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Evaluation of Social and Environmental Aspects of Lahore Metro Bus Transit Through Public Opinion

ABSTRACT

Metro Bus Transit (MBT) is highly innovative and advanced transportation technology. Due to rapid urbanization in city Lahore, construction of MBT was considered as top priority technology to balance the demand. The main objective of the study was to evaluate environmental and social impacts of MBT before and after its construction, and the willingness of the people to use it. The study was conducted using a questionnaire during and after the construction of MBT. Face-to-face interviews of 500 hundred respondents who were users, contractors, residents and non-residents along the corridors of MBT were conducted. Mostly, male users were found due to the higher seats availability for them in bus that caused gender inequality. MBT has influenced the livelihood of many people in a positive way such as it created jobs as respondents were expecting. Only lower socio-economic respondents shifted their mode of transportation from own vehicles to MBT. Despite this, the respondents also expressed the need to improve other infrastructures and projects such as electricity supply, education, healthcare facility and other basic needs. Respondents showed high willingness to use MBT rather than conventional public transport and satisfied from its impacts. However, more amendments and improvements should be proposed for enhancing the efficiency of Metro Bus Transit.

Key words: *urban transport, metro bus transit, comparative assessment, urbanization, willingness to use*

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INTRODUCTION

The urban population of the world has increased from 28.3% in 1950 to 50% in 2010 according to the *World Bank* (*2012*). Rapid urbanization has been a major problem of developing continents such as Asia, Africa and South America. It combines with motorization system imbalance the various social, economic and environmental components such as gender inequity, destruction of natural habitats, urban infrastructure, air pollution, residential and traffic congestion, and economics dynamics (*Wang et al. 2012*). South Asian cities are known with unique characteristics such as high population, employment density, mixed land use patterns, short trip length, and high shares of non-motorized transport. In these cities, stake of public transport and private vehicles tours are rising at the cost of non-motorized tours like walking, bicycling and Tonga (*Badami 2005*). Pakistan is most urbanized and populated country in south Asia (*World Bank 2012*). The abandoned growth of population and motorization in metropolitan cities stimulates many factors such as urban land use and transportation system that are socially, economically, and environmentally unsustainable in Pakistan (*Qureshi and Huapu 2007*). Lahore is the second largest metropolitan city with the area 1,172 km² of Pakistan, shows 64% literacy rate (*PSLMs 2007*). The population in suburb areas of Lahore is decreased and increased in urban areas during 2013-2014 due to the centralization (*GOP 2014*). It faced the drastic fluctuation in vehicles numbers from 1.25 M in 2005 to 1.7 M in 2008 (*GEF and UNDP 2010*). Vehicles registration has increased from 56 up to 116 per 1,000 inhabitants during the last 15 years (*LTC 2011*). Total registered Vehicles in Lahore were 2387993 in 2010 that included cars jeeps and station wagons (722012), motor cycles and scooters (1432639), trucks (18683), delivery vans (45094), buses (34132), taxis (11789), auto rickshaws (87541), other vehicles (36103) (*Bureau of Statistics 2011*). In this city, particulate matter (PM10 and PM2.5) mainly emitted from transport sector are 6 times higher than WHO principles (*Majid et al. 2012; Colbeck et al. 2010*). NOx was found 72% beyond thepermissible limits and causes pneumonia or bronchitis and seriously damage lung tissue (*Ashraf et al. 2013*). This air pollution increased the incidence of respiratory allergies in daily commuters (*Mirza et al. 2013; Colbeck et al. 2011*). Noise level was 1.45 times higher than the permissible level due to the heavy transportation (*Naseem 2012*).

