EVALUATION OF FACTORS THAT ENCOURAGE PUBLIC TRANSIT USAGE: A CASE STUDY OF LAHORE

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ABSTRACT: Mass Transit System is considered as one of the important parameter in reducing Public Transport (PT) problem worldwide. Commonly used systems under the umbrella of Mass Transit are Bus Rapid Transit System (BRTS) and Light Rail Transit System (LRTS). BRTS is considered better in urban transport planning because of its lesser construction cost and higher accessibility over LRTS. PT in Lahore is inadequate as compared to actual travel demand. This study / project aims at estimating the choice of informal transport as well as own-vehicle (private vehicle) users and also to identify encouraging factors which facilitate them to shift to BRTS. A Stated Preference (SP) approach was used to collect data about travel time, cost, distance, mode choice along with some socio-economic attributes, such as gender, age and occupation. Binary logistic regression was performed for creation of regression models. It was found that BRTS has a potential to attract motorcycle users. However, car users prefer their own vehicles. Modal shift of people was found dependent on travel time and trip cost.

Keywords: Bus Rapid Transit System; Public Transport; Binary Logistic Regression; Stated Preference.

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INTRODUCTION

To support the economic bustle cities must ensure that the demand of mobility must be fulfilled not only of the current scenario but also of the future demand.Urban population of any big city requires efficient and sustainable transportation network, which defines travel characteristics and level of service of cities (Nivesh, 2009). Traveller's Mode Choice is not only associated with trip purposes but condition of Public Transport System as well. Therefore, in developing as well as in developed countries improvement of public transport system has become a key concern in transportation planning.

Lahore is thesecond mostpopulated city of Pakistan with23.51% inter-censual increase(Safdar and Kazmi, 2014). Total area of the city is 1,772 sq. km and its estimated population as on 31st December, 2015 is 9.54 million with an annual growth rate of 3.32%. The total number of vehicles registered in Lahore is about 3,991,517 (PDS, 2016). The public transportation system in Lahore is currently under-developed, highly fragmented, inadequately managed, and inefficient. Morethan 800,000 passengers are using Public Transport System with 800 high occupancy buses operated by 13 private companies. There is a big gap between the demand and supply of a capable, environment friendly Public Transportation System (Javid, 2013). In recent past, a rapid growth in population and vehicle ownership has been observed which results in traffic congestion. The use of public transport is lesser than that of private transport. The modal split of different South Asian cities in comparison to Lahore is highlighted to show the ardent need of improving poor usage of public transport. Only 12.5% of city's total trips are made on public transport which is the lowest percentage among major Asian cities as is shown in Table-1.

To cater this problem, initiatives like the introduction of new and big bus fleets were taken by the government in 2011 but remained unable to solve this problem. The growing problem of gridlock and congestion constrains growth, curtail investment, and reduces the city's competitiveness worldwide (Jamal*et.al*; 2012). Increase in vehicle ownership is mainly due to poor operation of public transport and lack of provision of buses on major arterials of Lahore. People either have to own motorcycles, private cars or to use Para-transit mode such as a three wheeler motorcycle rickshaw or Auto-Rickshaw to commute. Due to limited operational capacity and financial problems, the bus services provided by Lahore Transport Company (LTC) is unable to meet travel demand. In most cases, research has been focused on planning, performance, and operation of Bus Rapid Transit (BRT), however relatively lesser research has been done to evaluate its contribution in transit usage (Robert, 2011).

With the increase in number of overheads and underpasses in the city, speed of traffic flow increases significantly resulting in higher ratio of fatal traffic

accidents, especially among pedestrians, non-motorized vehicles, motorcycles etc. (Vaishali*et.al*; 2007).

In order to cope with the ever increasing traffic congestion on the Lahore road network Metro Bus Service has been introduced in since 2013. A very formal definition for BRT is: "Bus Transit designed as an integrated system of distinct buses and a separate infrastructure with considerable independence from other traffic, allowing higher speed, reliability and safety than BTS" (Vuchic, 2007). It adopts an appreciablecorridor from northern suburb of Lahore i.e. Shahdara to south east direction i.e., uptoGajjumatta. According to Punjab Mass Transit Authority, Shahdara station has maximum daily ridership of 25,672 passengers (PMA, 2013). The introduction of transit line has reduced travel time and travel cost of passengers. A large amount of people travel from nearby cities/villages like Rana Town, Sheikhupura, Muridke, Imamia Colony, Kamoki etc. for work and educational purposes.

It has now been proposed to extend the existing MBS corridoralong Grand Trunk (G.T.) road fromShahdara towardsMuridke (study area). It has various residential societies like S.A. Garden etc. which are now developing on north boundary of Shahdara Station towards Muridke. This study is initiated with a scope, to investigate suitability of this extension in terms of modal shift, (ii) to investigate the factors leading to possible modal shift of passengers to Metro Bus System (MBS). The idea is to highlight/identify factors which can play key role to encourage the usage and self-sustainable operations of MBS.

MATERIALS AND METHODS

Data Collection: The complete information required for the primary data was collected from passengers using Public Transport (PT) User Perception Interview Surveys along with the identification of prospective sources of data and survey representation. The questionnaire was prepared for this survey asis shown in **Annex-A**. The approach of survey conducted in the field was based on Stated Preference (SP) and led to the development of a statistical utility (regression) model for the proposed extension of Lahore MBS. The survey was scheduled to cover the morning, noon and evening peaks.

