, south by the Gulf of Aden and west by the

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Fig. 1: The location of Sana'a (WHO, 2009)

Table 1: The numbers of car in Yemen in 2007 and 2008

Year	Private car	Taxi	Other vehicles	Total
2007	273,867	97,766	250,521	622,154
2008	302,892	107,915	259,530	670,337

(Central Statistical Organisation (CSO), 2011)

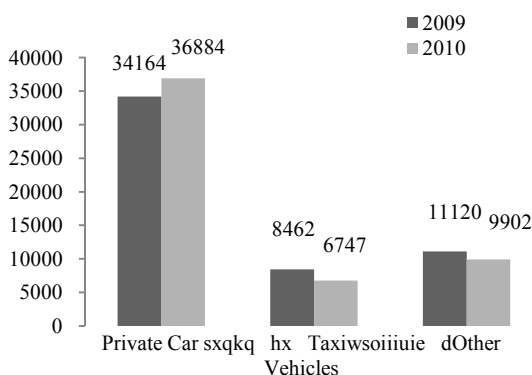


Fig. 2: Registered vehicle during 2009-2010 in Yemen; Central Statistical Organization CSO 2011

Red Sea. Area of Yemen covers about 527,970 sq km (about 203,850 sq mi) and the number of populations Yemen are 22389169 in 2007 (WHO, 2009). Sana'a is the capital of Yemen and the centre of Yemen Government. Figure 1 shows the location of Sana'a is one of the oldest continuously inhabited cities in the world. At an altitude of 2,300 meters (7,500 ft), it is also one of the highest capital cities in the world. the number of populations Sana'a are 1747627 in 2009 and area of Sana'a 1604 km² making it Yemen's largest city (TMOCCS, 2010). Yemen is a developing country which suffers the consequences of explosions in both human and motorization. This has been accompanied by a heavy toll of deaths and economic cost. There is currently no public transportation (buses) and no rail or metro network but one will also be built. The public transport system in Yemen is very poor and hence, the private transport increase was observed in private transport. Generally, non-motorized transport means to walk or use bicycles (Ryley, 2006).

In Yemen, the car, due to its inexpensive cost, has been a popular mode of transport in it. Consequently, casualties among car users constitute a high portion of total fatalities in these countries. The people are less non-motorized transport users, motorcycles increased in Yemen, it use large of motorcycles in the cities. Motorcycle is popular in Yemen and use it as a taxi especially at peak time of congestions, the number of motorcycle registers at 2008 are 10769 and the numbers of motorcycles not register more than this number (Central Statistical Organisation (CSO), 2011). Motorcycle users are more vulnerable to fatalities and injuries (Beck *et al.*, 2007). The motorcycles are allowed in highways; safety measures like compulsory wearing of helmet and exclusive motorcycle lane are not prevalent in Yemen. More than half of total traffic fatalities are death related to motorcycle accidents (Kulanthayan *et al.*, 2000). The increasing numbers of motor vehicles in Yemen, all kinds from own cars, private transport, taxis, motorcycles, trucks and heavy equipments as indication of the severity of congestion on major roads between main and interior cities (Almselati *et al.*, 2011). Table 1 refers to the number of private car, taxi and other vehicles in 2007 and 2008 in Yemen.

Figure 2 shows the registers cars in Yemen in 2009 and 2010 the private car and taxi increase four times of other types (Central Statistical Organisation (CSO), 2011).

In Sana'a (Fig. 3) capital city of Yemen the number of moving vehicles 300000 per day, register own car and taxi increased from 4812 in 2001 to 16834 in 2010. Consequently but after 2008 the government of Yemen controlled to register of taxes therefore the numbers of taxes and buses decrease (TMOCCS, 2009).

The best way around the Sana'a cities is Dababs, which are like minibuses holding about 10 people. Taxis are also a very common in Sana'a and in recent years where in 2003 the total numbers of taxis 257 but in 2007 the number increasing to 9180 in Sana'a



Fig. 3: The main road map of Sana'a streets (TMOCCS, 2009)

Table 2: The registered vehicles in Sana'a in 2001 to 2010

Year	Own car	Taxi and bus	Truck	Total
2001	3462	1350	1997	6809
2002	2039	532	453	3024
2003	1958	448	257	2663
2004	7866	2031	514	10411
2005	14002	3588	774	18364
2006	8641	1872	2886	13399
2007	9336	2305	9180	20821
2008	13811	2878	3752	20441
2009	14150	1550	4563	20263
2010	16454	380	3401	20239
Total	91719	16934	27777	136434

Table 3: Presented the cost of road traffic accident for main cities in Yemen on 2010

