World Conference on Transport Research - WCTR 2019 Mumbai 26-31 May 2019

Demand and Driver Supply Implications of Regular Public Transportation System for Policy Makers: A Case Study of Kandahar City, Afghanistan

Mohibullah Rahmat[a,b]*, Shoshi Mizokami[b]

[a]Lecturer, Dept. of Civil Engineering, Faculty of Engineering, University of Kandahar, District 9, Kandahar City, Kandahar, Afghanistan
[b]Professor, Dept. of Environmental Management and Planning, University of Kumamoto, Kurokami, Kumamoto-shi, Kumamoto 860-8555, Japan

Abstract

Kandahar city of Afghanistan being one of the largest cities of the country does not have any regular system of public transportation. Unfortunately, at the moment the entire picture of the current services and future plans is unclear due to the lack of travel behavioral data including trip rate, travel time distribution, modal share and so on. More serious is that mechanism behind the behavior has not been figured out, so that no comprehensive transportation planning was established from theoretical basis. As the unprecedented study in Kandahar city, this paper attempted to carry out a travel survey with RP/SP approach and to understand travel behavior for the first time, by focusing on determinant factors of demand for regular public transportation modes and supply of drivers using discrete choice modelling approach. The results revealed that travel time and travel cost are among the most influential factors for forecasting the demand of public transport. Other socio-demographic factors such as gender, age, monthly income, and vehicle ownership are also demand determinant factors. Particularly, consideration of women in all processes of planning and operating public transit is very essential. On the other hand, due to low income, higher working loads and some other job related factors, the drivers of paratransit system are not satisfied from their current jobs and have shown strong willingness to become bus drivers in future. Their willingness to change their jobs is effected by their personal income levels, other income sources, education and some other social factors.

1. Introduction

Mobility is a vital part of our lives, especially for those living in cities. Public Transportation is one of the most efficient modes of transport which provide the required mobility (Polat, 2012). The services of public transportation are commonly provided by government or private organizations. Irrespective of the providing party, the initial

* Corresponding author. Tel.: +93-700-308-110.
 E-mail address: mohib.rahmat@gmail.com.

investments and running costs are almost always high. On general basis, public transport service suppliers have to study and consider multiple factors to insure the productivity and efficiency of the services (Barnum et al., 2007; De Borger and Kerstens, 2006). Besides the construction and operation costs; avoiding or decreasing other undesired costs associated with environment and traffic congestions are also considered as top priorities of governmental authorities and policy makers. Basically, the decision makers and planners should, on one side, consider provision of efficient and customer satisfactory services to attract people and increase the ridership while, on the other side, make sure to minimize the investments, operating costs and other environmental and social costs (Polat, 2012).

On a general basis, policy-making could be defined as a process of providing a balanced response to the demands of various social groups. Normally, different groups will strive for their own benefits which may contradict the interests of other groups (Meyer and Miller, 2001). According to the findings of Meyer and Miller, (2001) the policies for public transportation could be divided into two categories: (1) will include the policies that would respond to the current demand of public transportation and (2) those policies that would increase the share of public transportation in daily trips.

Generally, the planners and decision makers confront tough multi-criteria decisions in terms of selection of the appropriate alternatives, various mode choices and some environmental impacts. And these decisions involve different interest groups, elected officials, the governmental agencies and the public (Meyer and Miller, 2001). Even some observers have categorized the decisions of public transportation system as both political and tactical process (Wachs, 1985).

Without understanding the dynamics of the system and travel behavior and patterns of the users, it is almost impossible to formulate precise forecasts for planning the services, marketing and making policies for fare allocation and other relevant issues (Polat, 2007; Taylor and Camilla, 2012). This means that understanding and recognizing the physical and behavioral factors that affect the demand of public transport is very essential.

1.1. Factors affecting the demand of public transportation

There is almost no doubt that the demand of public transport is affected by a wide range of factors; however, some may be more effective and important than others under certain situations. Similarly, according to (Balcombe et al., 2004) the demand of public transport is a complex function of almost all related factors and the change of one factor is more likely to affect the decisions and outcomes. As mentioned earlier there are numerous demand determinant factors of public transport such as frequency, travel time (waiting, access and in-vehicle time), speed, comfort, reliability (Hauer 1971), fare, service quality and mode of travel (Lythgoe and Wardman, 2002). Here we will discuss some of major factors in details as follow.

1.1.1. Travel cost and fare

Many researches show that cost of travel is one of the most determining elements of public transport demand (Albalate and Bel, 2010). The generalized cost of a trip is the combined sum of fares and the specific components of a traveler's valuation of her/his own time (Horn, 2004, 2003). Likewise, allocation of fares is very essential as it is the core source of income for the suppliers. It is believed that increase in fares of public transport will decrease the ridership and patronage. Fares are considered the most influential and determinant factors on patronage of public transport. (Bresson et al., 2004, 2003; Bonnel and Chausse, 2000; FitzRoy and Smith, 1998). Studies show that sensitivity of travelers to the changes of fares is not the same for all people. People who have access to cars are more sensitive to the changes of fares compared to those who do not have access to cars. Similarly, males are found to be more responsive than women and people with higher incomes are also more sensitive to these changes; however, they are believed to absorb the changes easily compared to low income travelers. (Balcombe et al., 2004). Similarly, considerations of subsidizing the system or other fare reduction policies can play very essential role in increasing the ridership and encouraging the use of public transport. (Bresson et al., 2003).

1.1.2. Travel time

Another influential and determinant demand factor for public transport is the travel time of the transport mode. Travel time is comprised of three main components namely access/walk time, waiting time and in-vehicle or journey time. The connection or interchange time is also added to the list by some researchers (krygsman et al., 2004). Each of these components has an effect on the patronage of public transport which may vary in size.

Accessibility is generally referred to the degree to which people can use the system with ease. Particularly for a public transport system, the accessibility is linked to the suitability of the transport network which enables the travelers to transfer from the entry point to the exit point in a reasonable time (Murray et al., 1998). Walking or access time is commonly perceived negatively on short trips (Walle and Steenberghen, 2006) therefore, it is very important to decrease the amount of walk time. Cervero, (2001) reported that increase in walk or access time (distance) is strongly linked to the decrease in use of public transport. Similarly, if the walk or access time exceeds a maximum threshold, it is believed that the travelers are likely to shift to other alternatives of transport modes and avoid public transit (Krkygsman et al., 2004).