In order to have an accurate benchmark for each trip type, commuters were asked several questions which confirmed their pattern of travel before and after the implementation of Lahore Metro Bus for trip purpose, trip timings, preferred mode further, to cover the Lahore Metro Bus characteristics several questions were asked like comfort, safety, reliability, convenience, accessibility, capacity, cleanliness etc. People were asked questions in the form of three best and worst characteristics of the PT available in Lahore in comparison to the Lahore Metro Bus. The socio-economic and demographical information including commuter's location of house, age, origin and destination, average monthly income, purpose of the trip, availability of vehicles and occupation was also asked. This information established the qualitative explanatory variables which were used in the development of the model.

In order to study travel characteristics of the commuters, questions were asked about total travel time, preferable mode of transport, alternative available modes of transport, cost of the total trip and the total distance travelled etc. For primary data collection, major areas were selected from the proposed extended routes of MBS Lahore. The routes were divided into three zones i.e., Shahdara Zone, Kala Shah Kaku (KSK) Zone and Muridke Zone. For detailed study and analysis, secondary data was also collected from sources included from Lahore Urban Transport Master Plan Study by JICA (Government of the Punjab, 2012).

Study Area and Data Representation: The study area for this studywas adjacent to proposed corridor for the extension of Lahore Metro Bus service from Shahdara to Muridke city. It comprisedof 11 Union Councils (UCs) of Shahdara and Muridke within 500 m range from proposed extended Lahore Metro Bus corridor on both sides. People residing in these Union Councils belonged to lower middle class income group as is shown in the Figure-1.

Figure 2show thelocation map of the proposed extended Metro Bus corridor from Shahdara to Muridkemarked in red. The green section of the figure show the existing MBS corridor from Gajjumatta to Shahdara.

It had typical mixed land use pattern. The proposed corridor crossed many industrial and education Institution and also passed nearby Kala Shah Kaku Interchange which connects this corridor (G.T. Road) with Motorway M-2.The length is 21.9 km for proposed corridor.

The situation of Public Transport System of Shahdara towards Muridke on G.T. road was also extremely poor. Traffic Counts Survey Data at ShahdaraMOR for 24 hours was among the parameters that was used for theestimation of modal shift. The traffic counts of Shahdara toward Muridkelink showed that the use of motorcycle wasthe highest i.e., 54.43% and most frequent Public Transport mode was Rickshaw/Qingqi. The category-wise vehicle distribution of collected datafor the study area is shown in the Figure-3.

Target Population: The sample population is interviewed from each union council based on the population of the study areaprojected on the census conducted in 1998 by Government of Pakistan. Table-2 showed growth rate and accordingly sample size calculation.Sample size was calculated as byCochran

Method (Cochran, 1977). The sample size formula for continuous data is as follow:

$$n_o = \frac{(t)^2 * (s)^2}{(d)^2}$$

Where,

t = value for selected alpha level in each tail (the alpha level of .05 indicates the level of risk the researcher is willing to take that true margin of error may exceed the acceptable margin of error.)

s = estimate of standard deviation in the population

d = acceptable margin of error for mean being estimate

Cochran's correction formula was also used to calculate the final sample size:

$$n_1 = \frac{n_o}{(1 + no / P)}$$

Where,

P = population size

n_0 = required return sample size according to Cochran's formula

n_1 = required return sample size because sample exceed required % of population.

After applying correction, a sample size of 288 was calculated.Commuters were interviewed and each commuter was given seven choice sets where he/she had to select the different current modes of travel along with the option of proposed extended MBS. A PT user perception survey was conducted in the study area.

The Sample choice set which was presented to the respondents for the purpose of data collection is shown in Table 3.

Binary Logistic Regression: The Binary Logistic Model was used to estimate the probability of a binary response based on one or more predictor (or independent) variables (features).The generalized utility model for all modes is as under:

U= ASC + (β_Ox Occupation) + (β_{MI}x Monthly Income) + (β_{TL}x Trip Length) + (β_{TC}x Travel Cost) + (β_{TT}x Total Travel Time) (1)

Here; β_O= Coefficient for Occupation

β_{MI} = Coefficient for Monthly Income

β_{TL}= Coefficient for Distance Travel

β_{TC}= Coefficient for Travel Cost

β_{TT}= Coefficient for Travel time

ACS = Alternative Specific Constant

Binary Logistic Regression Analysis Technique was used to develop models in order to study which attributes were significant in predicting the choice of transportation mode. As the willingness to shift to MBS wasdichotomous, this approach helped to study about the relationship of independent variables on dependent variables (Ben-Akiva and Lerman, 1985).

The utility equations were developed after the data analysis usingStatistical Package for the Social Sciences (SPSS) software. These equations weredeveloped for various modes including the MBS. Calculated willingness of the commuters to shift from local public transport modes available to the extended proposed MBS corridor was computed for assessing the possible modal shift if the project of proposed MBS extension was executed. Another analysis was done in SPSS to study the impact of trip behaviour / characteristics and different individual on the utility value of a particular mode including the MBS. This studywas conducted using the Binary Regression Model prediction about the change in the Public Transportation System.

RESULTS AND DISCUSSION

Based on the user interview survey in the study area, the results showed that the majority of commuters were male and their age was between 14 to 30 years. It was important to note that in Pakistan, mostly male memberssupport their families especially in lower and middle income class groups of the society. The gender and age distribution of sample is shown in Figure 4(a) and 4(b) respectively.