City	Accident	Fatalities	Seriously injured	Minor injury	Loses RY
Sana'a	4889	478	2453	2466	1052930000
Aden	1053	90	532	341	235095000
Taiz	1897	377	1046	1361	645370000
Hadramoot	321	53	151	304	80249000
Alhodeidah	1262	484	1383	596	442680000

(Central Statistical Organisation (CSO), 2011)

Table 4: The numbers of road accidents in Sana'a (TMOCCSR 2010)

Year	Accident	Fatalities	Seriously injured	Minor	Loses RY
2001	3451	208	952	1356	414906500
2002	3762	233	1132	1439	426053480
2003	4158	245	1247	1492	481364000
2004	4977	295	1374	1915	637182500
2005	5033	319	1453	2119	689448000
2006	4969	277	1517	2061	640590000
2007	5812	340	1981	2297	1033870000
2008	5958	366	2280	2610	1233150000
2009	5218	337	2019	2168	1168625000
2010	4889	478	2453	2466	1052930000

Yemen. Table 2 illustrates the registered vehicles in Sana'a in 2001 to 2010. Yemen has started using higher quality cars and companies are starting to take over the taxi business (TMOCCS, 2009).

Transport system provides many benefits, but it also causes many problems. It serves non-drivers poorly, distributes benefits and costs inequitably; financially burdensome to households, governments and businesses, increasingly inefficient due to traffic congestion and dispersed land use, a major cause of death and disability, contradicts environmental and quality of life objectives and relies on non-renewable resources that may become scarce in the future (Litman, 2003; Shokri *et al.*, 2012a).

Yemen is one of the most affected countries of the traffic accidents, the number of fatalities due to accidents of cars between deaths and injuries in 2009 are 22034 (WHO, 2009), the social and economic impacts of traffic accidents are very large annual losses of money in addition to the losses and the high proportion of social orphans and the disabled. Table 3 presented the number of accident, fatalities, serious and minor injuries and cost for main cities in Yemen such as Sana'a, Aden, Taiz, Hadramoot and Alhodeidah on 2010.

Table 4 presented the cost of Road Traffic Accident from 2001 to 2010 in Sana'a city. Road traffic risk may be defined as the probability of accident, injury, death and damages for a given amount of activity or exposure. Accident There is reason to believe that the risk increase for young car drivers is connected to the increased risk at night or weekend days. Accidents by young drivers are typically single

accidents especially at night during weekends (Ismail and Elmloshi, 2011). Road accidents were the main reasons cause of all deaths in Yemen as example Sana'a city the death, injuries and road accident as below in Table 4 (TMOCCS, 2010).

Base on the mentioned literature, the rapid increasing car users in Yemen and especially in Sana'a has resulted in congestion, accidents and casualties has prompted to undertake various studies to address this problem one of these studies was the shift of transportation mode from private car to public transportation in Yemen.

This study made an attempt to determine whether car users switch to public transportation mode if the Public Transportation (PT) is improved by decrease the travel time cost of PT and analysis the elements which are interfere to the travellers' decision for mode choice such as travel time, cost, convenient, safety and traveller habits.

MATERIALS AND METHODS

In this section the methodological analysis parts which are consists of data collection method, opinion that is used in this research for collecting data, model development and evaluation as well as the analytical and conceptual structure of the research are expressed as well.

In many capital cities of Arab countries including Sana'a the increasing number of car users involved in crashes and the associated injury travel demand management has been receive increasing attention for its potential to improve urban transport problems with undertaking various solutions to solve this problems. While managing urban travel demand is not only planning the transport system but also to get solution the issues of traffic congestion, accidents and environmental pollution from the increasing use of vehicles (Elmloshi and Asmail, 2010), shift model from private vehicle to public transport mode is another solution for this problem.

Model choice activities and the switch from private to a multimodal public transportation mode are investigated through data collection and interpreted using SPSS and logit choice model. The selection of data gathering methods according to Sekaran (2003) depends on the available facilities, the degree of accuracy required, expertise of the researcher, time span of the study, resources available for data collection and other related costs. It's expected to guarantee an excellent questionnaire design and the appearance of obvious and shared approach to the definition of related parameters. The questionnaire is expanding to directly address the objectives of the research.

There are two methods were followed to obtained information about numbers and type of cars, road traffic accidents and their injuries. In the first method is from Traffic Management Office for Capital City Sana'a TMOCCS, road traffic accidents database was published since latest 1991. All information about road

traffic accidents and numbers and types of vehicles in Yemen was obtained from TMOCCS and Central Statistical Organization in Yemen CSO. The second method surveying was carried in selected roads in Sana'a city area where there were higher car ownership users and micro buses and taxi available. The survey was done by questionnaires to get relevant data.