Waiting time is also a very essential component of the travel time. This time is the actual duration a traveler waits at the stop/station (Hauer, 1971). Researches show that travelers value waiting time higher than in-vehicle time. For example a study conducted on Dutch passengers show that the travelers weighted one minute of delay 2.3 times of one in-vehicle minute (Walle and Steenberghen, 2006).

In-vehicle time is also a major component of travel time. If all other times are equal among some transport modes, the longer the in-vehicle time is the lower the demand of public transport will be. (Polat, 2012)

1.1.3. Service quality

Numerous researchers such as Balcombe et al. (2004), Bresson et al. (2003), Francis (2002), Lythgoe and Wardman (2002) and FitzRoy and Smith (1998) have found that the quality of the services offered by public transport is the most important factor in determining travel demand. These findings show that service quality is composed of many prominent attributes such as frequency, walking distance, operating speed, reliability, waiting time, comfort, network coverage and park-and-ride schemes. The findings of Bresson et al., (2002) show that the quality of service for a specific mode of transport is not dependent only on the supply of that mode, but it also depends on the supply of other alternative modes.

1.1.4. Availability and costs of other travel modes

The choice set of available transport modes and the costs of these modes are closely related to the demand of the public transport. If the number of available modes is high, passengers will chose among the alternatives. Not only the availability of alternatives such as private and public modes will affect the demand of the public transport, but the prices of fuel and private vehicles will also affect the patronage of public transport. Private car ownership is among the most dominant factors behind lower use of public transport. (Bresson et al,. 2004).

1.1.5. The level of supply

People generally choose among the available modes of transport. If the supply of public transport is limited, it is less likely that travelers will prefer that mode and private car will replace the public modes (Polat, 2012). According to Bresson et al. (2004) the impacts of supply on demand can be decomposed into (1) quality and (2) quantity. With reference to his findings the quantity (seats kilometers) was found to have higher impacts while the impacts of quality (density of network and frequency) were not dominant on the patronage of public transport.

1.1.6. The economy

The household income levels, employment rate and overall economical and wealth status of the country are also considered among main determinants of the public transport use. The demand of public transport mainly depends on

household income and price of transport (Bresson et al., 2002). If the household income exceeds specific threshold, the demand of public transport will reduce as people will shift to using private cars. The employment rate of a country is also a very effective factor. The demand of the public transport will increase with increase in employment levels (Polat, 2012).

1.1.7. Population and socio-demographic factors

In a study conducted by Souche (2010), urban density is considered as a main variable in demining travel demand. Other studies also show that the demand for public transport is higher in dense cities compared to the cities with lower densities. Generally, the population density is directly related to the city surface and the change in city surface could affect the demand of public transport in various ways. If the city surface is large and widespread it becomes costly for private transportation (higher fuel consumption) and public modes can be more attractive and cost effective for traveling. However, in such cases the demand also depends of the degree of coverage by the public modes (Polat, 2012).

Social, demographic and cultural factors are also known as influential factors on demand of public transport. Frances (2002) considered population growth as a leading factor. Studies show that with shift in the age groups and structures, the demand is more likely to change (Nurdden et al., 2007; Balcombe et al., 2004). Bresson et al. (2004) found that among the younger population, car ownership and gender were not influential factors but for working age, disparities among men and women in terms of using public transport are substantial. Some other generalized conclusions are that men travel longer compared to women, young people are more likely to use public transport than elderly and more socially oriented people will also use public services more frequently compared to those who are not socially oriented. (Polat, 2012)

1.1.8. Governmental policies

Provision of public transportation is one of the main duties of local authorities. In absence of regular public transportation, the number of private cars will increase and the governmental authorities (e.g., municipalities) will need to tackle more problems such as traffic congestion, air pollution, extension of road networks, provision of parking facilities etc. So basically, there are two alternatives for governments to deal with in terms of supplying transport services. Either develop transport infrastructures or provide public transport services. In various Asian and European cities, the government policies are inclined towards public transportation (Polat, 2012).

Nurdden et al. (2007) conducted a study in Malaysia in order to identify some vital factors which can encourage the use of public transport. His findings show that 'reduced travel times', subsidized fares' and 'shorter distances from home to stops/stations' had a strong impact in discouraging the use of private vehicles.

Subsidizing the fares of public transport is one of the most effective policies adopted by most of the developed countries to attract as many people as possible to public transport. Asensio et al. (2003) found that almost all of developed cities deeply subsidize public transport services. The study further showed that the effect of subsidization policy is very essential in urban areas compared to small ones.

1.2. Transport in Kandahar city

Kandahar City being one of the 3 largest cities in Afghanistan is located 457km southeast of Kabul (Capital City of Afghanistan). The Central Statistics Organization of Afghanistan (CSO, 2017) recorded the population of Kandahar City at 448,262 persons in 2016; however this population was 385,700 people in 2011 which shows a clear growth. This increment of population has caused an expansion and development of the urban center filled by low income houses and crowded streets. These developments have generated some serious challenges for transportation providers and policy makers as they have to respond to the growing demand of transportation by providing convenient means of transport while simultaneously ensuring the economical, safety, environmental and other social demands. On the other hand, the dominance of private cars and motorcycles have also created several complications by contributing to traffic congestion, air pollution and other health related problems. Similar to other developing cities, motorcycle is the most dominant mode of transport in Kandahar City followed by private cars. Low income

families are mostly dependent on use of motorcycles while medium to high income families may own both motorcycles and cars. Low prices and ease of usage make motorcycles the first choice for the residents of Kandahar City.

Currently, Kandahar city lacks regular public transportation system and the only available mode of public transport is paratransit system. This system is operating as an irregular and/or informal system with very limited or no control from the governmental authorities. However, some private unions created by the owners of the sector have some rules and regulations in terms of fare allocation, scheduling and route selection. The paratransit system of Kandahar city is formed by only three types of vehicles namely regular car taxi, rickshaw and Zaranj-taxi (heavy duty motorcycles modified by locals for transport of people). As mentioned earlier, government does not have any control over the sector which resulted in existence of very old vehicles in the system; particularly, the taxi fleets are decades old.

With reference to their operational characteristics, paratransit system of Kandahar city can be divided into two groups. The first group which includes zaranj-taxis and some car taxis, operate on fixed routes. Generally the vehicles will have a stop (i.e. terminal) at both sides of the route and will wait for their turn. The vehicle will not leave the stop unless all seats are fully occupied. The fares for this category are fixed and much lower compared to the second category. One of the poorest characteristics of this category is their limited service and availability on very limited routes of the city. The second category includes the normal taxis and rickshaws which operate as regular taxi cabs. These taxis are available on almost all routes of the city and are charging much higher compared to the first category.