Children below 14 years travel by the automobiles on the decision of their parents and it was also found difficult to interview them. Therefore they were not considered in the survey.

Sample Characteristics: Most of the person interviewed for the present study belonged to lower middle group with monthly income of less than Rs. 5000 to Rs. 20,000 per month. Share of such respondents were observed to be around 51%. Motorcycles were owned about 31.7%. It clearly showed that this mode of transport was very common and most of the people preferred to use it as compared to other modes in our society as is shown in Table-4.

Majority of the individuals of the study area worked in private sector (48%), while the representation of students was the second highest i.e., 17%. This showed that the commuters travelling on the proposed corridor were mostly either working in private sector or were the students as is shown in Figure-5.

When studying the modal split for travel purpose and for work trips, majority of the people used motorcycle and only minority use private cars and rickshaws. For educational trips, the usage of Rickshaw/Qingqi highest about 46.2% as is shown in Table-5.

Comparing the public transport (rickshaw/Qingqi, mini-bus & bus)65.8% users could be considered as captive travellers of public transport with no vehicle owning as is shown in Table-6. As vehicle ownership increases, the chances of using public transport also decreases. The vehicle owned in a household was used by the head of the household

families in the most cases while remaining members relied on the public transport. The lower income groups preferably used Public Transport as is shown in Table-7.

Attitude towards Public Transportation: Opinion of respondents was collected and where,about 38.8% of the respondents told that saving on money was the best aspect of the public transport used at the Lahore. Whereas, 29.7% of the respondents considered accessibility as second best component of existing system as is shown in Figure-6. Similarly 15.4% respondents expressed the discomfort in public transport as worst aspect of existing public transport system as is shown in Figure-7.

Utility Models: This research was based on Stated Preference (SP) approach in which it was assumed that Lahore BRT was extended from Shahdara to Muridke. The same technique was adopted during study of Modal Shift towards BRTS in Asian developing cities (Satiennam*et.al;*2016). A PT user perception interview survey was carried out in the study area. As the commuters state their preference after perceiving cost of travel, travel time and travel comfort etc. The variables used for the binary logistic model were the proposed extended MBS attributes and the current travel choice attributes as given in Table-8.

The Binary Logistic Regression Analysis Technique was employed to model the attributes and preferences of the commuters through their stated choices. The utility functions, derived out of the choice sets help to observe the relative attractiveness of each alternative, for a given trip. The contribution of each attribute to a utility of an alternative was indicated by the sign of its coefficients. A positive value indicated a positive impact on the utility and opposite applied to negative value. The correlation of various attributes was analysed in Statistical Package for the Social Sciences (SPSS) software. Depending upon the value of regression coefficient selection of the attribute / choice set was done for derivation of utility equation (Nivesh, 2009).

The inclusion and exclusion of the variables was dependent on their significance test. If the parameter of a variable was giving very low significance test results, they were excluded. Based on this theory various models were developed which are described below.

The utility expression was used to determine the total utility of the MBS in comparison with different modes. In this case a high utility value indicated that the commuters preferred the MBS more and thus the MBS would be more attractive to its potential users. On the other hand, a lower Utility value indicated that the commuters preferred the MBS less meaning that the MBS would be less attractive to its potential users i.e. the commuters.

Model for Motorcycle: The estimated log was obtained from the following equation:

U_{MC}= 2.872 – (2.302 Occupation) + (0.122 Trip Length) + (0.071 Total Travel Time) – (0.056 Travel Cost) (3)

From Table-9, it observed that the impact of occupation was negative because its coefficient was computed to be β = -2.302 with standard error 1.193. The z is 0.054, which was significant compared to 0.05 (level of significance).Since z = 0.054 which wasclose to 0.05 level of significance, hence, the variable occupation contributed significantly to the willingness of MBS.This was contrary to the model developed for Jaipur BRT (Nivesh, 2009). Travel Cost had negative coefficient which suggested that the utility of alternative decreased as the value of these terms increased. For Surat city in India, the results of study showed that travel time, travel cost and trip length had negative impact (Kumar and Electricwala, 2014).

Cox and Snell's R square is the ratio of the likelihood that reflects the improvement of the full model over the intercept model. The smaller the ratio, the greater the improvement (Cox and Snell, 1989). Nagelkerke R square adjusted Cox and Snell's so that the range of possible values extended to 1 (Nagelkerke, 1991).

Model forRickshaw/Qingqi: The estimated logwas obtained from the following equation:

U_{AR}= – 2.233 + (0.083 Trip Length) (4)

It was reported that the impact of distance travel was positive because its coefficient was computed to be β = 0.083 with standard error of 0.058. The z was 0.153, which was highly non-significant compared to 0.05 (level of significance). Since z= 0.153was greater than 0.05 level of significance, hence, the variable distance travel contributed insignificantly to the willingness of MBS Table-10. According to the results, monthly income and travel time were playing no role in the utility of Rickshaw/Qingqi. In case of Jaipur BRT, income had a negative coefficient showing that modal shift towards BRT increased with increase in income of commuters (Nivesh, 2009).

Model for Car: The estimated log was obtained from the following equation:

U_{MC} = – 7.575 – (15.662 Occupation) + (1.570 Trip Length) + (0.002 Total Travel Time) – (0.232 Travel Cost) (5)

It was observed that the impact of occupation was negative because its coefficient was computed to be β = -15.662 with standard error 27992.541. The z was 1.000, which was highly non-significant compared to 0.05 level of significance. Since z = 1.000 was greater than 0.05 level of significance, hence, the variable occupation contributes insignificantly to the willingness of MBS Table-11. The results showed that travel time had negative estimated coefficient, same as in the case of

modal shift study from private car to Public Transport in Malaysia (Nurdden*et.al*, 2007).