That increased stress on evolving sustainable transportation systems and policy-oriented revisions to highlight the transport associated undesirable externalities such as air and noise pollution, accidents, congestion and social marginalization (*Zachariadis 2005*). Now Bus Rapid Transit (BRT) becoming more popular in developing urban areas due to its low running and operative cost, flexible and great service quality solution for growing transportation needs. ''BRT is a high-quality bus based transit system that delivers fast, comfortable, and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service (*Wright and Hook 2007*). As compared to rail based system, BRT has become a well-known transportation technology, which delivers high quality, high capacity transit at much lower cost (*Finn 2013; Hidalgo and Gutiérrez 2013*). In present times, there are almost 140 metro systems exist in the world. The best definition of metro bus is that a system which is independent of other roads or pedestrian traffic. They are planned with physical partition (*Laporte et al. 2011*). The main objective of a rapid transit system is to improve population's mobility (*Crottea et al. 2012*). In the beginning, it was initiated in South Africa and Nigeria (*Cannell 2008*) but now it is common in China, India, North America, Australia and Europe (*World Bank 2011*). The first intercontinental BRT system was completed in Istanbul (known as Metrobus in Turkey). This connection of Asia and Europe is unique in its nature (*Alpkokin and Ergun 2012*). Metros are mostly underground but in many world's cities, the network is over ground and in many countries its infrastructure is similar to the railway network (*Crottea et al. 2012*). The study was conducted on increasing impact of mass transit on energy use and its emission suggested that use of rapid transit system would reduce 31% energy consumption (*Khanna et al. 2011*). The comparative assessment study of 44 bus rapid transit systems throughout the world analyzed the variation cost depends upon the nature of location like high cost in developed countries and relatively low cost in developing countries (*Hensher and Golob 2008*). The Bus Rapid Transit (BRT) systems had the distinguished characteristics of transportation such as solution for traffic congestion, more comfortable, had over sufficient passenger capacity, higher speed and caused good impact on traffic and closet residential property values of BRT (*Deng and Nelson 2013; Lindau et al. 2008; Jun 2012; Dube et al. 2011*). The bus rapid transit systems was highly successful in Asian cities; Jakarta, Delhi and Beijing when it reveals a high contribution to the sustainable development of a these city. Others many ex-post evaluation was documented the spreading and success of this innovative transportation system in developing countries (*Mejia-Dugand et al. 2012; Kogdenko 2011*). The BRT is distinguished from the other transportation systems due to its walking access patterns and separate corridor in rapidly growing China (*Jiang et al., 2012*). Its increasing economy and motorization altered the urban outlook in recent decades. It has direct and indirect effects on the living and non-living goods of the city (*Munoz-Raskin 2010*).

In 2011, first Lahore Urban Transport Master Plan was prepared by Japan International Cooperation Agency (JICA) which is executed by Punjab Metro Authority in 2012-2013 (*PMA 2013*).

Features of Lahore Metro Bus Transit

Metro Bus Transit has two lanes with limited access corridor (10 m wide) on Ferozepur Road, Lahore. It is extended from Gajjumata to Shahdra (32 km) (**Figure 1**). It is divided into 27 stations with two platforms each and three docking bays. There are sliding doors (664) on the station. Escalators (104) are also used for elderly/ disable/ paralyzed people. It is established at grade (18) but somewhere it is elevated (9). Portion from Qaddafi Stadium to Bhatti Chowk is elevated (8.5 km). It has the off board ticketing with Automated Fare Collection/ Bus Scheduling System (AFC/ BSS), Vehicle Location System (VLS), Passenger Information System (PIS) and Intelligent Traffic System (ITS). There are 45 articulated air conditioned buses with seating capacity of 38+1 but total passenger capacity is 160 (including seating, standing places and driver seat). These buses have a frequency of three minutes. There is also a precision docking for driver assistance. It has level boarding for passenger convenience (*TEPA 2013*).

Major objectives of the study were to evaluate the environmental importance of MBT through public opinion; social impacts of MBT and livelihood status before and after its construction; and willingness to use and the satisfaction towards MBT.

METHODOLOGY

Study Area

The study area was the corridor of MBT with a length of 32 km, built on the main Feroze pur road from Shahdara to Gajjumata in the city of Lahore, with a population of approximately 10 million. There are 27 stations on this bus routes, each station is approximately at a distance of 1 km in between. Only a few have longer distances in between, like from the Kalma Chowk Station (*LTC 2011*). The study was conducted using a questionnaire which was divided into two phases; pre and post evaluation of MBT. In pre-evaluation the selected population was residents, pedestrian along the corridor of MBT and the contractors