The paratransit system of Kandahar city has number of deficiencies in terms of level of service; the most crucial being the irregular services provided by the system. Similarly, the existence of very old vehicles, lack of attention to safety regulations and fluctuations in fares are other problems associated with the current paratransit transport. Considering these problems, the governmental policy makers are trying to introduce alternative public modes in accordance with sustainable transportation policies to attract private car users. However, introduction of regular public transportation needs extensive work. Unfortunately, at the moment the entire picture of the current services and future plans is unclear due to the lack of travel behavioral data including trip rate, travel time distribution, modal share and so on. More serious is that mechanism behind the behavior has not been figured out, so that no comprehensive transportation planning was established from theoretical basis. For instance, there is no discussion weather scheduled bus service should replace the existing paratransit that provides a reliable and cheap mode of transport as well as job opportunities to the poor as a driver. As the unprecedented study in Kandahar city, this paper attempts to carry out a travel survey with RP/SP approach and to understand travel behavior for the first time, by focusing on determinant factors of demand of regular public transportation modes and supply of drivers using discrete choice modelling approach. The findings of this study will contribute to offering future perspective and making a scientific decision of urban transport planning.

1.2.1. The transformation process

As mentioned earlier, due to the population growth and dominance of private vehicles which is associated with multiple transport related problems; the government of Kandahar city is planning to introduce a regular mode of public transport. However, this transformation is a very complex and challenging process and will demand extensive efforts. Multiple studies are available regarding the transformation from paratransit system to more advance and regular modes of public transport. As initial modes of public transportation, paratranist systems are almost always transformed fully or partially to more regular modes. In many developing countries, this process is a political one and requires tremendous amount of negotiation. Likewise, as this sector provides a cheap and accessible mode of transport to the poorest population, the transformation or eradication of the system is socially problematic as well (Zhou, 2012).

The positive or negative consequences, of developing i.e. moving from paratransit to more advanced and regular modes of public transportation are not shared among the cities around the world. Besides, social and cultural issues the perspectives of the cities may play a vital role in determination of outcomes. Similarly, the networks of the system and the dependencies will also affect the extent of the changes (Ferro and Bhrens, 2015).

Another vital issue for transforming from paratransit to regular modes is consideration of the impact of the system on peripheral areas. Because of unsystematic decisions, flexibility and demand-dependent nature of the paratransit systems, they are operating in urban areas and have covered the city centers. This coverage is caused by residents to travel and by the opportunities presented to paratransit operators (Garcia, 2007). Theoretically, the direct routes of paratransit systems group in central areas where the demand is high as a result of high levels of activities, however, they disperse as they move far from the central areas. Consequently, the competition level also drops in exterior areas of the city center (Ferro and Bhrens, 2015). According to some researches after introduction of regular public modes, the characteristics of the paratransit systems will change significantly. One good example is of Santiago in Chile where a BRT system was introduced in 2007. After introduction of the system a lot of characteristics of the paratransit systems were changed (Figueroa, 2005; Gomez, 2012).

It is very obvious that a part of the city can be replaced by regular public modes; however, in some areas complete eradication of the paratransit system is almost impossible. Therefore, it is important to consider the inclusion of the paratransit sector in the development and reform initiatives of public transportation; though, researchers have identified various obstacles for doing so. Initially, these negotiations will take a long time and in most cases they will be demanding (Ferro and Bhrens, 2015). Schalekamp and Behrens, (2010) have studied implementations of BRT systems in some of South African cities and they argued that engaging the incumbent operators into the process has caused numerous unexpected delays and obstacles throughout the implementation process. It is explained that prior to engaging the paratransit operators into the process, it is essential to consider the context-specific paratransit relevant path dependencies as well. The authors further emphasize that without consideration of the contextual adaption the transferring engagement approach may not be successful (Schalekamp and Behrens, 2010).

The second major obstacle in the process of including paratransit as "formal" or "regular" operator in the developing process is the extra cost resulting from this decision. Flores and Zegras (2012) 20) conducted a research to study the costs of various phases of BRT implementation in Mexico City. Their findings proposed two conceptual options for engaging the paratransit operators to the process. The options were termed as "fostering" changes and "forcing" changes. According to the arguments of the authors, fostering changes will result in progressively complex negotiations with the operators as well as compromises in the designs of the system which will result in generating more costs. On the other hand, the costs associated with forcing changes were called to be of more political and social. As a conclusion the authors explain that considering fostering approach could be more expensive in the long term (Flores and Zegras, 2012).

1.2.2. Consideration of gender in planning public transport

Initially, in 1990s the studies in developing countries recognized that the patterns of transport demand for men and women are often considerably different and usually the transport needs of women are not considered in the policies of transport sector (Riverson et al., 2006). Various studies have showed that rural and urban woman may have different travel needs; still similarities have been identified by multiple studies. A study conducted in Bangladesh showed that the rural female residents have their own travel needs; however, they are less than the needs of men travelers. These findings were confirmed by other similar researches conducted in Ghana and Tanzania (IT Transport-UK, 2002). The findings further state that woman are not really concerned about their travel time compared to men which apparently reflects their lack of financial abilities as in most cases men control household income. Likewise, women living in poor urban areas may have their own substantial transport needs.

As a developing country Afghanistan shares most of transportation related characteristics with their other developing counterparts, however, cultural and social conservations makes Afghanistan a very unique case. Particularly, Kandahar city has totally different social and cultural traditions which are directly correlated to the transportation sectors of the city. In this part of the country, women are not able to ride bicycle, motorcycles or drive a car. Though the governmental laws encourage female to drive but due to some traditions and cultural issues, it becomes almost impossible for women to drive or ride. These limitations have created some serious transport related obstacles for female residents of the city. The public modes which currently are limited to paratransit are the lone options for women of the city to travel from one place to another. The major problem is that these services are not available at all parts of the city and makes it very difficult for women to travel. Not only the accessibility of the

current modes is limited, the fares are also considerably high and put an extra financial burden on most of the households.