Model for Bus: The estimated log was obtained from the following equation:

U_{MC} = – 1.367 – (0.018 Occupation) + (0.819 Trip Length) – (0.993 Total Travel Time) – (0.008 Travel Cost) (6)

It was reportedthat the impact of occupation was negative because its coefficient was computed to be as β = -0.018 with standard error 1.506. The z was 0.991, which was highly non-significant compared to 0.05 (level of significance). Since z = 0.991 was greater at 0.05 level of significance, hence, the variable occupation contributednon-significantly to the willingness of MBS Table-12. According to the results, the travel time and travel cost had negative coefficients and these were in line with results of obtained in Surat City for utility shift from SMC Bus to BRTS (Kumar and Electricwala, 2014).

The transportation policies needed to be designed, whileconsidering the results of utility models for appropriate modal shift and these policies should be consistent with the local socio-economic characteristics and transportation problems.

The models developed showed that travel time was the most significant factor that could encourage public transit use for Car and Bus modes. The model for Motorcycle showed that the occupation was the most significant parameter, in order to encourage the modal shift. The results showed that commuters preferred the use of Rickshaw/Qingqi as a public transport because of its minimal headway and cheaper cost. Modal shift of this mode could be achieved more than 90% by providing a service like BRTS which had good quality service, proper headway and less fare too. The results of this study correlate the fact that any future extension of MBS may be done according to the modal shift data collected through this research.

Table 1. Modal Split in Asian Cities.

Cities	Public Transport (%)	Private Transport (%)	Walk (%)	Cycle (%)	Para Transit (%)
Lahore	12.5	34.9	39.9	5.1	7.6
Ahmedabad	16	42	22	14	6
Bangalore	35	25	26	7	7
Beijing	21	20	21	32	3
Delhi	42	19	21	12	6
Mumbai	45	15	27	6	7

Source: Japan International Cooperation Agency (JICA), 2012 (Lahore); Land Transport Authority, www.lta.gov.sg (other Indian cities), 2014.

Table 2. Population Growth Rates.

Sr. No.	UC Name	Population Growth Rates (%) 1998-2014	Sample Size
1	Shahdara	2.65	24
2	Muridke	2.12	66
3	Shekhan	2.31	13
4	Qaiser Town	2.65	26
5	Faisal Park	2.65	29
6	KotMohibbu	2.65	26
7	Aziz Colony	2.65	28
8	Ferozewala	2.10	33
9	NangalKaswala	2.35	14
10	Chak 44	2.31	11
11	Noon	2.35	18
Average Growth Rate		**2.43**	**288**

Source: Punjab Development Statistics

Table 3. Choice Set and variables.

CHOICE	Option 1	Option 2 (i)
Mode of Travel	MBS	Motorcycle
Service Frequency	Every 5 mins Every 3 mins	
Time to get from home to transit or motorcycle / car	Within 10 mins	
Travel Time (in-vehicle)		
Time to get from transit or motorcycle / car to destination	Within 10 mins	
Cost	Rs. 20 / trip	
Additional Cost: Ownership cost, Depreciation, Parking Costs	No	Yes
Comfort Level	Seat available/ Comfortable Standing	

Table 4. Vehicle Ownership

Vehicle Category	Percentage (%)
Car	6.7
Motorcycle	31.7
Bicycle	5.1
Others	9.5
No Vehicle	47.0
Total	**100.0**

Table 5. Mode Used by Commuters.

Mode Type	Percentage (%)
Car	4.5
Motorcycle	22.8
Auto-Rickshaw	4.5
Qingqi	46.2
Mini-Bus	7.9
Bus	8.6
Bicycle / Walking	4.5
Others	1.0
Total	**100.0**

Table 6. Vehicle Ownership of Public Transport Users.

Vehicle Ownership	Percentage (%)
No vehicle	65.8
1	26.1
2	7.0
3	1.1
Total	**100.0**

Table 7. Choice of Mode w.r.t. Income of the Individual.

Mode	% Walk	% Private	% Public
Rs.5000	0.3%	0.7%	5.2%
Rs.5001-Rs.20,000	2.1%	9.3%	35.9%
Rs.20,001-Rs.35,000	0.0%	7.6%	9.7%
Rs.35,001-Rs.50,000	0.0%	2.8%	2.4%
>Rs.50,000	0.0%	2.1%	0.7%
No Income	0.7%	5.5%	15.2%
Total	**3%**	**28%**	**69%**

Table 8. Input Variables.

Name of Attribute	Unit	Variable Type	Description
Travel Time	Minutes	Continuous	Total travel time for the trip (Walk time to MBS stop + In-vehicle Time)
Travel Cost	Rupees	Continuous	Total cost of the one way trip
Trip Length	Km	Continuous	Distance from origin to destination for Home work trips or Home Education trips
Personal Income	Rupees	Continuous	Individual Monthly Income
Occupation	Logic	Categorical	Occupation of a person – 0: Dependent, 1: Independent
ASC	-	-	Alternative (Mode) Specific Constant

Note: Occupation consists of two categories; dependent includes students, housewife and jobless while independent includes government job, private job, business and labour.