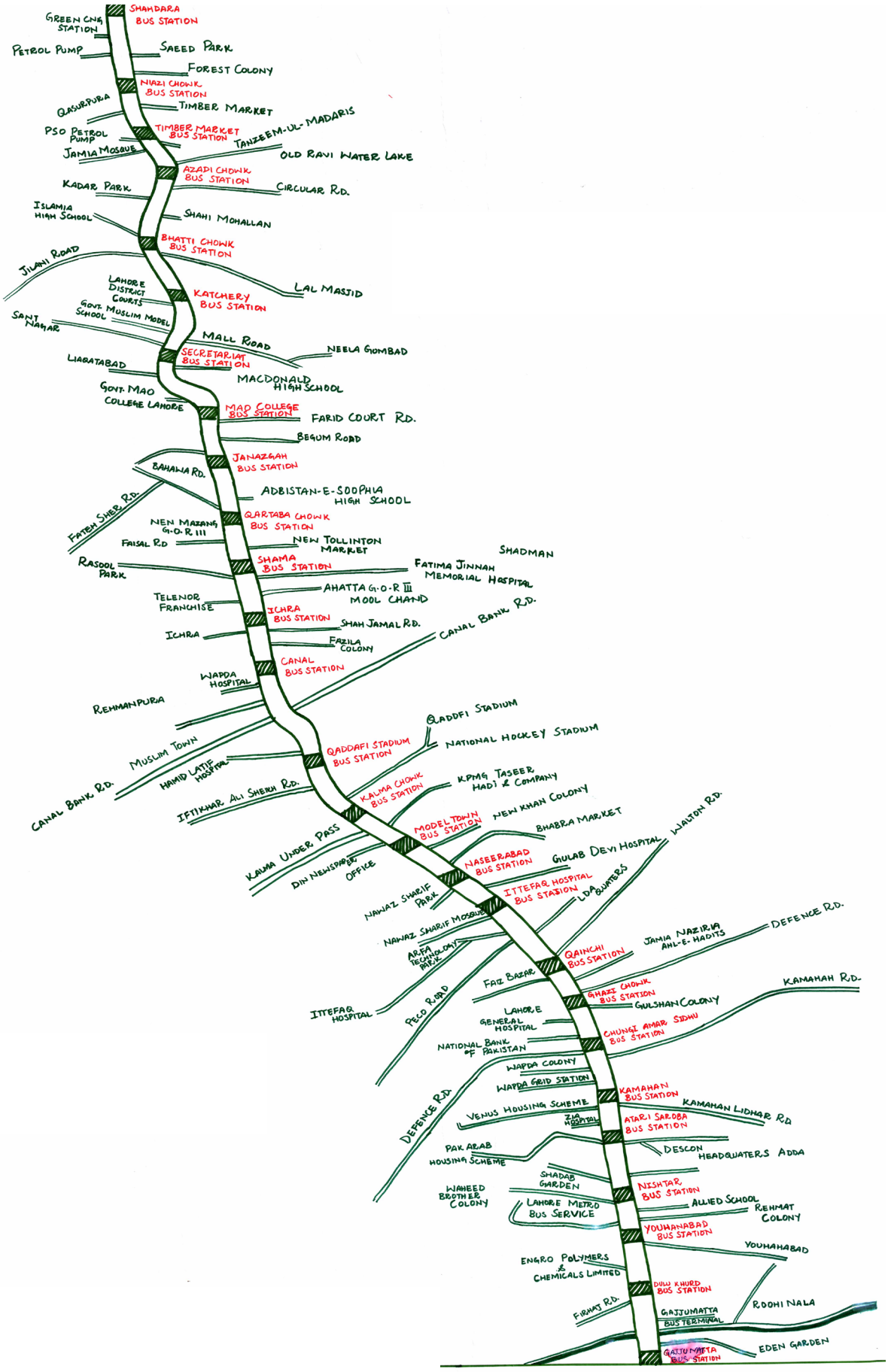

Figure 1. Lahore Metro Bus Transit's Route (from Gajjumata to Shahdara). It has a length of 32 km with 27 stations.

who participated in the construction of MBT. Whereas in the post evaluation, the respondents were only users either residents or non-residents of MBT. This study conducted individual interviews with different people in both phases, considering in the second phase that the target was only users of the metro bus and shared their experience (**Figure 1**).

Study Duration

The duration of pre evaluation was from 27 December 2012 to 08 February 2013 before the start of the operations of the metro bus. The MBT started on 10 February 2013 while post evaluation was done during its operation. The duration of post evaluation was from 02 April 2013 to 07 May 2013. Interviews were done to get public opinions on social, economic and environmental aspects of MBT.

Sample size

Ten people from each station were interviewed separately in the pre and post evaluation in each of the 27MBT stations. The total size is 10* 27 = ± 270 ≈ 250. A total of 250 questionnaires were filled during the pre-evaluation and 250 in the post evaluation, making total sample size of 500, which was a good representation of the target population.

Field survey

A pilot survey was designed to access the reliability of the questionnaire. Fifteen questionnaires were pre-tested at the MBT corridors. This helped in improving the questionnaire. After the evaluating the pre-test, some questions were excluded and few were added to achieve desired objectives of the study. The improvements were made in the final questionnaire. After a pilot survey, the field survey was done with 500 interviewees.

