SOCIO-ECONOMIC AND PHYSICAL IMPACTS OF METRO BUS TRANSIT RAWALPINDI – A CASE STUDY

By

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DEDICATED TO

My Beloved Parents

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First of all, I am thankful to the Almighty God who gave me strength, guidance, power of mind, protection, skills and blessed me to complete my research honestly and efficiently. Next, I would like to express my gratitude to my beloved parents who have been my source of inspiration and gave me strength, courage and supported me emotionally, spiritually, morally and financially for this venture. I am thankful to them for sharing words of advice and boosting up my confidence to finish the study. I also want to pay regards to my supervisor for guidance, encouragement and advice he has provided throughout my time as his student. I would also like to thank all the members of staff at National University of Sciences and Technology who helped me during my whole journey. in my supervisor's absence.

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(Maryam Kousar)

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LIST OF ACRONYMS

BRT - Bus Rapid Transit

MRT - Mass Rapid Transit

RWP - Rawalpindi

ISL - Islamabad

NESPAK - National Engineering Services Pakistan Pvt Limited

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ABSTRACT

Bus rapid transit (BRT) grows in popularity in Pakistan in recent years. It is pretty advanced and cost-effective transportation system which is used in the world due to its high speed and low cost. Rawalpindi Metro Bus Transit was implemented in 2015 which connects Islamabad and Rawalpindi. Different researchers have reported mixed impacts of BRT on adjacent communities and businesses around the world. The Socioeconomic impacts of Rawalpindi Metro is very important issue for the people residing along the metro corridors. However, no such research, highlighting the socioeconomic and physical impacts of BRT, is available in the context of Pakistan. Thus, the main objective of the study was to evaluate social, economic and physical impacts of BRT before and after its construction on adjacent communities and businesses. Study was conducted through questionnaire survey with a sample size of 500 respondents. The study findings revealed that BRT has positively influenced the livelihood of people by creating jobs and other opportunities. It has reduced the level of road accidents, noise pollution and traffic congestion. Further BRT has become the favorite mode of transport for people and it has reduced the trip length and trip duration since its emergence. However, respondents have raised questions about the operational efficiency of BRT and station operations supervision. Secondly, there is limited park and ride facilities available at BRT stations along with poor feeder routes.

CHAPTER 1

Introduction

1.1 Background

Urbanization is one of the most major problems occurring around the world at a very rapid rate. Developing and under developed countries are experiencing rapid growth of urbanization due to which they are facing severe problems and challenges.

Urbanization is defined as the number of people that migrate from rural to urban area causing physical growth of that area which can be in horizontal or vertical form. Urbanization is not only the problem of some of the cities in the world but this phenomenon is making transformations globally.30% of the world's population was urban in 1950 and is projected to rise to 66% by 2050(Kugelman, 2013).

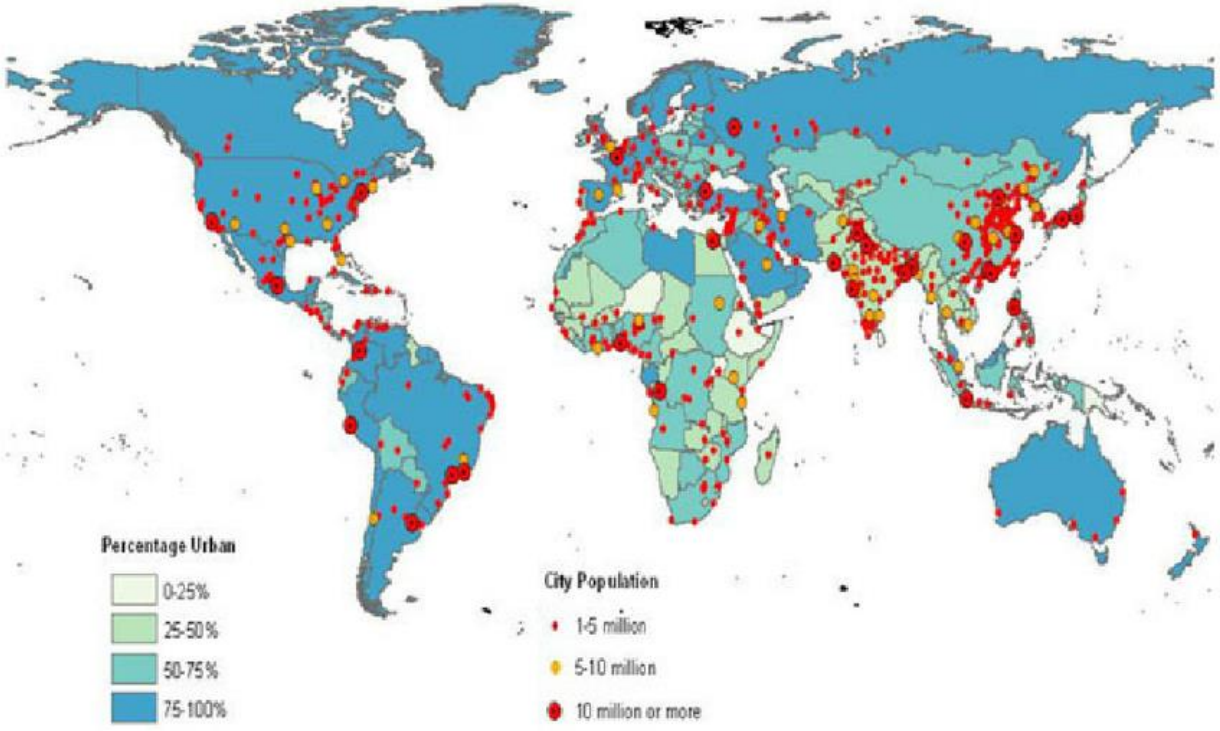

Figure 1: Urbanization in the World

Rapid urbanization is one of the major problems of many continents and developing countries. The rate of urbanization of Africa and Asia is faster than the other regions and are projected to become urban to 56 and 64% by 2050 respectively(Nations, 2014). Pakistan is one of the fastest urbanizing country in South Asia. Urban population in Pakistan has risen from 17% in 1951 to 37% in 2010. According to the projections almost50 percent of the inhabitants will be living in town areas in next 10 to 15 years (Husain, 2016).