Table 9. Model Results for Motorcycle in SPSS.

Parameter	Estimate (B)	Standard Error (S.E.)	Sig. (Z)	Exp(B) / p-value
*Occupation (1)	-2.302	1.193	0.054	0.100
Monthly Income	0.000	0.000	0.424	1.000
Distance Travel	0.122	196.442	1.000	1.129
Total Travel Time	0.071	261.923	1.000	1.074
Trip Cost	-0.056	0.118	0.633	0.945
Constant	2.872	1.805	0.112	17.678
*Occupation (1) means workers				
Nagelkerke R-square	0.252	Cox and Snell R-square	0.103	

Table 10. Model Results for Rickshaw/Qingqi in SPSS.

Parameter	Estimate (B)	Standard Error (S.E.)	Sig. (Z)	Exp(B) / p-value
Monthly Income	0.000	0.000	0.531	1.000
Distance Travel	0.083	0.058	0.153	1.087
Total Travel Time	0.000	0.001	0.559	1.000
Constant	-2.233	2.600	0.390	0.107
Nagelkerke R-square	0.326	Cox and Snell R-square	0.177	

Table 11. Model Results for Car in SPSS.

Parameter	Estimate (B)	Standard Error (S.E.)	Sig. (Z)	Exp(B) / p-value
*Occupation (1)	-15.662	27992.541	1.000	0.000
Monthly Income	0.000	0.000	0.228	1.000
Distance Travel	1.570	11.823	0.894	4.808
Total Travel Time	0.002	0.009	0.814	1.002
Trip Cost	-0.232	1.786	0.897	0.793
Constant	-7.575	6.263	0.227	0.001
*Occupation (1) means workers				
Nagelkerke R-square	0.344	Cox and Snell R-square	0.227	

Table 12. Model Results for Bus in SPSS.

Parameter	Estimate (B)	Standard Error (S.E.)	Sig. (Z)	Exp(B) / p-value
*Occupation (1)	-0.018	1.506	0.991	0.982
Monthly Income	0.000	0.000	0.359	1.000
Distance Travel	0.819	1.024	0.424	2.269
Total Travel Time	-0.993	1.196	0.407	0.371
Trip Cost	-0.008	0.011	0.452	0.992
Constant	-1.367	1.353	0.313	0.255
*Occupation (1) means workers				
Nagelkerke R-square	0.171	Cox and Snell R-square	0.090	

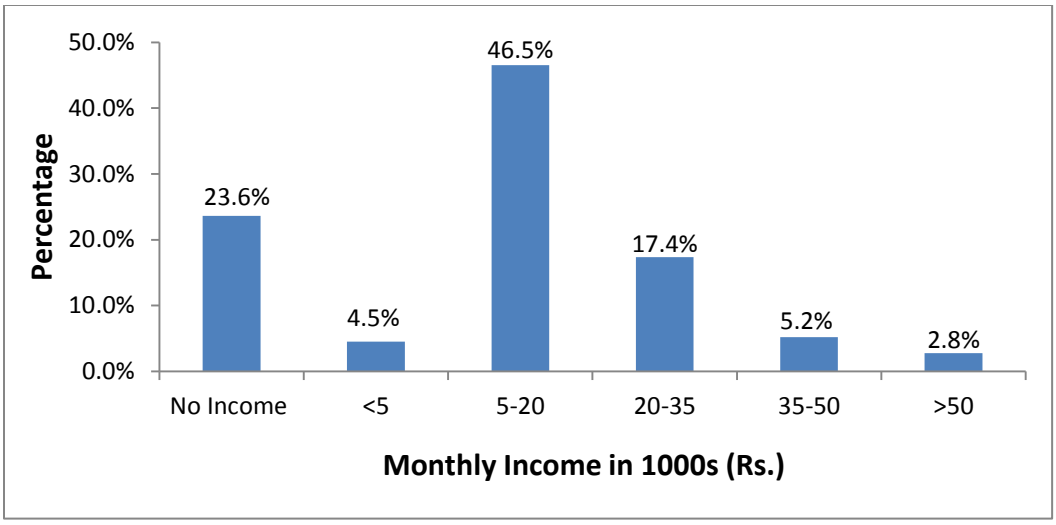

Figure 1. Sample Population: Monthly Individual Income (Rs.)