Questionnaire Survey

Each respondent was informed about the importance of MBT construction and its uses. Moreover, respondents were that MBT will be beneficial in terms of job creation, reducing traffic congestion in its route as well as improving environmental conditions by reducing noise pollution and air pollution then the conventional busses. Questionnaire of the research study was comprised of three parts gathering informationas demographic, socio-economic aspects, and impacts on environment due to MBT construction (**Table 1**).

Demographic Information. It includes the respondents gender, age, marital status, education, occupation and monthly income, which showed the social class of the respondents. This will determine how education and income

Table 1. The questionnaire sections.

Sections	Questions
Demographic Information of respondents	Gender
	Age
	Education
	Occupation
	Monthly income
Social and Economic aspects of Metro Bus Transit	Current mode of transportation to travel within the city
	Daily travel purpose
	Preference of metro bus system instead of using your own vehicle
	Distance from your house to nearly Metro bus station
	If far/very far, prefer travel on through it
	Satisfied with local (conventional) bus system
	Time efficient than previous bus system
	Willingness to pay the bus fare (for travelling one time)
	Increase commercial property value in its corridor
	Decrease residential property value around it
	MBT will help reducing the unemployment
	Rather than construction of MBT, there could be improvement in any other project
Environmental aspects of MBT	Tackle severe traffic congestion
	Reduce in air pollution
	Reduce the number of accidents
	Provide secure way of transportation
	Rate on the social, economical & environmental benefits of MBT
	Environment friendly project
	Establishment of green belts along the MBT corridors

status of the respondents, which are vital determinants of the study.

Social and Economic Aspects. Information about the respondents' current mode of transportation and preference to use MBT instead of personal vehicle was gathered. The MBT has different stations which are approximately at a distance of 1 km in between. Some people only refuse to use MBT because the station is far from their house. Respondents were asked if they are still willing to ride the MBT even if the station if far from their homes. Also, some questions were about the value of commercial and residential properties along the MBT corridor, as this area is one of the rising business districts in Lohore.

One of the questions was about fare- how much are they willing to pay? In the post evaluation, the respondents were asked about the time efficiency of the transportation system and if the MBT has a positive impact on the employment rate.

Environmental Aspects. This section was very important based on the health and environmental aspects. Some questions were based on air pollution, traffic congestion and accidents. The respondents also gave opinions about the green belt established around the corridor. In the post evaluation, the question of how to improve the speed of the MBT was included.

RESULTS AND DISCUSSION

Descriptive Analysis: Pre and Post Evaluation

Descriptive analysis showed the frequency and percentage of the questions which were asked from the respondents of urban city Lahore.

Demographic Information of Respondents

During the pre-evaluation, few pedestrian-respondents were interviewed due to many constructions, hustle and bustle along the MBT route (ferozepur road, Lahore). However, after the completion of MBT, more pedestrian-respondents were interviewed in the post evaluation. In both assessments, most of the data was gathered from the males because females were hesitant to answers the questions. In Pakistan, most of the females, specifically housewives, do not travel on a daily basis. Moreover, government implemented a policy according to it, seat availability to males are higher than females which caused gender inequality. It may be one of the reasons for low percentage in female category. Middle-aged people (21 to 40) were higher users of MBT. The aged were in low numbers because it is difficult for them to access some entry and exit points, located under ground or above ground. Mostly people who have education above 12 years of schooling were willing to use the MBT daily because it meets their standards and gave good remarks for it. People with low income preferred to ride the MBT since as it was economical and gives a comfortable journey. Before the start of MBT, mostly the same group of income respondents showed willingness to use than the high income group (**Table 2**).

Social and Economic Aspects of Metro Bus Transit System

People were very optimistic and hopeful for the MBT. According to the survey, respondents wanted the fares to be less than 20 rupees (< $ 0.2). Respondents had positive opinions for MBT. More than half people said that MBT will reduce the unemployment rate in Pakistan. Most of the people thought MBT has given improvements compared to any other project. Meanwhile, rich people did not agree to leave their own vehicles on both surveys. Before the MBT, people used motor bikes within the city. They did not depend on the conventional buses because of poor services and inconvenience. Also, they cannot afford the high fares of public transport like the Lahore local Daewoo (**Table 3**). But after the launch of MBT, high peak was seen in Metro Bus Transit. Most people said they shifted their mode of transportation from motorbike and old buses to MBT (**Figure 2**). Those who were willing to use MBT belong to the lower income bracket who were non-users and unsatisfied old users of conventional public transport. In the economic perspective, frequent users were willing to pay the 20 rupees ($ 0.2). MBT has positive effects on employment, as most people said it reduced the commuting time and increased the accessibility towards work. Accessibility to other establishments such as hospitals, schools and colleges also improved since these are situated along MBT route.