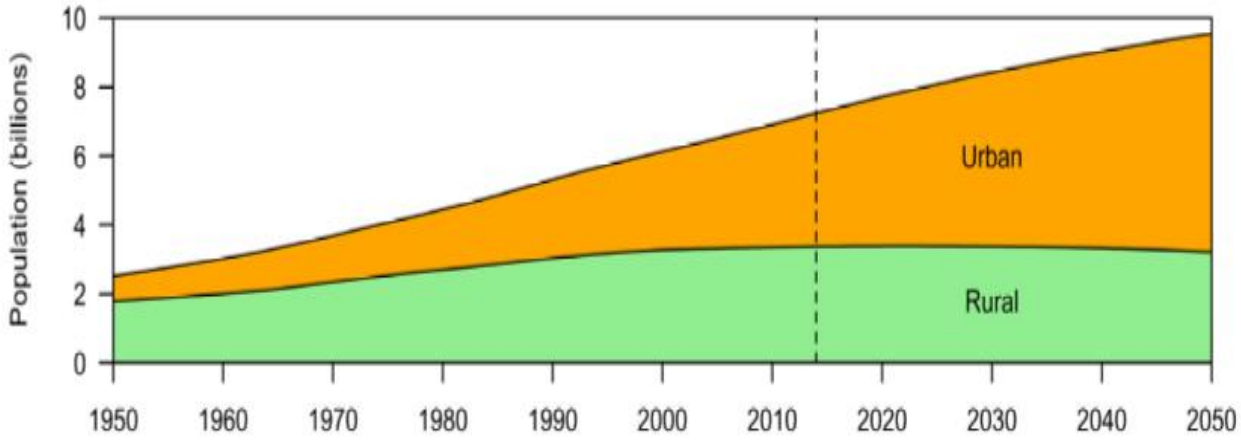

Figure 2: The worlds urban and rural populations, estimated for 1950-2014 and projected to 2050

Data source: United Nations (2014) World Urbanization Prospects: The 2014 Revision.

Islamabad-Rawalpindi is the fourth largest metropolitan region of Pakistan having an area of 906 sq.km and 154 sq.km respectively. It principally consists of twin cities of Islamabad and Rawalpindi along with several gated suburbs such as Bahria Town and DHA Islamabad.

Due to urbanization many urban issues are generating such as lack of affordable housing, high population density, inadequate infrastructure, flooding, pollution, slum creation, crime, traffic congestion and poverty. In developing countries urban road congestion, road safety, lack of transport services in rural areas, reliable access to roads and poor air quality emissions are main problems associated with transportation division (Pojani, 2015).

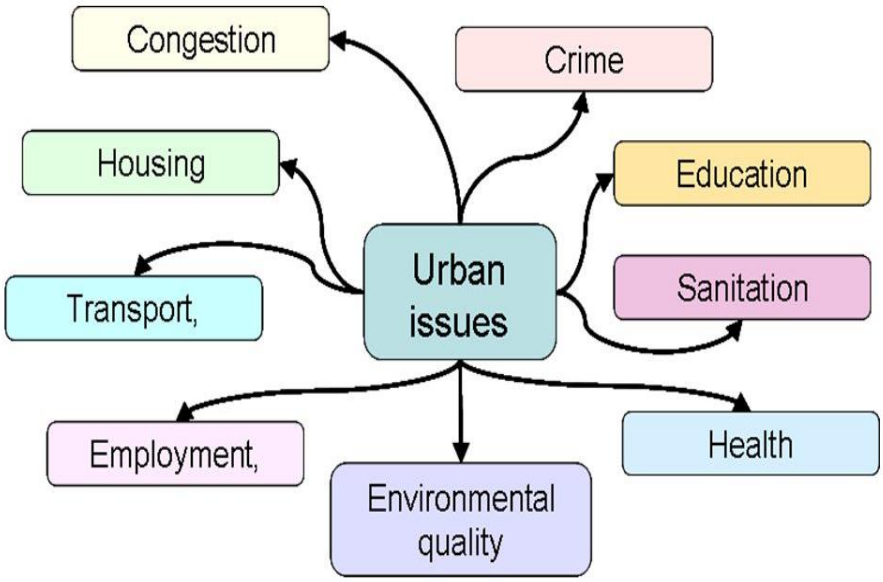

Figure 3: Problems due to Urbanization

Due to this mobility and accessibility has been affected at large. Increased number of vehicular registrations is the main cause of traffic congestion. When there are too many cars for the roadway due to inadequate mass transit options this will give rise to the traffic congestion. Vehicle registration in Islamabad-Rawalpindi has increased in a substantial way in last 10-15 years which has brought too much congestion in urban areas. Traffic jams are produced by more cars which increases the pollution and accidents level and decreases the public transport efficiency(Cascajo, 2004). Many countries had taken steps to improve transportation issues such as building new roads, highways and motorways.

Transportation system has played an important role in transforming social, economic and environmental geography of many countries(Seyal, 2017). Mega projects impact the surrounding of the area and that city socially, economically and environmentally. For the overwhelming majority of developing town residents, only transportation system is everyday means to education employment and public amenities, particularly once such services are outside the feasible distance

of walking or cycling(Wright, 2007). Developments are accompanied by various economic activities providing local employment and a source of employment in these sectors(Allport, 2000). The Construction of roads has particular environmental impacts: erosion, traffic, noise, water pollution and work practices which need to be managed by road contractors (Bank, 2011).

In developing countries, such as China, Indonesia and India, transport sector can be categorized with continuously growing private car ownership and with rapid motorization (Kogdenko, 2011). However, majority of the population in these countries still use public transport. Therefore, more enhancement is needed in public transport rather than building flyovers and new roads for increasing number of cars and vehicles. There are presently twenty BRTs operational in Asia and concerning 50 are deliberate to be built (Venter, 2009).

1.2 History of BRT

The history of BRT includes variability of preceding efforts to advance the transportation experience and conditions for the client. New projects can bring development but also at the same can affect the lifestyle of people living nearby. Development is viewed as a multi-dimensional process involving change in structure, habit attitude and institution as well as acceleration of economic growth (Wanjiku, 2014). Over the past decades BRT systems have tough augmented quality due to their capacity to deliver enticing service levels at a lower value than those of metro and heavy systems(Ingvardson, 2017). A lot of cities are turning to BRT as the way of affordably increasing transit services to increase mobility, reduce traffic congestion and decrease carbon emissions(Cervero, 2010). To solve the problem of traffic congestion, increase mobility and reduce carbon emissions, a lot of cities are turning to bus rapid transit (Cervero,2011).

Curitiba (Brazil) BRT

Curitiba is considered as one of the primary cities to implement a BRT system. The major development of BRT happened with the progress of the 'surface subway' in 1974 in Curitiba (Brazil). Initially rail-based metro system was planned to be constructed however lack of economic capacity resulted within the application of additional inventive approach. At that point rather than metro lines, initiating from the town centre city began to develop procedure of busway corridor. Now a days the advanced Curitiba BRT represent a world example of BRT with bi-articulated buses and tubed stations (Demery, 2004).