Nomenclature

RP	Revealed Preference
SP	Stated Preference
NL	Nested Logit
MNL	Multinomial Logit
$Pr(i)$	The probability of the decision-maker choosing alternative i
V_j	The systematic component of the utility of alternative j.
C_1	Alternative specific constant for mode j
$\beta_{1j}, \beta_{2j}, ... \beta_{nj}$	Coefficients associated with explanatory variables
$X_{1n}, X_{2n}, ... X_{qn}$	Explanatory variables for individual n
q	Number of explanatory variables in the model

---

2. Methodology

2.1. Data Collection

For collection of the data, two questionnaires were designed. The first questionnaire was designed to collect the data about demand of the public transport and to identify the factors which may affect the mode choice behaviors of respondents. This questionnaire was divided into three sections. The first section was aimed to collect the general data about vehicle ownership, family income, family members etc. Section two was designed to collect the daily trip data for one working day in the middle of the week. The respondents were asked to register their trip characteristics such as start and end time of the trip, trip purpose, accompanying persons, mode of the trip and total distance traveled. A total of six trips per day were placed in the questionnaire. The third section of the questionnaire was designed for SP survey.

The SP survey was designed in accordance to Fractional Factorial Design. Four options of transportation modes such as private car, private motorcycle and taxi (currently available modes) and bus (future plan), were selected to prepare SP choice sets. The private modes had two attributes (i.e. travel time and travel cost) and every attribute had three levels. The public modes (Taxi and Bus) have three attributes (i.e. travel time, waiting time and travel cost) at three levels each. An example of one choice set is shown in Fig 1.
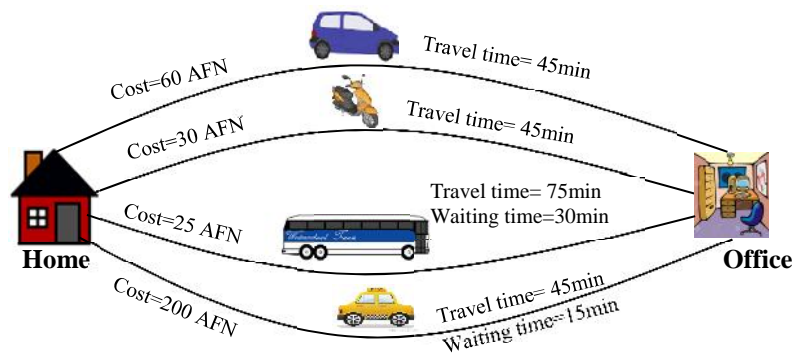

Fig.1 An example of choice SP choice set

The survey was conducted in September and October of 2016. A total of 1500 questionnaires were distributed to 300 households from which around 1000 were returned and/or collected and 603 questionnaires coming from 180 households were found eligible for use in the study.

In order to have a clear insight about the characteristics of the drivers of the current paratransit system a second questionnaire was also developed. This questionnaire was also divided into three main parts. The first part comprised some socio-demographic and family members' information. The second part of the questionnaire was designated to questions related to the paratransit vehicles such as age of the vehicle, type of gas/fuel used, maintenance and other expenses of the vehicle etc. The final part of the questionnaire asked the drivers regarding various aspects of their jobs as well as some questions related to quality of life (QOL). As most of the paratransit drivers in Kandahar city are illiterate, therefore, the method of the survey was chosen to be face-to-face interviews. This survey was also conducted in September and October of 2016 and five professional interviewers were hired and trained to interview the drivers. A total of 480 drivers were approached, 263 drivers agreed to take part in the survey; 63 drivers did not answer all parts of the questionnaire which resulted in 200 completed and eligible samples.

2.2. Method of analysis

After the completion of the surveys a database was developed for digitizing responses, cleaning outliers and imputing missing. Later, an overall aggregate analysis was conducted to check various aspects of the responses and control the overall status of the data. Finally, the mathematical function of discrete choice modeling approach was chosen for analysis of SP data. More precisely, the technique of Multinomial Logit Model, and two structures of Nested Logit Models were used for the analysis. On a general basis a typical multinomial logit model has the following form which was used for this study without further modifications:

$$\Pr(i) = \frac{\exp{(V_i)}}{\sum_{j=1}^{J} \exp{(V_j)}} \tag{1}$$

Similarly, the utility of an individual (n) from mode j, Vjn, can be derived as a linear function of explanatory variables as follows:

$$V_{jn} = C_1 + \beta_{1j}X_{1n} + \beta_{2j}X_{2n} + \cdots + \beta_{nj}X_{qn} \tag{2}$$

As mentioned earlier after obtaining the results from running the first Multinomial Logit Model, it was decided to check whether the public modes and private modes have some shared attributes among them or not. Therefore, we divided the SP choices into two sub groups and created two various nests for proposed nested models which are shown in Fig 2. The aim of these structures was to see the relationship between bus and taxi as well as car and motorcycle.

The data was analyzed using the R statistical package by programming the utility and probability functions into the software.
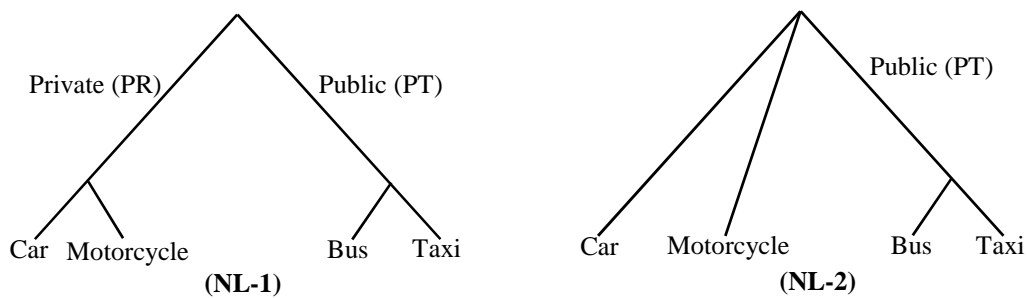

Fig.2 Structures of Nests

3. Result and Discussion

3.1. Descriptive analysis of household and individual data

With reference to the findings of the previous researches discussed in the first section of this paper, in order to identify the demand of public transportation it is important to study the social and demographical attributes of the public and check their impacts on mode choice selection and other transport related decisions. The results obtained from the aggregate analysis of our study showed that the respondents who took part in this study are mostly young as 38.5% of them were recorded to have an age interval of 20-30 years. These numbers show that young generation is a big part of the population in Kandahar city and their travel-related characteristics and mode choice behaviors should be properly studied and considered in planning regular public transport. Considering the gender aspect of the study the participation of female respondents is only 18%. With respect to the context of Afghanistan and its current educational system particularly for female residents, the education level of our participants are quite good since 34% of them were holders of bachelor degrees where 31% had completed high school studies. Most of the participants were students with a percentage of 37.9%. Self-employed participants occupied the second place with a percentage of 23.3%. The numbers obtained from the survey show that the income level of the participants is mostly in the range of medium-to-high considering Afghanistan's condition. The numbers show that 21.7% of the residents have a monthly income of 20,000-30,000. With respect to the income level of residents and the condition of public transportation system, one can assume the high use of private vehicles for daily trips. This has been confirmed by the study as almost every house (99.44%) has at least one type of private vehicle which includes bicycle, motorcycle, car and Zaranj. However, the numbers for motorcycle ownership is the highest. The results showed that 87.2% of the houses have at least one motorcycle per family. Other details of the demographics are presented in Table 1.