Since the operations of the MBT started, respondents mentioned that other projects can now be invested after the MBT. *Deng and Nelson* (*2012*) found that 75.4% diverted from previous bus system to BRT. *Nugroho et al.* (*2010*) studied almost 14% private car users altered their transportation mode to BRT within four months in the city of Jakarta. *Echeverry et al.* (*2004*) studied the travel time for users of the city reduced by 32%. *Gutierrez* (*2010*) mentioned the BRT showed better performance, user satisfaction, travel time, reliability and improved urban environment than the previous bus system they used. Metro bus has positive impact on commercial and negative on residential property value from construction to its operation (**Figure 3**). *Rodriguez and Mojica* (*2009*) studied positive property development impacts resulting

from implementation of BRT in Bogota. The hedonic price model showed that the new service generates and increase in house price ranging from 6.9% to 2.9%, forthose properties located close to the service corridor. Same study was also done in Seoul (*Cervero and Kang 2011*).

Environmental Aspects of Metro Bus Transit System

The respondents agreed that MBT has reduced air and noise pollution further and explained about their improved health status. Before, people riding the conventional

Table 2. Demographic Characteristics of study population.

Variables	Description	Pre-evaluation Frequency (Percentage) N (%)	Post-evaluation Frequency (Percentage) N (%)
Respondent	Station (pedestrian)	124 (49.6)	134 (53.6)
	Residential of MBT corridors	126 (50.4)	116 (46.4)
Gender	Male	190 (76)	152 (60.8)
	Female	60 (24)	98 (39.2)
Age	21-30	121 (48)	154 (61.6)
	31-40	65 (26)	54 (21.6)
	41-50	36 (14.4)	19 (7.6)
	Above 50	28 (11.6)	23 (9.2)
Education	No schooling	11 (4.4)	27 (10.8)
	1-5 years of schooling	11 (4.4)	20 (8)
	6-12 years of schooling	107 (42.6)	89 (35.6)
	Above 12 years of schooling	121 (48.6)	114 (45.6)
Occupation	Government/Semi-govt	23 (9.2)	13 (5.2)
	Private/ Business	171 (68.4)	133 (53.2)
	Student	34 (13.6)	77 (30.8)
	Unemployed	1 (0.4)	2 (0.8)
	Housewife	21 (8.4)	25 (10)
Monthly income	Less than 10,000	43 (17.2)	65 (26)
	10,000 to 20,000	76 (30.4)	75 (30)
	20,000 to 30,000	31 (12.4)	26 (10.4)
	30,000 to 40,000	21 (8.4)	20 (8)
	More than 50,000	24 (9.6)	11 (4.4)
	Not Applicable (not earning)	55 (22)	53 (21.2)

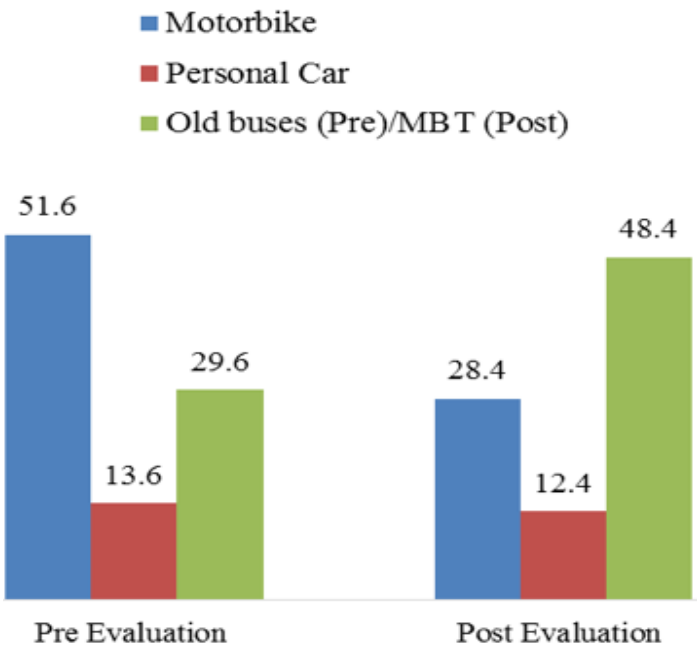

Figure 2. Shift Mode of Transportation toward MBT (%).