Picture 1: Curitiba BRT with bi-articulated busses and modernistic tubed stations

Canada BRT

BRT in Canada has been established in several cities, including smaller cities such as Waterloo, Kelowna, Halifax, Brampton, Saint John, Brampton, and York Region, and larger cities including Toronto, Winnipeg, Ottawa and Vancouver. In Ottawa, the construction of the BRT system led to over $675 million U.S. in new economic development around transit stations.

Picture 2: Canada BRT system

This research aims to study and evaluate social, economic and physical impacts of Rawalpindi-Islamabad Metro Bus Service on the adjacent communities. It will be aiming to quantify each and every aspect of the evaluation and will cover the limitations and gaps of previous researches on this topic. Social impacts may include usability of metro, privacy and safety. This will also give a brief overview on economic impacts of the system such as fuel consumption, traffic congestion, income, employment rate and property rents and values. Beside this several physical and environmental elements will be taken under consideration which mainly contributes to impact any

mass transit system. The results obtained by this research can be utilized for overall impact evaluation of Rawalpindi-Islamabad Metro Bus Service.

This evaluation can be used to identify social, economic and physical impacts of BRT on adjacent communities. Possible deficiencies can be pointed out and steps can be taken to enhance these parameters. BRT systems are considered effective, once it shows huge influence to the sustainable change of a particular city. This will be gauged on three foremost sustainability dimensions, Social, Economic and Environment.

In opportunities where BRT can improve connectivity and accessibility between employment hubs, substantial economic development can occur. These benefits can be seen through redeveloped land, increased property values, and the creation of new employment hubs along BRT corridors. Several case studies across the United States have shown significant benefits to the surrounding community after the construction of BRT lines.

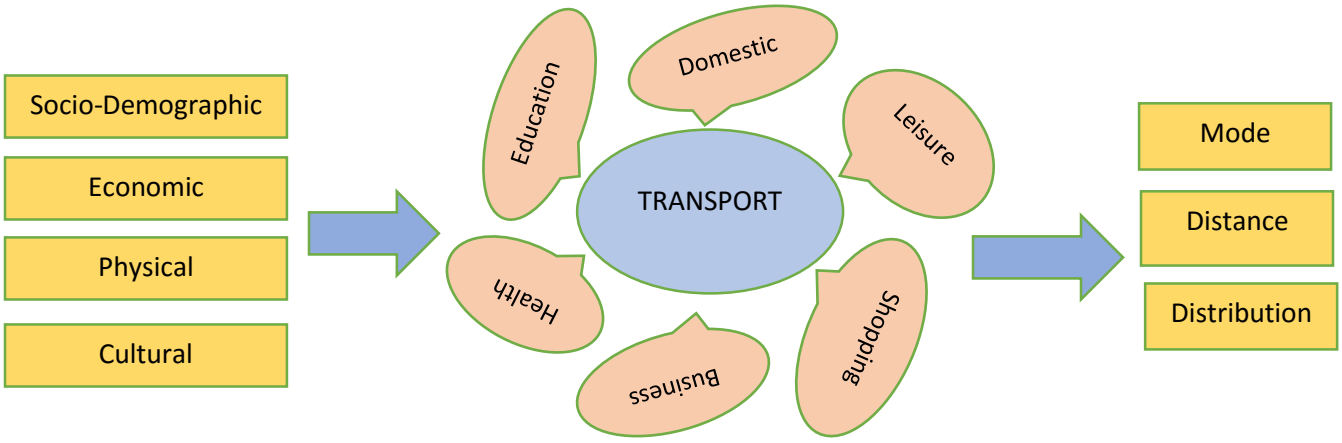

Figure4: Demand for Transportation

The above figure represents that initially it is more vital to understand people desires, abilities and present opportunities in order to recognize the demand for issues related to transportation. People's need is frequently inclined by external aspects such as socio-demographical, economic, physical and cultural factors. These factors determine the demand for transportation, transport model choice, the distance travelled, etc.

BRT system is a public transport concept, which provides the chance for developing municipalities to make first-class transit system at reasonable price. BRT is perceived as a system that includes the infrastructure (buses, bus lanes, stations and terminals) with organized procedure, so as to deliver a better quality of service than a conventional bus system and to draw in travelers who would else drive personal cars on congested urban roads. BRT are thought about as a more cost-effective alternate to a rail-based system, such as metro or light rail(Mazharul Hoque, 2013).

Most important core components of a BRT are considered following:

- Segregated lanes
- Fast boarding
- Surrounded stations that are comfortable and safe
- Higher frequency and less waiting time
- Pre-board collection of fare guaranteeing faster services
- Clear map of route and signage
- Free transfers between lines

Apart from these features, when BRT is properly designed and implemented it contributes to the following objectives:

- Decrease in commuter's trip length
- Decrease in traffic congestion
- Decrease in local pollution

- Optimizes the existing transport means in the area (metro)
- Improvement in quality of life of the society

1.3 Problem Statement

New development in transportation system plays an important role in changing social and economic conditions of the people residing along sides (Wanjiku, 2014).They always have positive and negative effects on the society. Social, Economic and Physical are the key impacts which should be addressed in every new development project. In Many development projects we usually ignore these impacts prior during or after the construction. On the one hand these projects provide ease and settle for the users and riders but on the other hand they may increase traffic congestion and environmental pollution. Transportation projects have many effects on the society such as mobility, accessibility, safety, employment rates, land values and environmental impacts.

The Rawalpindi-Islamabad Socio Economic impact evaluation aimed to address the problems after the construction of Metro. Effects such as traffic congestion, traffic accident, noise, disturbance, Crime level, safety and sky rocketing land values are addressed.

The study is therefore important to the people residing along the corridors of metro by evaluating the socio-economic and environmental effects of the construction of the Rawalpindi-Islamabad Metro Bus transit.

1.4 Research Questions

The research will be aimed at answering following questions:

1. What are the social impacts of metro line on adjacent communities?
2. What are the economic impacts of metro line on adjacent communities?
3. What are the physical impacts of metro line on adjacent communities?

4. How the adjacent communities are affected by the noise pollution?
5. What is the perception of people about metro?
6. What is the utility level of users?

1.5 Objectives of Study

The research is guided by the following objectives:

1. To investigate the Social Impacts of Metro Line on adjacent communities.
2. To investigate the Economic Impacts of Metro Line on adjacent communities.
3. To investigate the Physical Impacts of Metro Line on adjacent communities.
4. To document the lesson learnt for the similar projects in future.