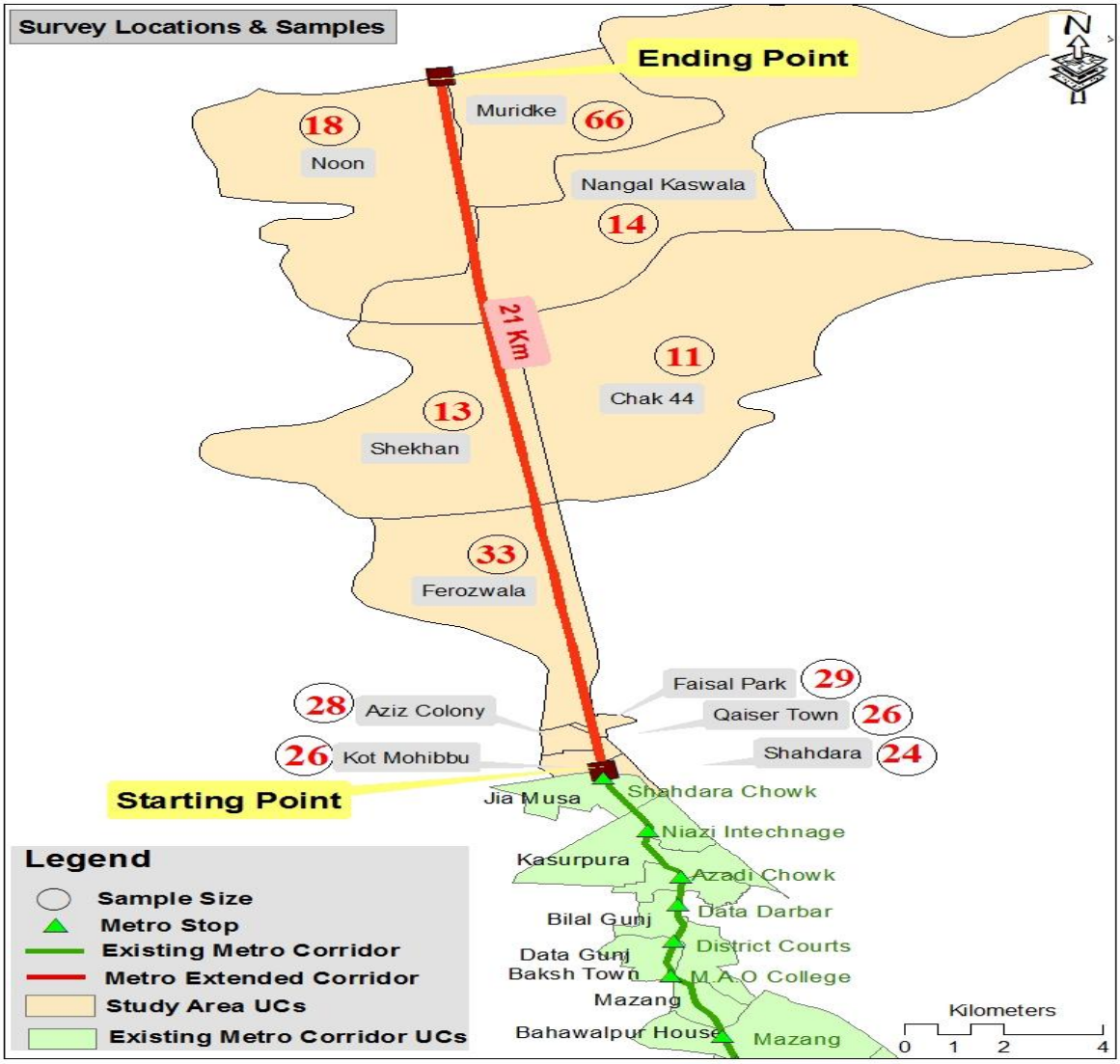

Figure 2. Location Map of Study Area

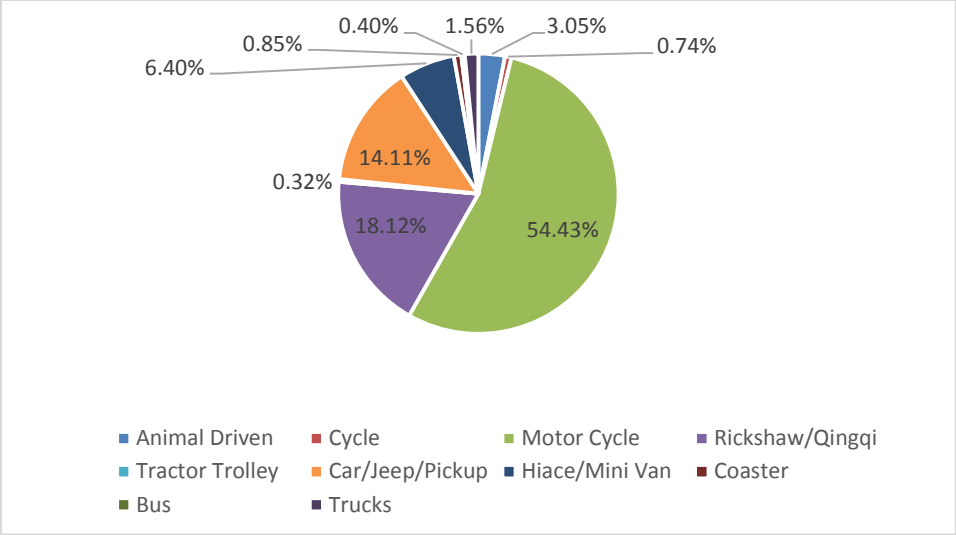

Figure 3. Category-wise Vehicle Distribution of Sample in Study Area

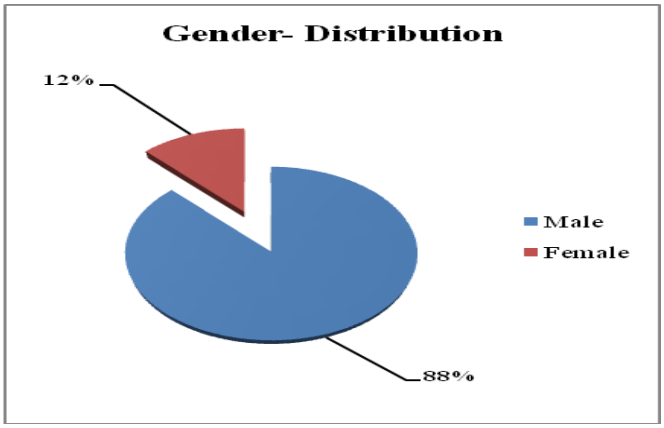

Figure 4(a). Gender Distribution

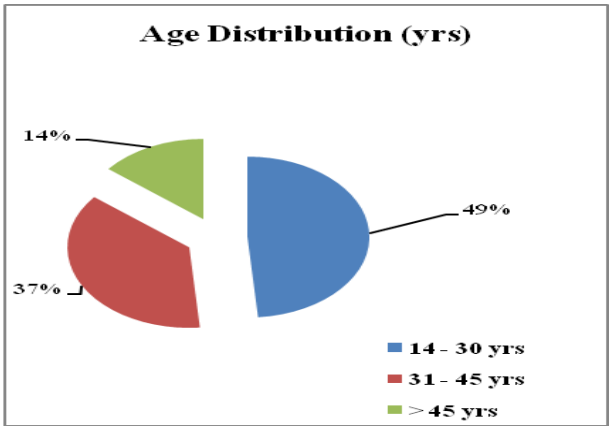

Figure 4(b). Age Distribution

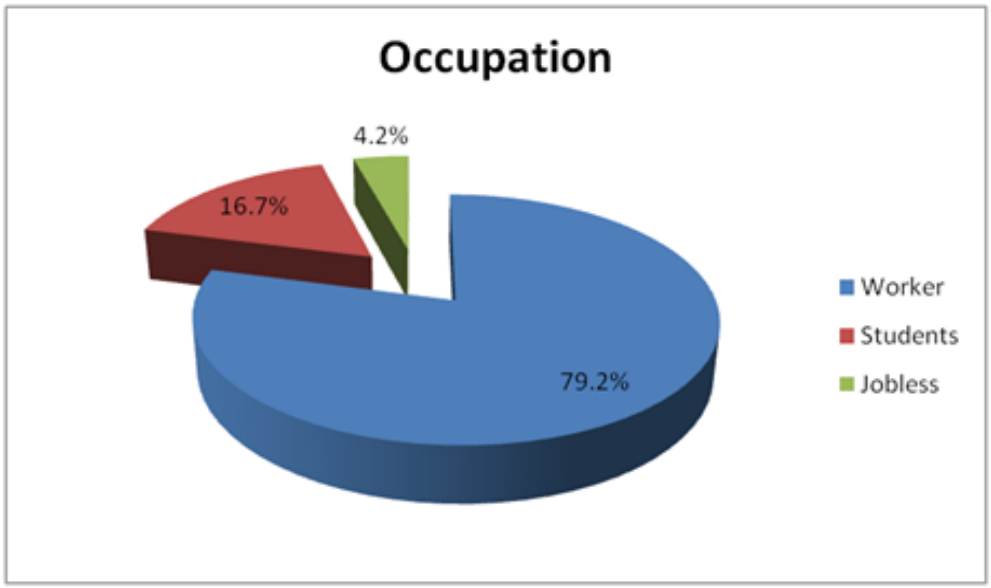

Figure 5. Sample Population: Occupation

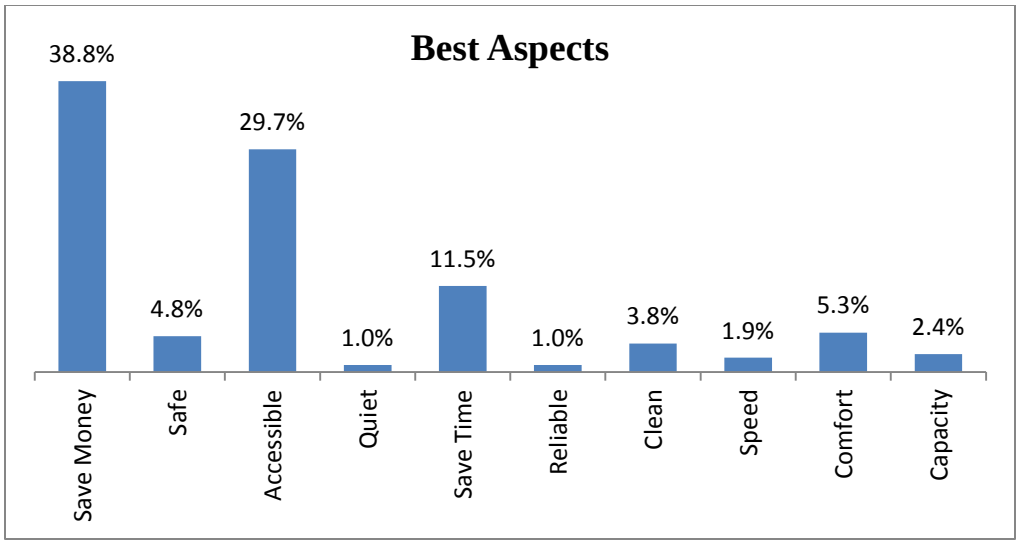

Figure 6. Best Aspects of Public Transport of Lahore

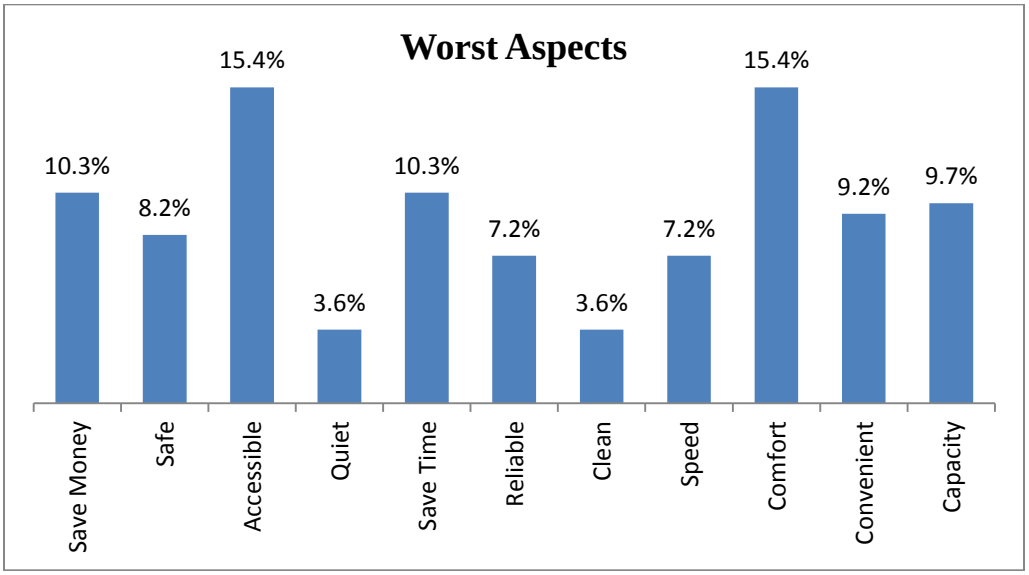

Figure 7. Worst Aspects of Public Transport of Lahore

Conclusions: It is concluded that Rickshaw/Qingqihas the maximum usageas public transport mode in the study area, while motorcycle is the most used private mode in the study area. The maximum modal shift possibility was for Rickshaw/Qingqi.Travel time was the significant attribute and showed the highest significance value in modal shift tothe proposed extendedBRT.Commuters having an educational trip purpose showed the highest trend of shifting towards BRT.The majority of the commuters belonging to lower middle income group and about 89% were willing to shift to BRT in case of its extension.The ridership is expected to be highest during school and office timings.The results of this study would be helpful in planning a BRTS in developing cities where the usage of two wheeler private motorcycles and three wheeler motorcycle rickshaws usage is on higher side. BRTS has more probability to attract these mode users.