Table 1 Descriptive statistics of demographic characteristics of respondents

	Characteristic	Portion (%)		Characteristic	Portion (%)
	1-10	3.8		No Income	1.7
	10-20	25.2		Below 5000	0.6
	20-30	38.5		5001-10,000	9.4
Age	30-40	16.3	Monthly Household Income (1USD = 68Afn at the time of study	10,001 -20,000	20.6
	40-50	8.3		20,001-30,000	21.7
	50-60	5.8		30,001-40,000	13.9
	60	2.2		40,001-50,000	13.3
	Master / Doctor	4.0		50,001-80,000	10.0
	Bachelor	34.0		80,001-100,000	3.9
	High School	31.5		>100,000	5.0
Education	Secondary School	14.9	House Ownership	Own the house	81.0
	Primary school	4.5		On rent/lease	19.0
	Religious Studies	2.5	Marital Status	Single	47
	Literate (read &write)	2.7		Married	53
	Illiterate	6.0	Gender	Male	88
	Government Worker	15		Female	12
	Self-employed	23.3	Driving Licence	Own Licence	38
	Private Firm/NGO Worker	7		Do not own any	62
Occupation	Teacher/Instructor	10.9	Car Ownership	Yes	66.1
	Student (Education)	37.9		No	33.9
	Housewife	1.5	Motorcycle Ownership	Yes	87.2
	No Occupation/Retired	4.4		No	12.9

3.2. Analysis of demand (the users)

As mentioned in previous sections, the first questionnaire was designed to obtain the trip dairies of the residents in various parts of the city. 603 residents recorded a total of 1937 trips. Further calculations showed that on average

basis, every individual had 3.21 trips per day. Our findings showed that trip dairies of men and women are completely different. On average basis men are making 3.3 trips per day and women make fewer trips as 2.7 daily trips were recorded. One of the main reasons behind this fact is the cultural and social rules and regulations which limited the mode choices and transport alternatives of women in Kandahar city. When the number of the trips increases, the distance travelled will also increase, so it is understandable that on average, women travel over shorter lengths compared to men. The results show that every man in Kandahar city travels about 16.2km per day which is much higher compared to the length of 9.8km travelled by women. With similar manner, the length of every trip is also shorter for female residents. Every trip made by men will cover an average length of 5.1km, while for women the average length of each trip is just 3.7km. Similarly, the trip purposes also varied between male and female participants. Generally, about half of the trips (43.9%) were made for going 'back to home'. Educational trips which were recorded at 20% were the second on the list. Furthermore, the results show (Fig 4) that most trips are made by using motorcycles which comprises 45% of the total trips. Car is the second dominant mode which is used for 23.3% of the trips. However, the most important issue is the limited use of public modes with only 4.4% value.
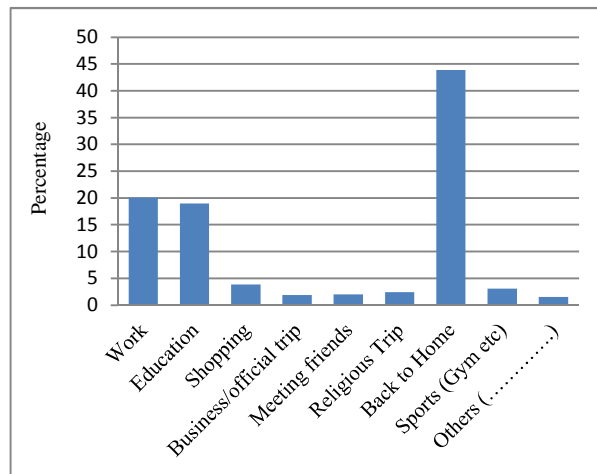

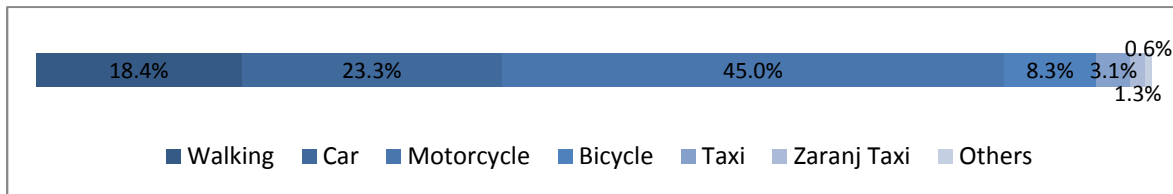Fig.3 Distribution of trips with respect to trip purpose

Fig.4 Distribution of mode share in daily trips

With respect to the findings of the study it's very clear that the female population of the city have smaller choice sets for using transportation in their daily lives. Due to some cultural and social traditions and limitations, women are not able to ride and/or drive by their selves. This leaves two alternatives for women to travel from one place to another; they should go with their family members or use the public transportation. However, the current available public transportation modes i.e. paratransit has limited coverage and the fares are also reasonably high. This could be the main reason that the female respondents showed a much higher eagerness to use the bus system in the future compared to the male respondents. Fig 5 shows the remaining details.
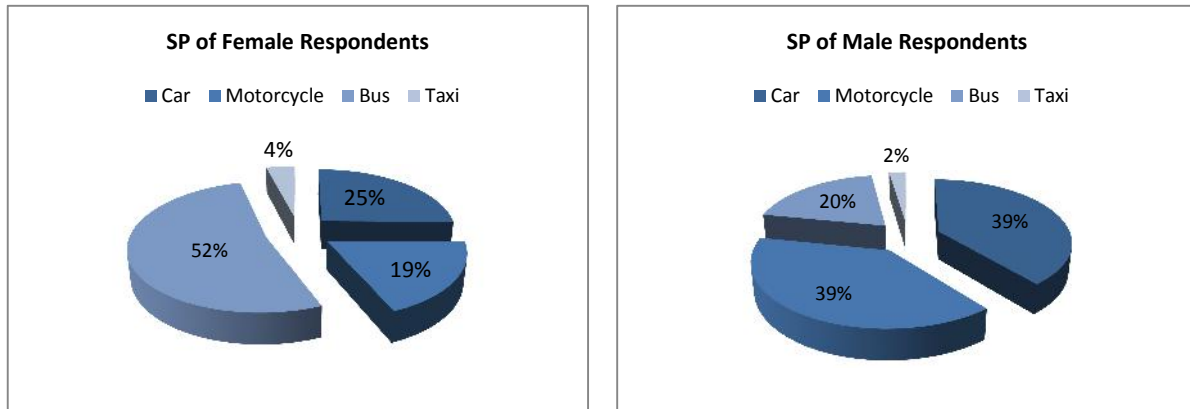
Fig.5 Transportation mode choices with respect to gender