1.6 Scope of Research

In Pakistan, due to the rapid urbanization traffic congestion has increased which disturbs the mobility and accessibility of passengers. People living around the metro line suffers from many Social and Economic impacts due the construction of metro line.

The scope of the research is limited to evaluate the impacts of economy and environment on Rawalpindi Metro Bus Service starting Sadder to Faizabad Rawalpindi on the basis of survey data. It also helps to provide comparison of pre and post impacts of metro at diverse areas in a specific city and also satisfaction and willingness of people to use the MBT.

CHAPTER 2

Literature Review

2.1 Socio Economic Impacts

Development is seen as an important component in any country's vision in the world, however it can have major impacts on the environment, social and economic life of the same countries. New projects can bring development but also at the same can affect the lifestyle of people living nearby (Wanjiku, 2014).It is a tenet of urban planning that transportation networks help shape the spatial configuration of cities(Vinha, 2005). However, transport also carries an important social and environmental load, which cannot be neglected. Developments are accompanied by various economic activities providing local employment and a source of employment in these sectors(Allport, 2000). Effective public transit is central to development(Wright, 2007). The Construction of roads has particular environmental impacts: erosion, traffic, noise, water pollution and work practices which need to be managed by road contractors (Bank, 2011).Corridors along the BRT may have a positive influence on safety of traffic by decreasing the frequency of injuries, fatalities and traffic incidents.

It is however expected in general that road development projects must be economically viable, socially acceptable and environmentally sound(Wanjiku, 2014).Transportation improvements that have occurred since the start of the industrial revolution have been connected to growing Economic opportunities. A particular transport approach has been developed at every stage of societal development(Masood, 2011). Business community has also been severely influenced as a result of mega metro project, as congested highways heads to reduced number of customers because of traffic jams, lack of parking lots, roads blockage, and longer alternate routes (Bibi,2015). Public transportation is an important key to improve quality of life for cities and has been an important

issue in the world due to high passenger demand with traffic jam. It is a key to show development of the cities(Buran, 2013).

BRT and LRT systems have experienced increased popularity over the past few decades due to their enhanced service levels at a lower rate than those of significant rail and metro systems(Ingvardson, 2017). Metro Bus system is considered essential when the population exceeds one million (Gupta,2015).

The two important indicators of economic growth in a society are mobility and transportation. But these indicators decline with the passage of time if not checked properly i.e. traffic congestion (Patankar, 2007).To solve the problem of traffic congestion, increase mobility and reduce carbon emissions, a lot of cities are initiating bus rapid transit. BRT has gained increasing popularity worldwide. Most advanced BRT services found today are in Brazil, Columbia, Latin America, Bagota, Cali, Curitiba, Chile, Peru, Lima and Santiago (Cervero,2011).

Socio-Economic Impact evaluation of megaprojects are important to learn about new projects. It is important to consider different aspects during the economic evaluation of mega projects. But it is also essential to evaluate projects impacts on their surroundings(Korytarova, 2014). Evaluation of the impacts will only be done to ensure that all aspects will be incorporated and to minimize errors in future projects(Patankar, 2007).

In short, socioeconomic evaluations of the project is related to its lifecycle. Usually socioeconomic evaluation in the planning phase also includes indirect economic benefits to the locals, regional and even the national economy but in the evaluation the actors should also pay attention to the expected impacts on the sociocultural factors such as quality of life, lifestyle and values (Lehtonen, 2016).

This analysis relies on qualitative and quantitative measures of impacts. Development impacts are generally evaluated in terms of changes in community demographics, housing, employment and income, market effects, public services, and aesthetic qualities of the community.

2.2 Physical Impacts

According to Economic theory and literature people are willing to pay higher housing costs to lower their costs of transportation to areas of economic activity (Perk, 2017). Environment quality is an indicator of regional quality of life, subsidizing the well-being and health of the general public and sustainability of natural and urban setting. The true impact of BRT isn't merely the physical system however the enhancements it creates in lives of people. Evaluating the projected impacts on economic development, traffic levels, social interactions and urban form all help to regulate whether the BRT system will enhance real value. Transportation projects characteristically bring positive environmental impacts through the decrease of private vehicle use and consequent related emissions (Baghini, 2014). According to extensive analysis urban properties respond absolutely to transportation developments. Usually this takes the shape of higher property values (Cervero, 2011).

In Seoul, Korea (Cervero, 2011) found new BRT's created extremely limited land value rewards. Land markets take advantage of the accessibility of the BRT's mainly helping higher-density inhabited uses. Dwellings which were in 300 meters of the BRT stations knowledgeable about land worth of 5 to 10 percent, whereas retail and alternative non-residential uses which were in radius 150 meters of the BRT stations benefitted in increase of 3 to 25 percent.

High-quality BRTs, like all urban transport will have an effect on the standard of living, efficiency, health and safety of individuals residing in cities (Hurst, 2014). BRTs reduces emission of

greenhouse gases as it has positive environmental impacts that subsidize air pollution and climate change. Decrease in emissions of vehicles can be attained in numerous ways by enhancing the bus service, fuel efficiency and reducing vehicle kilometers travelled. BRT systems also offer valuable public health benefits to society in three main ways: reduced road fatalities and injuries, reduced personal exposure to harmful air pollutants, and increased physical activity for BRT users (Carrigan, 2014).

BRT systems have further impacts associated with land use, urban development, crime rates, employment and even public tax revenues(Cervero, 2004). BRTs might also accelerate changes within the varieties of residential, industrial, office, retail or the density of areas close to stations. Additionally, to put up existing demand of travel along corridor, BRT might persuade higher-density growth along the stations as a result of magnified convenience and better pedestrian volumes. In Seoul, new BRT facilities resulted in demand in market for higher-density residential lands (Cervero, 2011).

In developing countries car ownership is continuously rising, leading to problems such as air pollution and congestion, deteriorating public transport facilities. Income per capita and ownership of private vehicle has also a strong association with each other which means if the income is higher it becomes more inexpensive to have a car.

2.3 Benefits of Bus Rapid Transit

Taotang Deng et al 2013 overviews bus rapid system and stated that BRT provides high operating speed, high capacity and convenience, lower cost and ease encouraging passengers to use it. BRT offer high level of service to the users and can be projected to have a positive effect on travel behavior change. It has the competence to advance the accessibility of the land close to the BRT

stations and can have a positive impact on property values. It is also more flexible and can be built economically and incrementally compared with other forms of Mass Transit (Deng, 2013). BRT has progressively become an attractive urban transit alternative in many Asian developing cities due to its cost-effective and flexible implementation (Satiennam, 2006). BRT designing involves a service plan that meets the requirements of the population and employment centers in the area and matches the demand for service which is a main step in defining a BRT system.