REFERENCES

Ben-Avika, M. and S. R. Lerman, (1985). Discrete Choice Analysis. Theory and Application to Travel Demand. Cambridge, MA: MIT Press.

Cochran, W. G. (1977). Sampling Techniques. 3rd Ed. John Wiley and Sons; New York.

Cox, D.R. and E.J. Snell (1989). Analysis of Binary Data. 2ndEd.Chapman and Hall; London

Javid, M.A. (2013). A Study for Public Perceptions in Integrating Transportation Demand Management Measures in Developing Countries: A Study in Lahore. Yokohama

National University, Graduate School of Engineering. 28 p

Jamal, T., F. Mazhar, and I. S. Kaukab. (2012). Transport Network Lahore City. Pakistan Journal of Science.64(4): 320-325

Kumar, R. and F.Electricwala. (2014). Impact of Proposed Modal Shift from Private Users to Bus Rapid Transit System: An Indian City Case Study. International Journal of Civil, Structural, Construction and Architectural Engineering. 8(6): 658-662

Government of the Punjab (2012). The Project for Lahore Urban Transport Master Plan in the Islamic Republic of Pakistan, ALMEC Corporation Oriental Consultant Co. Ltd., Japan International Cooperation Agency. Final Report

Land Transport Authority, Singapore Government. (2014). Passenger Transport Mode Shares in World Cities, Journeys; 54-64

Nagelkerke, N.J.D. (1991). A note on a general definition of the coefficient of determination,Biometrika.78: 691-692