Fig 3 clearly proves that due to limited transportation choices women are in more need of public transportation. Therefore, it is very important for the government and all transportation policy makers to consider the gender issues in planning new regular modes of transportation and/or upgrading the current paratransit system. With respect to the context of the city and other cultural and social limitations, it is recommended that policy makers should consider women residents in all transportation planning particularly, the public transport. While designing public transport, it is very important to consider female-oriented stops, access routes to and from stops, fare allocation for middle class female residents and more importantly the flexibility of networks to major schools and universities of the city as most of female trips are made for educational purposes.

3.2.1. Results of MNL and NL

As explained earlier, the SP sets designed for this study included four modes of public transportation. Three of the modes are currently existing and one mode i.e. bus is considered for future plan. The respondents were asked to select one mode with respect to their attributes. The responses were then analyzed through use of MNL approach. Almost all of the explanatory variables showed statistical significance. As almost 70% of our respondents were aged below 30 we decided to divide the age groups into two parts and see if the different age groups can affect the choices. Likewise, income was also divided into three categories to check the significance of every group. The t-values of all income categories are significant with a negative sign. Similarly with a t-value of 1.704 consideration of gender will also be important variable for planning public transport. Most importantly the estimation results showed that the residents of Kandahar city gave more importance to the travel time of their trips which coincides with other findings of similar studies (Polat, 2012; Walle and Steenberghen, 2006; Krkygsman et al., 2004; Cervero, 2001). Therefore, controlling the travel time (walking and access time, waiting time and in-vehicle time) of public transport will be very important factor in identifying the demand of transit and planning public transport. The coefficient for the cost of travel modes with a smaller value than travel time is still significant suggesting the importance of cost as well. In other words the coefficient of the cost suggests that the fares of the public modes should be controlled which may attract more riders for the public modes. The reason behind the smaller value of travel cost compared to the time of travel could be because of the relatively good income of most of the households who participated in the study. Another reason is the participation of female residents in the study. In Kandahar city, female residents are not working and their financial issues are taken care of by their parents, husbands or brothers. Therefore, women are not really concerned about the expenses of the trips which affected the results.

After obtaining the results of the MNL model, the authors thought that there might be some common and shared attributes between the public modes (taxi and bus) and private modes (car and motorcycle) hence; the first nested structure (NL-1) was developed to check the changes in values of variables. In this model we grouped (nested) public transport (bus and taxi) and private transport (car and motorcycle) to see if there are shared attributes. Once the model was run, the logsum of private mode had a coefficient of 1.101 which suggested weak bond between car

and motorcycle, though, the logsum value for public mode was significant at 0.857. Later the second nested structure was chosen (NL-2) where only public modes were grouped together while private modes were left alone. The estimations confirmed a stronger bond between public modes. As it can be seen in Table 2, the values of explanatory variables are much smaller in NL models compared to the MNL and most of them are not significant. Still we wanted to keep the results which will give an insight for future studies. The details of estimations for all the models are listed in Table 2.

Table 2 Estimation results of all models

Variables	MNL		NL-1		NL-2	
	Parameter	t-value	Parameter	t-value	Parameter	t-value
Taxi Constant	3.262	7.734	0.587	1.654	0.321	1.325
Motorcycle Constant	2.589	16.806	1.034	4.323	0.687	6.047
Bus Constant	2.523	12.562	-0.783	-0.397	-1.014	-0.813
Age1 (0-20)	-0.489	-1.495	-0.501	-1.389	-0.318	-1.115
Age2 (20-60)	-0.457	-1.316	-0.442	-1.203	-0.264	-0.917
Car Ownership	1.014	7.989	1.053	4.416	1.012	8.785
Income1 (0-10,000)	-0.549	-2.683	-0.611	-2.435	-0.578	-3.058
Income2 (10,000-30,000)	-0.548	-4.002	-0.607	-3.512	-0.534	-4.313
Income3 (30,000-50,000)	-0.221	-1.547	-0.227	-1.487	-0.161	-1.252
Gender	0.282	1.704	1.973	3.661	1.969	3.648
Travel Cost	-0.002	-1.684	-0.003	-1.117	-0.002	-0.834
Travel Time	-0.009	-3.121	-0.011	-3.292	-0.010	-4.011
Logsum Private		NA	1.101	4.447	NA	NA
Logsum Public		NA	0.867	1.142	0.731	1.422
Rho-Square		0.184		0.184		-0.014
Adjusted Rho-Square		0.179		0.179		-0.019

3.3. Analysis of supply (the drivers)

For having a clear evaluation of the paratransit system of Kandahar city and providing suggestions about supply of drivers for future public transit; we developed a binary logit model 'Career Change Model' for analyzing a part of the data obtained from interviews with the drivers of the current paratrnsit system. We wanted to see how many of the current paratransit drivers will show willingness to become bus drivers once a regular bus system is introduced and which factors will affect their decisions.