CHAPTER 3

Research Methodology

3.1 Study Area

Rawalpindi-Islamabad Metro bus Service is Bus Rapid Transit service that is provided to occupants of twin cities of Rawalpindi and Islamabad. It starts from Flashman Hotel, Sadder and finishes at Pak Secretariat, Islamabad. Presently there is just a single course which is 22.5 km long however two future extension of this route is being planned which will connect the primary course(Jalil, 2018).

The whole area of metro under Rawalpindi region was taken under study which starts from Faizabad station to Flashman Hotel Sadder. The length of the total route of metro in Rawalpindi is 8.6km. This whole length was divided into 10 zones with a buffer of 500m on both sides also the stations were surveyed alternatively to cover maximum area along the sides.

This research was hybrid as both qualitative and quantitative was accessed for the analysis.

3.2 Research Instruments

Number of different indicators were adopted for this study (Annexure C). These indicators were adopted due to their relevance to the study after literature review of different reports, journal articles and previous approaches. These indicators were used for developing questionnaires for field survey, expert opinion survey and checklist of observatory survey.

The indicators considered in social impacts are usability of metro, Number of accidents, crime and interaction between the people due to metro. Privacy and safety were also considered as the main indicator in social impacts.

Furthermore, the indicators which were considered in economic impacts were income, employment rate, economic and financial loss, fuel consumption, shops rents and no of customers. The data collected from these indicators was then evaluated using Statistical Analysis.

Performance of BRT in social block is being evaluated by the use of increased road safety, travel convenience, and safety and privacy. The assessment of these measures will provide with the understanding of the BRT implementation effects on the Society.

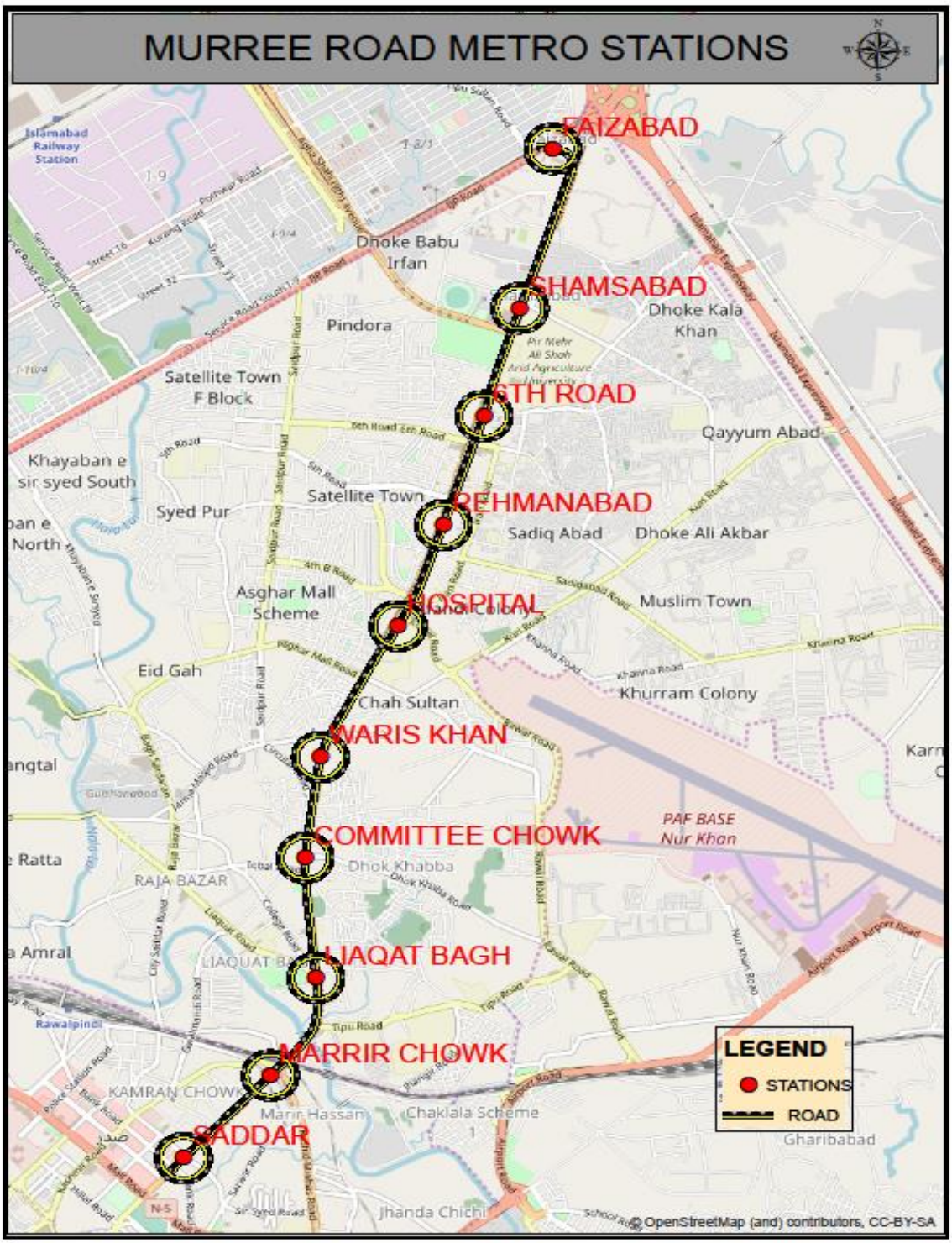

Figure 5: Travel Route Map of BRT

3.3 Data Collection

After developing detailed methodological approach to perform field study, next phase was data collection.

Two types of data were collected for analysis purpose.

3.3.1 Primary Data Collection

Primary data was collected through the following data collection techniques:

1. Field Survey

Field survey was conducted along the corridors of metro in Rwp Region so that basic characteristics of the study area can be identified and analyzed. Two different types of questionnaires were developed based on the indicators identifies with the help of literature review. Based on questionnaires two different surveys were conducted. One survey was conducted from the local residents living along the corridors of metro and second survey was conducted from the business community who are running businesses along the metro corridor. This survey was carried out so that perception of the local people can be obtained and considered. This helped in addressing issues of present situation of BRT as well as helped in gaining opinion of the people regarding future interventions in the study area for improving the present conditions.