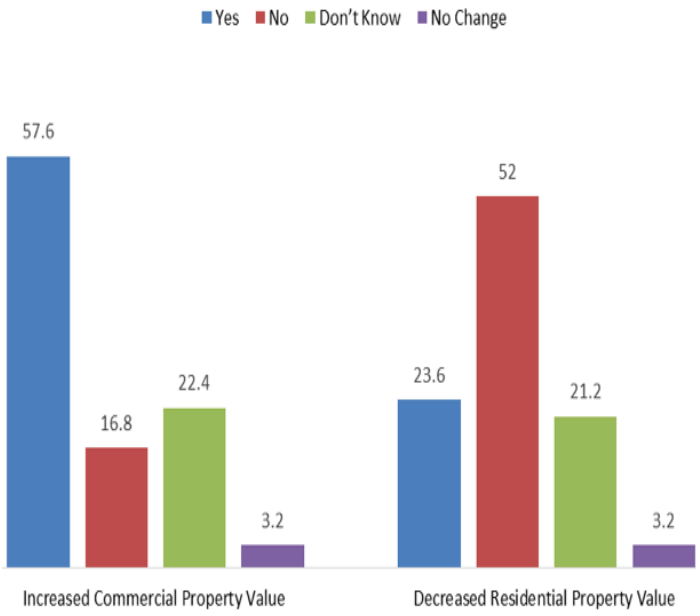

Figure 3. Impacts of MBT on property value in Post Evaluation (%).

Table 3. Social and Economic Aspects of Metro Bus Transit System.

Variables	Description	Pre-evaluation Frequency (Percentage) N (%)	Post-evaluation Frequency (Percentage) N (%)
Current mode of transportation to travel within the city	Motorbike	129 (51.6)	71 (28.4)
	Personal car	34 (13.6)	31 (12.4)
	Public transport	74 (29.6)	121 (48.4)
	Pedestrian	6 (2.4)	12 (4.8)
	Others	7 (2.8)	15 (6)
Daily travel purpose	Work/job	140 (56.0)	122 (48.8)
	Schooling	39 (15.6)	57 (22.8)
	Shopping/Recreation	11 (4.4)	17 (6.8)
	Business	54 (21.6)	29 (11.6)
	Other	6 (2.4)	12 (4.8)
	Not Applicable	0 (0)	13 (5.2)
Prefer metro bus system instead of using your own vehicle	Yes	188 (75.2)	182 (72.8)
	No	62 (24.8)	68 (27.2)
Distance from your house to nearly Metro bus station	Very near	33 (13.2)	25 (10)
	Near	129 (51.6)	126 (50.4)
	Far (< 2 km)	51 (20.4)	60 (24)
	Very far (> 2 km)	37 (14.8)	39 (15.6)
If far/very far, prefer travel on through it	Yes	167 (66.8)	165 (66)
	No	83 (33.2)	85 (34)
Satisfied with local (conventional) bus system	Yes	87 (34.8)	77 (30.8)
	No	163 (65.2)	173 (69.2)
Time efficient than previous bus system	Yes	231 (92.4)	234 (93.6)
	No	14 (5.6)	16 (6.4)
	Don't know	5 (2)	0 (0)
Willingness to pay the bus fare (PKR)	< 20	173 (63.2)	10 (4)
	20	60 (24)	214 (85.6)
	>20	13 (5.2)	16 (6.4)
	Any other concession facility	4 (1.6)	10 (4)
Increase commercial property value in its corridor	Yes	161 (64.4)	144 (57.6)
	No	70 (28)	42 (16.8)
	Don't know	19 (7.6)	56 (22.4)
	No change	0 (0)	8 (3.2)
Decrease residential property value around it	Yes	71 (28.4)	59 (23.6)
	No	157 (62.8)	130 (52)
	Don't know	22 (8.8)	53 (21.2)
	No change	0 (0)	8 (3.2)
MBT will help reducing the unemployment	Yes	142 (56.8)	177 (70.8)
	No	99 (39.6)	62 (24.8)
	Don't know	9 (3.6)	11 (4.4)
Rather than construction of MBT, there could be improvement in any other project	Yes	122 (48.8)	134 (53.6)
	No	126 (50.4)	113 (45.2)
	Don't know	2 (0.8)	3 (1.2)

transport suffered respiratory allergies like coughing, asthma, flu, and improper functioning of lungs (**Table 4**). Majority of respondents said the greenery around MBT should be increased as it is beneficial for the environment (**Figure 4**). These absorbs noise pollution and reduce the air pollution by filtering out the undesirable particles. Most respondents said that MBT had improved travel speed as compared to the conventional bus system, since it is more economical to travel 32 km a long route in 20 PKR ($ 0.2). Overall, the post evaluation highlighted that the respondents were happy with the project outcome. An immense change has been seen in traffic congestion and road safety of Lahore after the operation of MBT.