The socio-demographic statistics show that most of the paratransit drivers in Kandahar city are aged from 20-50 years (92.5%). The majority of drivers are married (89.5%) and a big percentage (62%) is illiterate. However, some of them have very basic knowledge which is limited to only reading and writing. One interesting point is that 20% of the drivers confessed that they do not own any type of driving license and are still driving freely. Though in reality this number is way bigger as most of the drivers are afraid and will give a false statement by saying they have a driving license. This means that the knowledge about the traffic rules and regulations is very limited among the taxi drivers which may contribute to the amount of accidents as well as the level of congestion in the city. On the other hand, the income level of the drivers is much lower compared to other normal residents of the city. Based on the findings, 54% of the drivers have a monthly income of 5,000-10,000 which can be categorized as low income in the context of Afghanistan though the drivers are working as hard as other residents of the city or even harder as almost 80% of the drivers are driving 40km or higher per day (Fig 6) and full time drivers are working at least 8-10 hours per day. With reference to the low income of the paratransit drivers, it is very obvious that the drivers do not have any other sources of the income which is proved by their response for the question which asked the drivers why they chose this job, 91% stated that they had no other choices (Fig 7).
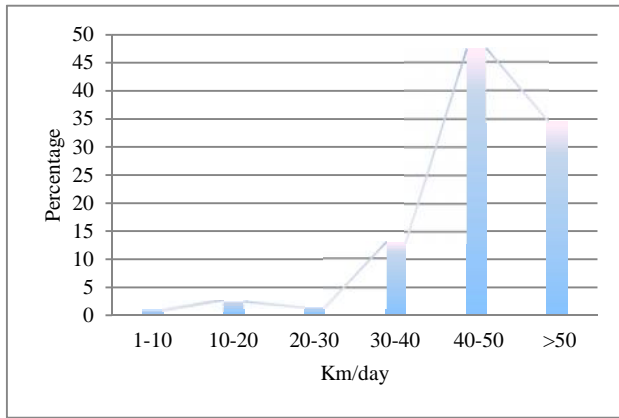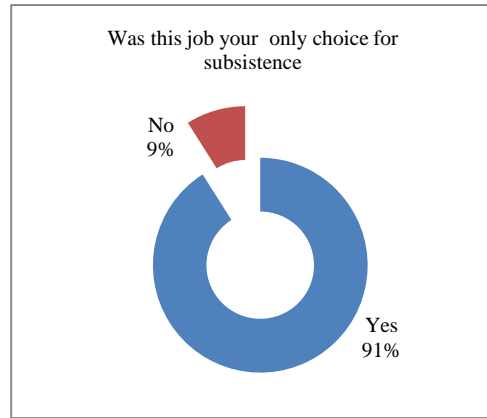
Fig.6 Daily mileage of drivers

Fig.7 Reason of choosing this job

3.3.1. Results of binary logit model

In order to study and estimate the supply of drivers for the new bus system, we ran a binary logit model for the questions asking the drivers about whether they want to change their jobs, and if they want, do they want to be bus drivers in the future. A t-value of 3.749 for the 'willingness to be bus driver' which is the highest in our model shows strong significance and suggests that current paratrasit drivers are willing to be bus drivers in the future. As shown in Table 3, there are other factors also which may affect their decisions. Age and income level are from the main factors. Surprisingly, variable of 'education' is also significant with a plus sign which means that the drivers with education are more likely to change their jobs and be bus drivers.

The strong willingness of the paratransit drivers to become bus drivers could be a good sign for policy makers as most of the drivers who are also the owners of the paratransit vehicles do not oppose introduction of regular public transport, and on the contrary they will join and support the new systems. However, the allocation of fair amount of monthly salaries and/or private public partnership schemes could be very essential and effective to attract these drivers from paratransit to the public modes. Still, if we consider the amount of the drivers required for an entire system of public transport for example bus system; these drivers may not be sufficient. Nevertheless, other residents of Kandahar city who are jobless and/or not happy from their current jobs may also show eagerness in becoming bus drivers.

Table 3 Binary model estimation results

Variables	Estimates	t-value
Age1 (16-30)	2.664	2.986
Age2 (30-60)	2.274	2.691
Education	0.597	1.698
Personal income	-0.698	-1.554
Other income sources	-0.398	-1.309
Possession of license	0.788	1.991
Taxi ownership	-0.435	-0.858
Willingness to change job and be bus drivers	1.280	3.749
Log Likeratio		0.088

4. Conclusion

This study focused on demand and driver supply aspects of the currently available paratransit system of Kandahar city as well as the probable future modes. The results of the RP survey showed that very few people use the current

paratransit system for their daily trips. However, due to multiple reasons relevant to the current services of paratransit system the residents of the city are keen to have access to the regular public modes. This claim is confirmed by the results obtained from the SP survey. Moreover, the results of MNL and NL suggested that the public residing in Kandahar city are more sensitive to the travel time of the current and future transportation modes. Therefore, controlling the travel time (walking and access time, waiting time and in-vehicle time) of public transport will be very important factor in identifying the demand of transit and planning public transport. The coefficient for the cost of travel with a smaller t-value compared to travel time is also statistically significant suggesting the importance of cost. In other words the coefficient of the cost suggests that the fares of the public modes should be controlled which may attract more riders for the public modes. Additionally, the coefficients of age, gender, car ownership and income are also significant signifying the importance of these factors in planning a regular public transportation system. All these factors are essential demand determinant factors for public transportation and will strongly affect the demand of the transit modes. Therefore, it is vital for the governmental officials and policy makers of Kandahar city to take these factors into consideration while planning a regular public mode for the city.

The SP analysis also showed that willingness of women to use a regular bus system in the future is much higher compared to the willingness of men. This fact is strengthened by the significance of gender in our MNL and NL models. Of course one of the main reasons for such eagerness is the limitation of currently available transportation modes to female residents as they are not able to drive and/or ride by their own. Therefore, in order to plan and provide a public transportation system which will be favorable and accessible to both men and women; consideration of gender in all processes of designing, planning and running public transport will be very important for Kandahar city. All over the world multiple studies have suggested several issues and theoretical solutions regarding gender and public transportation, however, the successful intervention of these findings and policies are not found at large scale in most of the developing countries. For Kandahar city, in order to overcome the great challenges, barriers and obstacles posed by people, culture and traditions, security and conservative society; it will be essential for the government to work in partnership with all stakeholders from various sectors, administrations and civil societies.

Furthermore, for developing an efficient and sustainable system of public transport, consideration of the drivers is also vital. With reference to the findings of this study the drivers of public modes in Kandahar city are not really satisfied from their jobs and income levels. Furthermore, their income is much lower compared to incomes of other residents working the same amount or even less. This has made the drivers to think about changing their jobs and show eagerness in becoming bus drivers in future. The willingness to change their jobs and become bus drivers is affected by their personal income levels, other income sources, education and some other social factors.

On the other hand, the fact that the current paratransit system will be active even after introduction of a regular public transportation system cannot be ignored. Therefore, it is very important to consider the betterment of this system as well. Though the current paratransit system is not controlled by the government, still government can play a very important role in supporting the growth and improvement of the paratransit system by proposing and enforcing some regulations to manage paratransit. Even after having regular public transport services, paratransit sector is needed as feeders to the main modes.