2. Observatory Survey

This survey involved field visit and collection of pictorial data. This is a qualitative form of data which helped in understanding the present situation of the study area with the help of the checklist that was devised with the help of indicators that were identified after review of literature. The checklist helped in noting down all each characteristic of the study area. The aim of this survey was to observe the existing situation of BRT along its corridors of the study area.

3. Interviews

Interviews play a very important role in shaping the outcome of the entire research. Different experts and professional were approached for obtaining expert opinion about the Social, Economic and Physical Impacts of Metro on its corridors. Semi-structured interviews were conducted that comprised of questions regarding different indicators which were taken into consideration during the study. Also, real estate agents were interviewed regards increase in land values along the corridor's pf metro.

3.3.2 Secondary Data Collection

Secondary data was collected from previous articles and published reports. Data regarding Social and economic impacts after the construction of metro was collected.

3.4 Sample Size

Two questionnaires were developed with a total sample size of 500. One for the people residing along the corridors of metro and one for the people running business along the corridors of metro. There were 150 respondents from the community and 350 from the business.

The survey points were taken alternatively and equal sample size was collected from each station. Minimum 50 samples were collected from each station. Data was then collected through Questionnaire surveys and interviews from the concerned authorities.

3.5 Data Analysis

This portion includes the analysis of collected primary and secondary data. Data collected from all sources was compiled and analyzed with the help of soft wares like Microsoft office, Microsoft Excel, SPSS (Statistical Package of Social Sciences). This includes analyzing mean, averages, percentages, cross tables etc. It also includes the comparison of pre and post impacts of Rwp-Isl Metrobus Service. In the end gaps and constraints were identified and solutions were proposed.

3.3Flow Chart

The complete research methodology is explained with the help of flow chart shown in figure 1. It shows that the research started with the literature review of various socio-economic studies of metro around the globe. It was followed up by Data Collection Phase in which two types of data was collected, Primary and Secondary data. Primary Data was collected directly from field by conducting questionnaire surveys and secondary data was collected from previous articles and published reports. In the next step, raw data was converted in to useful information by performing evaluation using Statistical Analysis. In the end results of analysis is discussed and conclusions are drawn along with some recommendations.

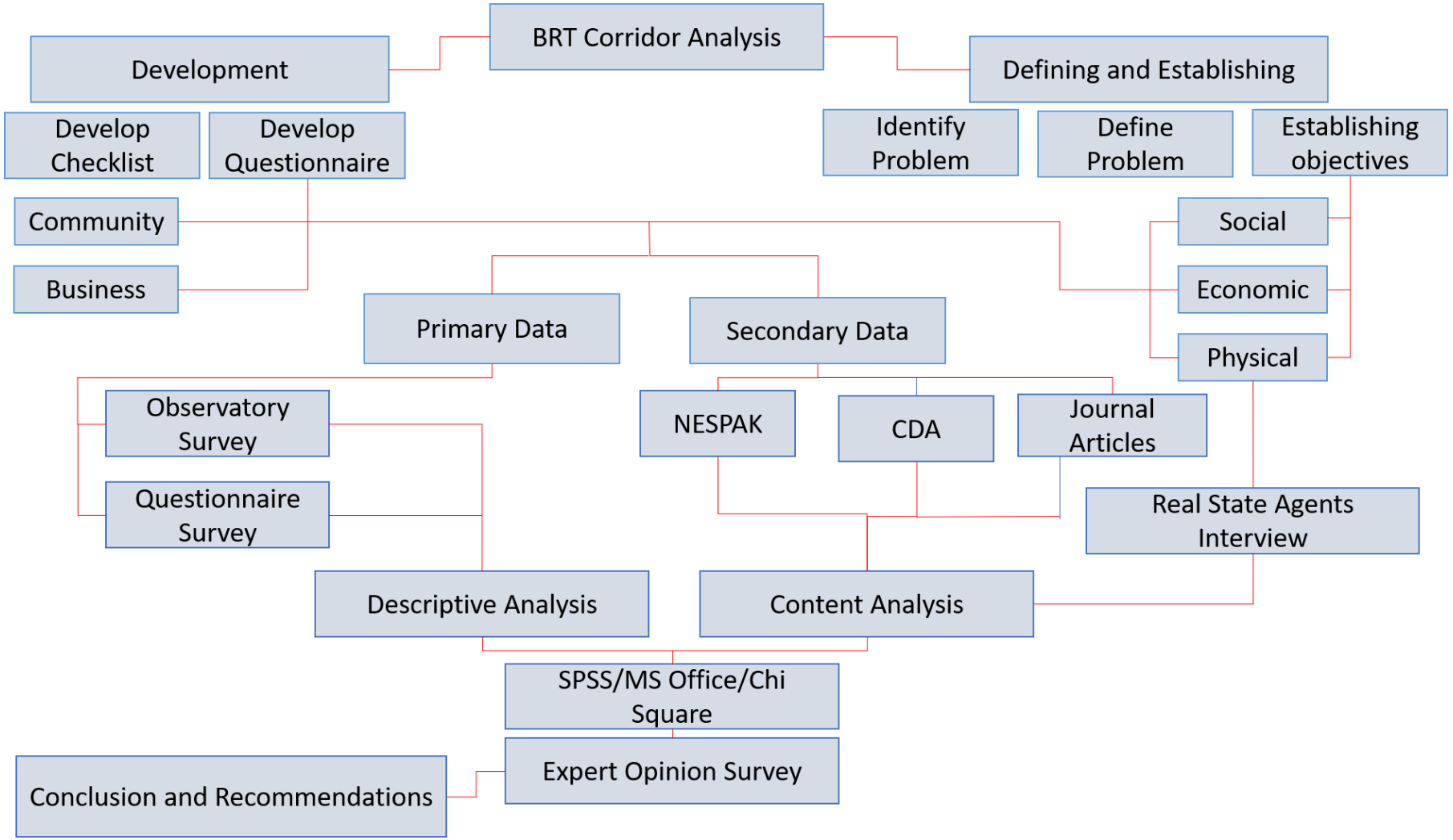

Figure 6: Research Methodology Framework

CHAPTER 4

Results and Discussion

This chapter describes the results of primary and secondary data collected through surveys and interviews.