BRT improved bus service on mixed traffic to totally segregated systems (*Finn et al. 2011*). In the some cities of world, MBT helped in reducing air pollution and energy consumption by 61% (*Echeverry et al. 2004;*

Table 4. Environmental Aspects of Metro Bus Transit System.

Question asked (Variable)	Description of the Choice	Pre-evaluation Frequency (Percentage) N (%)	Post-evaluation Frequency (Percentage) N (%)
Tackle severe traffic congestion	Yes	176 (70.4)	191 (76.4)
	No	62 (24.8)	42 (16.8)
	Don't know	12 (4.8)	17 (6.8)
Reduce in air pollution	Yes	190 (76)	177 (70.8)
	No	55 (22)	54 (21.6)
	Don't know	5 (2)	19 (7.6)
Reduce the number of accidents	Yes	201 (80.4)	211 (84.4)
	No	42 (16.8)	32 (12.8)
	Don't know	7 (2.8)	7 (2.8)
Provide secure way of transportation	Yes	232 (92.8)	229 (91.6)
	No	17 (6.8)	20 (8.0)
	Don't know	1 (0.4)	1 (0.4)
Rate on the social, economical & environmental benefits of MBT	Very good	96 (38.4)	126 (50.4)
	Good	90 (36)	70 (28)
	Average	50 (20)	45 (18)
	Poor	5 (2)	6 (2.4)
	Very poor	9 (3.6)	3 (1.2)
Environment friendly project	Yes	206 (82.4)	206 (82.4)
	No	30 (12)	26 (10.4)
	Don't know	14 (5.6)	18 (7.2)
Establishment of thick green belts along the MBT corridors	Yes	224 (89.6)	107 (42.8)
	No	18 (7.2)	133 (53.2)
	Don't know	7 (2.8)	10 (4)

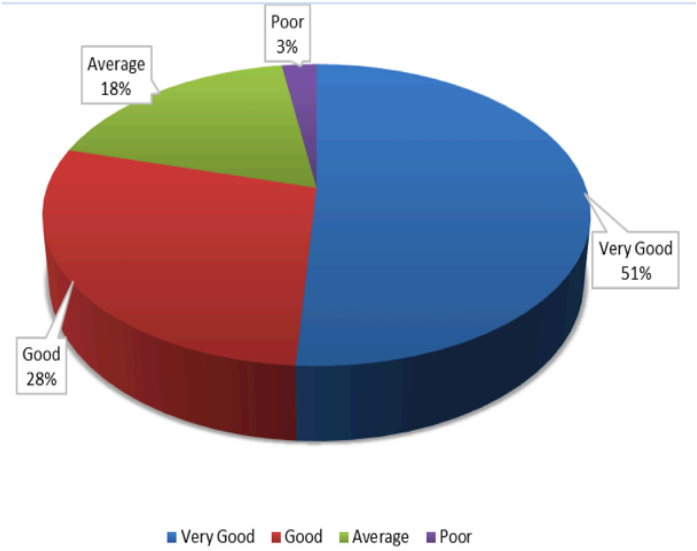

Figure 4. Social, Economical and Environmental benefits of MBT in Post Evaluation.

Pang and Mu 2007; Satterfield et al. 2009). Similar research is needed in case of Lahore. Energy crisis could be averted because of the low fuel consumption by shifting the mode of transportation from private vehicles to MBT. In Turkey, Istanbul Public Transport Authority estimated that fuel consumption had been reduced by Metro Bus Transit (*Schipper et al. 2009; Rosenthal 2009*).

Association between the Variables of Post Evaluation Data

Pearson chi-square was applied on some variables for the significant association between them.

Preference of MBT with the Distance from Houses

There is a significant association between the preference of MBT and station distance from houses with $P = 0.01$, as most people preferred the MBT due to lowest distance accessibility (**Figure 5**). But some also preferred who lived far from the station because it is comfortable and economical.

Use the Mode of Transportation for Daily Purpose

Most people used the MBT and motorbike for their job purposes. Many students used the MBT to go to school. Further, some businessmen used it as alternative to other transportion (**Figure 6**). MBT has shown a positive effect on employment rate. One of the reasons is timely arrivals and covers long distances in few minutes. MBT created jobs for its management. It also created jobs for managers and coordinators, staff for ticketing offices, as well as for the guards and sweepers. The job balance was positive in spite of the elimination of conventional buses, similar in

Bogota (*EMBARQ 2009*).