Nivesh, C. (2009).Analyzing Modal Shift: Case of BRTS Jaipur.MSc diss., Faculty of Planning and Public Policy, CEPT University, Ahmedabad, India.

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 Sciences. 7(7):1013-1018.

Punjab Development Statistics. (PDS)(2016). Bureau of Statistics, Government of the Punjab. 388 p

Punjab Mass Transit Authority.(PMA)(2013). Government of the Punjab

Satiennam, T., S.Jaensirisak, W.Satiennam and S. Detdamrong (2016). Potential for modal shift by passenger car and motorcycle users towards Bus Rapid Transit (BRT) in an Asian developing city.International Association of Traffic and Safety Sciences. 39(2): 121-129

Vedagiri, P. andV. T. Arasan(2009).Estimating Modal Shift of Car Travellers to Bus on introduction to Bus Priority System. Journal of Transportation System Engineering and Information Technology. 9(6): 120-124

Robert, D.(2011).An Ex Post Evaluation of the Ridership Impacts of the Viva Bus Transit System.MSc diss., University of Toronto.

Safdar, A.S., and S.J.K. Kazmi (2014). Analysis of Population Growth and Urban Development in Lahore – Pakistan using Geospatial Techniques: Suggested some future Options: South Asian Studies. A Research Journal of South Asian Studies. 29(1): 269-280

Vaishali, M. P., R. Kumar and G. Tiwari. (2007).Impacts of bus transit lanes on traffic and commuter mobility. Journal of Urban Planning and Development. 133(2): 99-106

Vuchic, V. R. (2007). Urban Transit Systems and Technology. 1st Ed. John Wiley and Sons, Hoboken, New Jersey. 532 p