Two basic approaches are used in this study for data collection, Revealed Preference (RP) which is focused more on personal information and Stated Preference (SP) methods that concentrate on trip characteristics. The respondents for this survey are the own car, taxi and mini bus users in study area who use their mode to go to work, study and shopping. The respondents selected randomly. The data collection was done through field study observation and survey. The survey was done using questionnaires to get relevant data. The respondents for this survey are the own car users at study areas who use own car to make their trips to work, study and shopping and the citizens who did not use own car in their trips. Brief questionnaires will be formed to ensure for user's comprehension and they are in the form of open and close ended questions. The questionnaires were printed by two languages, Arabic and English language, to provide easier understanding and answering for some respondents. There are three sections in this survey. Section A is about respondent's personal information that will help to get the respondent's basic information for this research. Section B is a section that requires respondents to fill in information about their trip characteristics and purpose such as work, study and shopping trips. Section C only for use own car their portion are 73.6% ,which wrote notice for that in questionnaires and any respondent not use own car their portion 26.40% not fill this section because to know how many use own car in respondents and to recognized the their feeling when to ask them about shifting to other modes. There are several questions that correspond with respondents' views, recommendation and opinions. These questions provide the opportunity for the respondents to give their opinion. The questions are formulated in such as way that could help the respondent answer the questionnaire easily and quickly. Respondents will be selected randomly from residential areas which does not have public transportation services. The selected respondents are based on private transportation vehicle (taxi and mini bus) and own car users who use their private vehicles as their mode of transportation to go to their trips. The questionnaires were pre-tested by a pilot survey. The purpose of the pilot survey is to test whether the respondents understand the questions. Also pilot survey is purposely done to see the pattern of answers given by the respondents. Fifty applications of questionnaires were distributed in Sana'a city. These fifty respondents were selected randomly from own car and private transport vehicle users in Sana'a city. A total of 1000 questionnaires were collected in 8 months from (Sep. 2010 to April 2011). Statistical Package for Social Science (SPSS) version 17.0 and Microsoft

office Excel 2007 software were used to analysis the questionnaire.

RESULTS AND DISCUSSION

Alternative mode of transport for car users: According to the increasing the number of the private vehicle number (Hill, 1965), the study made an attempt to determine whether car users had access to other modes of transport or not (Fig. 4). Based on the analysis of the collected data, about 51 % of car users had access to the public transport mode, while 21.80 % had no access to alternative modes and 26.4% already not used car own car. Therefore the total number of car users had access to other modes are 78.20%.

Based on Fig. 5 the collected data illustrates that the 26.4% of the users don't use the PT for their travelling, 39.9% of the traveler believe that the PT condition is poor, 28.8% and 3.6% of the travelers are considered that the PT is good and very good mode respectively and 1.3% think that the current PT has an excellent condition and performance.

Analysis of the collected data reveals (Fig. 6) that the improving the condition of the PT has the straight impact on the mode choice of the travelers. While the own car users prefer switch to public transport by 31.80% would shift to bus as an alternative mode of transport, 15.50% would access to Light Rail as an alternative mode of transport, 9.90% would access to Under Ground as an alternative mode of transport and 13% would access to public taxi as an alternative mode of transport, 2.10% would access to other such as motorcycle or bicycles and 26.40% already not use own cars.

Reasons convince to switch from using own car to public transport: In considering the reasons convince to a mode shift from car travel to public transport, it is necessary to understand the factors, which support the great majority of active car users to using Public Transport (PT) system as a regular means of transport. Table 5 presented the major reasons identified when survey respondents were asked to name or, select from a given list, the factors which would influence their decision to use Public transport. The factor of most significance encouraging car users to using the public transport was that the "High traffic congestion and delay". This statement received an average rating of:

- 10.1 % if the PT service is available
- 30% if the PT fare is cheap
- 22% if the PT service is fast
- 5.1% if the PT vehicles are safe
- 4.2% if the PT vehicles are clean and comfortable
- 2.1% if the PT covered all desirable routes
- 26, 4% already not use own car