The engagement of the paratransit operators into the process of planning, implementing and running a more advanced and regular public transport system is also essential for policy makers. This inclusion can be for short and long terms. However, this process will be highly affected by the context and environment of the city as well as the objectives of the restructuring or introduction program. Though, at all conditions, it is very essential to consider the degree of including the paratransit operators into the process which will result in various risks such as inclusion costs, local and peripheral coverage and risks associated with accessibilities.

References

Albalate, D. and G. Bel, 2010. What shapes local public transportation in Europe? Economics, mobility, Institutions and Geography. Journal of Transport. Research. Part E, 46, 775-790.

Asensio, J., A. Matas and J.L. Raymond, 2003. Redistributive effects of subsidies to urban public transport in Spain. Journal of Transport Review 23, 433-452.

Balcombe, R., R. Mackett, N. Paulley, J. Preston and J. Shires et al., 2004. The demand for public transport: A practical guide. Transportation Research Laboratory: TRL Report 593, http://eprints.ucl.ac.uk/1349/1/2004_42.pdf.

Barnum, D.T., S. McNeil and J. Hart, 2007. Comparing the efficiency of public transportation subunits using data envelopment analysis. Journal of Public Transport, 10, 1-16.

Bonnel, P. and A. Chausse, 2000. Urban Travel: competition and pricing. Journal of Transport Review, 20, 385-401.

Bresson, G., J. Dargay, J.L. Madre and A. Pirotte, 2003. The main determinants of the demand for public transport: A comparative analysis of England and France using shrinkage estimators. Journal of Transport Research Part A, 37, 605-627.

Bresson, G., J. Dargay, J.L. Madre and A. Pirotte, 2004. Economic and structural determinants of the demand for public transport: An analysis on a panel of French urban areas using shrinkage estimators. Journal of Transport Research Part A, 38, 269-285.

Bresson, G., J.L. Madre and A. Pirotte, 2002. Forecasting demand for public transport in Paris region. Comparison between a time-series and a panel data econometrics approaches. Working Paper.

Central Statistics Organization (CSO). 2017: Afghanistan Statistical Yearbook 2016-17, Kabul, Afghanistan.

Cervero, R. and K. Kockelman, 1997. Travel demand and the 3Ds: Density, diversity and design. Journal of Transport Research Part D: Transport Environment, 2, 199-219.

Cervero, R., 2001. Walk and ride: Factors influencing pedestrian access to transit. Journal of Public Transport, 3.4, 1-23.

De Borger, B. and K. Kerstens, 2006. The performance of bus-transit operators. Document de travail du LEM. 2006-3 (21p).

Ferro, P.S., and Bhrens R., 2015. From direct to trunk-and-feeder public transport services in the Urban South: Territorial implications. Jjournal of transport and land use, 8.1, 123-136.

Figueroa, O., 2005. Transporte urbano y globalización–Políticas y efectos en América Latina. Journal of Revista EURE (Santiago) 31.94, 41-53.

FitzRoy, F. and I. Smith, 1998. Public transport demand in Freiburg: Why did patronage double in decade? Journal of Transport Policy, 5, 163-173.

Flores, O., and C. Zegras., 2012. The cost of inclusion: Incorporating existing bus and paratransit operators into Mexico City's BRT. 12th Conference on Advanced Systems for Public Transport (CASPT), Santiago, Chile. 23-27.

Francis, P., 2002. Forecasting travel in the Paris region: Benefits and limits of an econometric approach. Journal of Recherche Transport Securite, 77, 243-258.

García, A. P, 2007. Movilidad, pobreza y exclusión social–Un estudio de caso en la ciudad de Lima. Ph.D. dissertation, Universitat Autònoma de Barcelona, Barce-lona, Spain.

Gómez Lobo, A., 2012. The ups and downs of a public transport reform: The case of Transantiago. Serie documentos de trabajo SDT354, Universidad de Chile, Departamento de Economía, Santiago, Chile.

Hauer, E., 1971. Fleet selection for public transportation routes? Journal of Transport Science, 5, 1-21.

IT Transport, UK (funded by DFID). The Value of Time in Least Developed Countries: The African Studies (R8307) (accessible on www.transportlinks.org).

Krkygsman, S., M. Dijst and T. Arentze, 2004. Multimodal public transport: An analysis of travel time elements and the interconnectivity ratio. Journal of Transport Policy, 11, 265-275.

Lythgoe, W.F. and M. Wardman, 2002. Demand for rail travel to and from airports. Journal of Transportat, 29, 125-143.

Meyer D., and J. Miller, 2001. Urban transportation planning 2nd ed. New York, NY:McGraw Hill.

Murray A., R. Davis, R. Stimson and L. Ferreira, 1998. Public transport access. Journal of Transport Research Part D, 3, 319-328.

Nurdden, A., R.A.O.K. Rahmat and A. Ismail, 2007. Effect of transportation policies on modal shift from private car to public transport in Malaysia. Journal of Applied Science, 7, 1013-1018.

Polat, C., 2007. Review of the literature and discussion on marketing and forecasting demand for urban public transport services. European Journal of Scientific Research, 19, 174-199.

Polat, C., 2012. The Demand Determinants for Urban Public Transport Services: A Review of the Literature. Journal of Applied Sciences, 12.12, 1211-1231.

Riverson, J., Kunieda M., Roberts, P. Lewi, N., Walker, V., M., 2006. An overview of women's transport issues in developing countries the challenges in addressing gender dimensions of transport in developing countries: lessons from world bank's projects, TRB Annual Meeting CD-ROM.

Schalekamp, H., and R. Behrens., 2010. Engaging paratransit on public transport reform initiatives in South Africa: A critique of policy and an investigation of appropriate engagement approach. Journal of Research in Transportation Economics 29, 371-378.

Souche, S., 2010. Measuring the structural determinants of urban travel demand. Journal of Transport Policy, 17, 127-134.

Taylor, B.D. and N.Y. Camilla, 2012. Fink, (n/a). Factors influencing transit ridership: A Review and analysis of the ridership literature. UCLA Deptment of Urban Planning, UCLA Institute of Transport Studies, Working Paper.

Wachs M., 1985. Management vs. political perspectives on transit policy making. Journal of Planning Education and Research 4.3, 39-45.

Walle, S.V. and T. Steenberghen, 2006. Space and time related determinants of public transport use in trip chain. Journal of Transport Research Part A, 40, 151-162.

Zhou, J,. 2012. Sustainable Transport in the US: A Review of Proposals, Policies, and Programs since 2000. Frontiers of Architectural Research, 1.2, 150-165.