Accessibility to Station and Success of MBT

People who had the high accessibility to MBT station, said this project successful because it has good impacts on their lives. *Darido* (*2006*) studied that one of the main advantages of BRT was higher operating speed. This equated to a 38.3% reduction in average travel times for passengers (**Figure 7**).

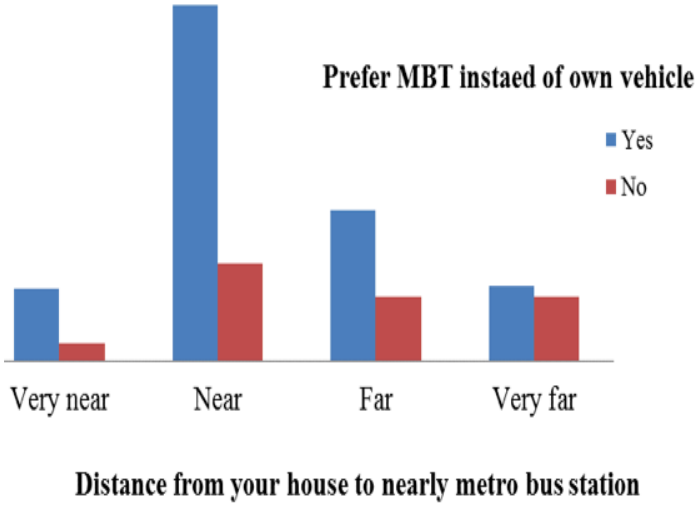

Figure 5. Preference of MBT.

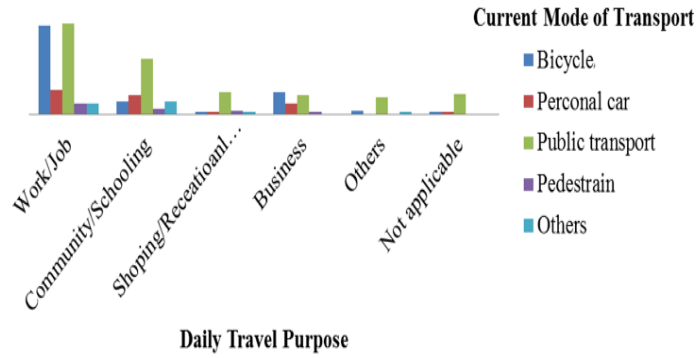

Figure 6. Use the Mode of Transportation for Daily Purpose.

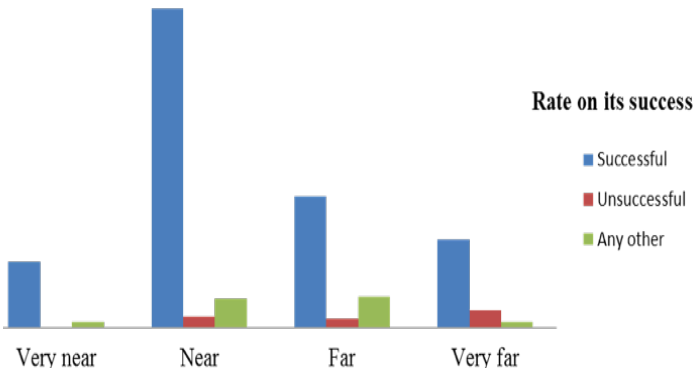

Figure 7. Accessibility to Station.

CONCLUSIONS

Metro Bus Transit was a new project in Pakistan that has revolutionized transport sector. Overall, it was good for the people of Lahore to travel within the city. It was beneficial for lower class people, who had less income and low living standards. Its quality and fare were better than conventional bus system that's why most people preferred to ride it. People were very hopeful for MBT so their views remained same to some extent before and after implementation. MBT gave benefits to many people and provided secure way of transportation. It increased traffic safety by reducing the frequency of traffic incidents, injuries and deaths. It helped in reducing the traffic jam due to its separate track from mixed traditional traffic. It improved environmental condition and health of respondents by reducing air and noise pollution. It was time efficient and cost effective. After getting people's opinions and analysis of observations, people showed high willingness to use rather than basic mode of public transport and were satisfied from its impacts in this growing period of urbanization. But citizens of Lahore need improvement in other projects also, such as power supply, education and health facilities. It made a pathway to build various modernized transportation projects not within Lahore but also targeted different major cities.

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