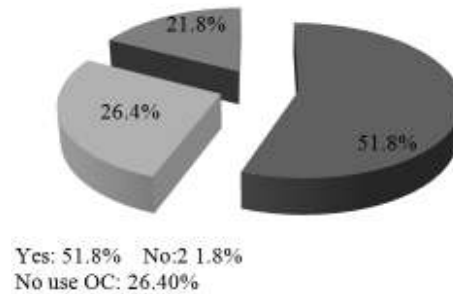


Fig. 4: Access to the public transport mode

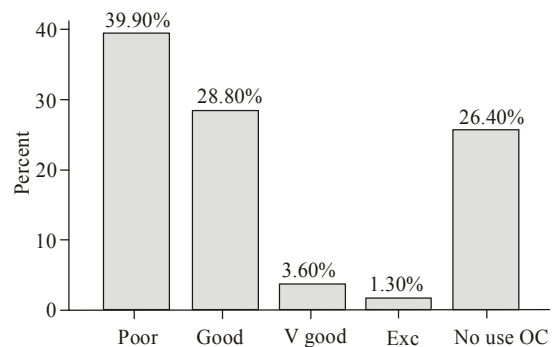


Fig. 5: Opinion of traveler in public transportation

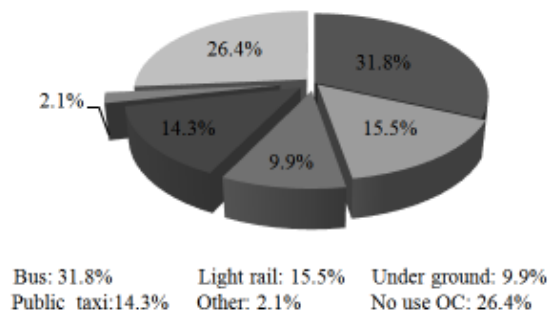


Fig. 6: Switch preference

Table 5: Reasons can convince to switch from using own car to public transport

	Frequency	%	Valid percent	Cumulative percent
Available	101	10.1	10.1	10.1
Fare cheap	300	30.0	30.0	40.1
Fast	220	22.0	22.0	62.1
Safe	52	5.2	5.2	67.3
Clean and comfortable	42	4.2	4.2	71.5
Routes are Covered	21	2.1	2.1	73.6
No use OC	264	26.4	26.4	100
Total	1000	100.0	100.0	

Improving the travel time for the public transport: Transportation is an important service to daily trip. However, due to the increase of private vehicles usage on the road, it has caused many problems such as traffic congestion, accidents, air pollution and lost of

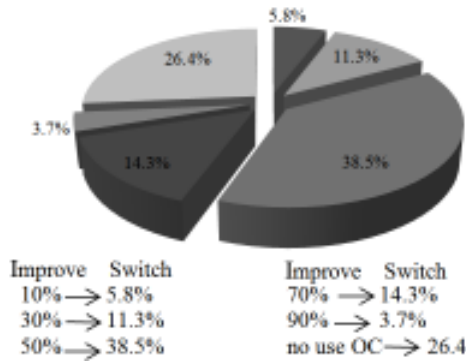


Fig. 7: The impact of the improving the travel time on traveler

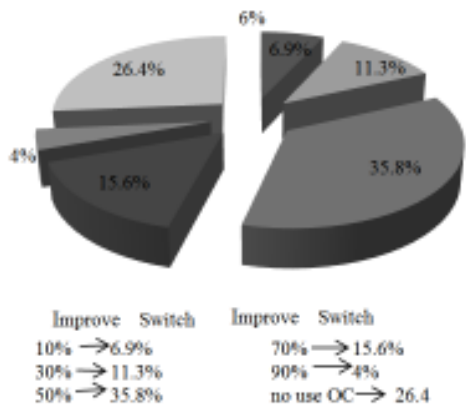


Fig. 8: The impact of the improving the cost on traveler

unproductive times on the road. Reduction of travel time by introducing public transport mode will encourage users or drivers to switch to this mode. The switching to public transport mode may reduce traffic congestion, improve travel time and increase road safety. The results from the study shows the users or drivers or travelers prefer to switch to public transport if the travel time for trips road network improved significantly.

Improvement or reduction in travel time by 10% will encourage about 5.8% to switch, reduction of 30% will encourage about 11.30% to switch, reduction of 50% will encourage 38.50% to switch, reduction of 70% encourage 14.30% to switch and finally reduction of 90% encourage 3.70% to switch to the public transport (Fig. 7).

Improving the travel coast for the public transport:

The other factor affect decision making in choosing travel mode is travel cost. Travel cost is considered an important reason for mode choice. The results from the study shows the users or drivers or travelers prefer to switch to public transport if the travel cost for trips road network improved significantly. Improvement or reduction in travel cost by 10% will encourage about 6.9% to switch, reduction of 30% will encourage about

11.30% to switch, reduction of 50% will encourage 35.80% to switch, reduction of 70% encourage 15.60% to switch and finally reduction of 90% encourage 4.0 % to switch to the public transport (Fig. 8).

CONCLUSION

This study indicate the needs of introducing an efficient public transport system to reduce the traffic problems such as traffic congestion, road accidents and delay in travel time on roads network for all trips. The study attempted to conduct mode choice behavior of travelers and trip characteristics of two modes of transport namely car and public transport. Utility of the two modes were compared to determine the important reasons behind the choice of a particular mode and the circumstances, which might cause travelers to change their choice for the car. In order to promote greater use of public transport, this study examined the effect on car use if total public transportation travel time, travel costs the results suggest that travel time and travel cost are characteristics that determine why car use is a favored modal choice. The findings of this research can be concluded that the travel time and travel cost have significant influence on model shift from car to public transport.

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