4.1 Demographic Profile

Assessments and calculations are based on demographic considerations therefore it is extremely important to evaluate who to survey and the way to breakdown overall survey response information into significant groups of respondents (Defranzo, 2012)**.**

The Table 2 shows the demographic information of people living along the metro corridors and the people who are running business along the corridors of metro. Majority of the respondents were male (*n*=447, 89.5%) compared to female (*n*=53, 10.6%). While collecting the data during the survey, there was no female respondent in business community because in Pakistani culture female used to stay at home and usually work from home whereas male member of the family is running outdoor businesses. Furthermore, the age of respondents is concerned, mostly middle age people (31-40 aged group) are running businesses while in community mostly lower age people were staying at home because the people who are running businesses are mainly from the same locality and the people staying at home are either lower age group people and women who have lower education level. 23.8% were under the age group of 21-30 while only 10.8% and 10% belonged to younger and older people respectively.

Table 1: Demographic Information

Characteristics	Business n	Community n	Total n(%)
Gender			
Male	350	97	447(89.4)
Female	0	53	53(10.6)
Age			
10-20	5	49	54(10.8)
21-30	79	40	119(23.8)
31-40	138	27	165(33)
41-50	93	19	112(22.4)
>50	35	15	50(10)
Education Level			
Illiterate	61	4	65(13)
Primary	117	26	143(28.6)
Inter	97	64	161(32.2)
Graduation	72	55	127(25.4)
Diploma	3	1	4(0.8)
Occupation			
Unemployed& Retired	6	29	35(7)
Student	4	69	73(14.6)
Self Employed	190	19	209(41.8)
Govt Employee	0	12	12(2.4)
Private Employee	150	21	171(34.2)

Likewise, majority of the people running business were not very much educated whereas the respondents of community were mostly intermediate. According to the survey, almost one third of the respondents have attained 12 years of education (32.2%, 161 people) and similar number of respondents have completed Primary Education (28.6% ,143 people), and one-fourth of the respondents have completed their Graduation Degree (25.4%, 127 people) while 13% (65 people) were reported not having a certificate, diploma or degree.

Finally, most of the people running business were self-employed (41.8%), however private employees are also very common in business enterprise (34.2%) while there are only 12 people doing private business from community and that is because there is some small commercial area within community premises where some commercial activity exists and also 12 people have constructed shops inside their homes.

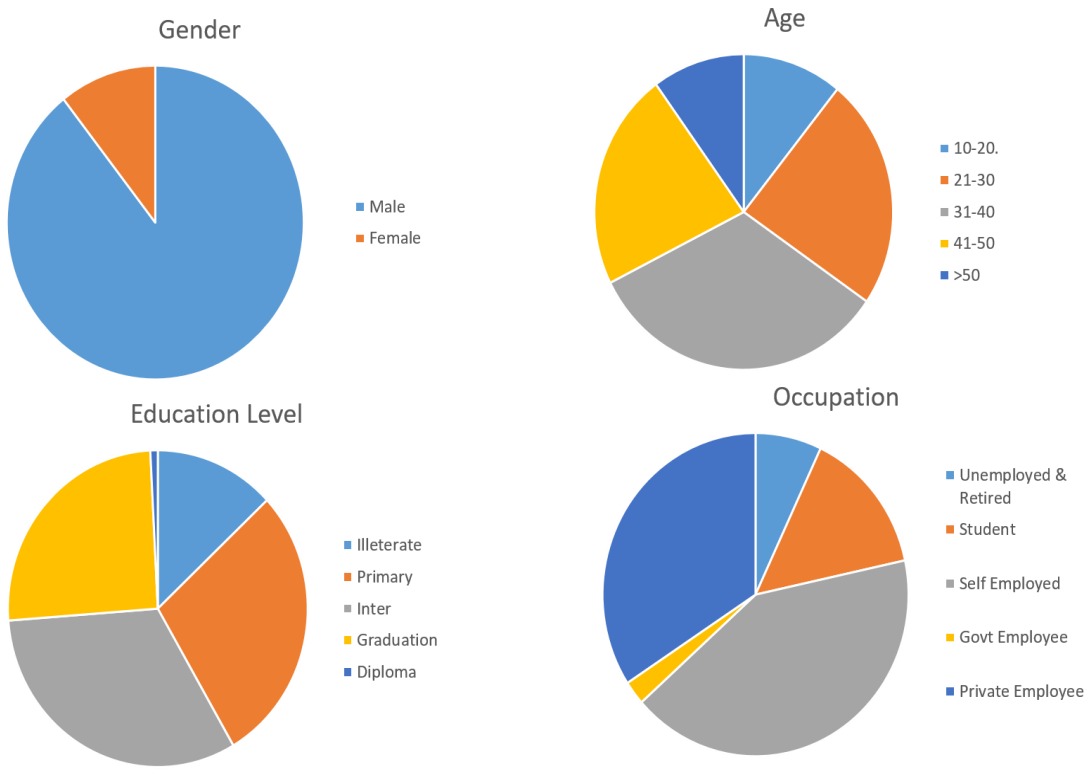

Figure 7: Demographic Information

4.2 Social Impacts

To gauge the possible socio-economic impacts of the metro bus transit, a detailed survey was conducted in which sample of 500 people were interviewed. The results of the survey are presented in the following sections.

4.2.1 Usability of Metro

Usability is considered as an important design goal for public transit enterprises. It is also an important element of any mega transportation project as it enhances the ease and settle(Cervero, 2010)**.**

As a general Summary of results shows that the usability has improved as an emergence of metro. The result of survey reflects that metro is the main mean of transport and more than half of respondent (55.8%) use metro after its emergence. And when they were asked about their means of travel before the metro they told that they were using cars but the cars were causing congestion due to which they prefer to use metro. Moreover, they highlighted the fact that metro stations are easily accessible from their homes and they can easily use them to travel.

Table 2: Usability of Metro

Characteristics	**Business**		**Community**		**Total**		**Male**		**Female**		**Total**	
Means of Travel	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Public(non metro)	48	302	21	129	69	431	64	363	5	48	69	411
Car	30	320	58	92	88	412	59	388	29	24	88	412
Bike	266	84	78	72	344	156	323	124	21	32	344	156
Metro	178	172	101	49	279	221	239	208	40	13	279	221

The table 3 outlines transportation preference by the people living and running business along the metro corridors. As is obvious, bike and metro are the most common means of travelling in the two mentioned categories. 68.8% of the people use bike as a transport because the people from business group come from different community as well and bike is convenient for the people travelling in Rawalpindi due to heavy traffic conditions. Interestingly, people did not use public transport quite often both in business and community enterprises only 13.8% of the total

respondents use public transport which made public transport the least common mode of transportation and this is because of the easy access to metro stations.

Usability of Metro criterion is gauged whether travelling with the new BRT system became more convenient for commuters, in comparison to a bus service before BRT implementation. Few key indicators are used for this assessment: trip length, accessibility, travel comfort, reduction of travel time and time to reach metro station.

Trip length is the length of the trip from the traveler pickup to the drop-off location and is usually measured in distance or in time(Group, 2008). The foremost essential explanatory factor in traveler transport for fare level on a journey is travel distance(Mathisen, 2006)**.** According to this survey, trip length of 18% of people is between 5-10km and 17% of the people is 10-15km which shows that majority of the people who are running businesses along the metro corridors also lives in the same community. Overall, MBT has shown a positive effect on reduction in travel time. Users of Johannesburg BRT saves 13 minutes on average each way(Eunice Vaz, 2011)whereas in Istanbul turkey the typical Metro bus passenger saves 52 minutes per day(Pelin Alpkokin, 2012)**.** The most vital factors to be considered are cost, travel time and comfort. There are also some other aspects which can govern the complete decision to travel and the choice of a particular mode of transportation. These aspects are: trip length, trip frequency, trip reliability and trip urgency. However, in general, people incline to choose for the shortest, least costly and most comfortable way of transportation. The significance of these three factors and their effect on a traveler's decision (e.g. student vs. retired person's transportation behavior) depends on a person's abilities, needs and opportunities (Demery, 2004).

Table 3: Usability of Metro

Characteristics	Business n	Community n	Total n	Male n	Female n	Total n
Trip Length						
Within 5km	28	14	42	37	5	42
5-10km	61	57	118	99	19	118
10-15km	85	23	108	101	7	108
15-20km	69	22	91	81	10	91
>20km	12	3	15	13	2	15
Reduction in Travel Time due to Metro						
<10min	230	54	284	266	18	284
10-15min	95	35	130	118	12	130
15-20min	3	12	15	10	5	15
20-25min	0	12	12	5	7	12
>25min	0	14	14	10	4	14
Time to reach Metro Station						
>10min	187	111	298	254	44	298
10-15min	123	23	146	140	6	146
15-20min	17	6	23	21	2	23
20-25min	2	3	5	5	0	5
>25min	5	4	9	9	0	9

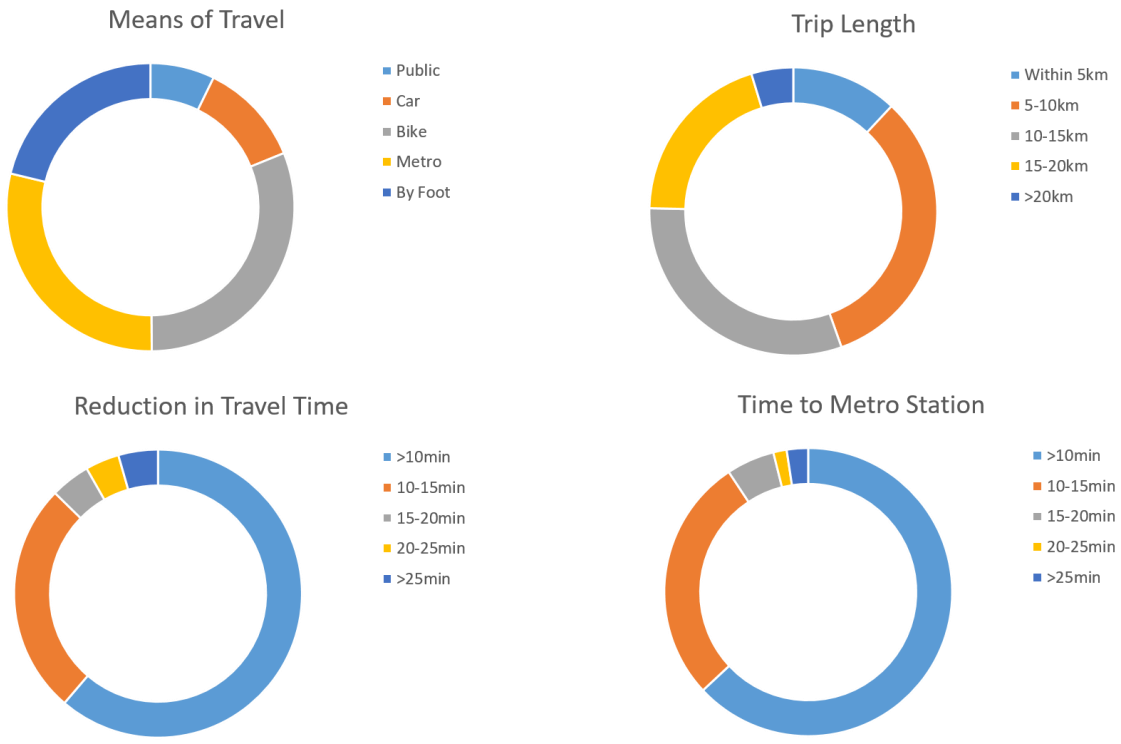

Figure 8: Usability of Metro

Travel time benefit is one of the foremost reasons for extending and upgrading public transport(Ingvardson, 2017). Travel time is the time that a traveler spends on board the vehicle from time of boarding to arriving time at the destination. In short, time that traveler spends on the transit vehicle is called travel time(Group, 2008). In this survey, 42% of the people take less than 10mins to reach the metro station which reflects that metro stations are easily accessible and near from their work places and homes. Moreover, murree road is the main central business point that's why it attracts people for recreational activities. According to one of the respondents it only benefited few areas of Rawalpindi region like Murree road. As, murree road is the main central business point that's why it attracts people for recreational activities which causes congestion but now the road width has increased and have more parking spaces which therefore increases the mobility and accessibility of this area.

4.2.2 Safety and Privacy

Implementing BRT systems contributes to reductions in traffic crashes and fatalities. Dedicated bus lanes scale back interaction between buses and different vehicles, limiting the chance for car accidents(Carrigan, 2013).TransMilenioin Bogota's has subsidized reductions in injuries and crashes on two of the its main corridors(Juan Pablo Bocarejo, 2012) whereas BRTs in the Latin American have subsidized to decrease in crashes and fatalities of over 40% on the highways where they were executed(Carrigan, 2013).

According to the survey conducted in Rawalpindi region as shown in Table 4 almost half of the people (53.8%) responded that No of Accidents reduced after the construction of metro whereas almost 35.6% of the respondents thinks that accident level is same before and after the BRT. There is always a relationship between social interaction and crime(Sah, 1991). The Amount of social interactions is highest in petty crimes, moderate in more serious crimes, and almost negligible in murder(Glaeser, 1996). In the table below, it shows that according to half of the respondents (54.4%) there is no effect of BRT on crimes and the level is same as before where as 67.2% people observed that interaction is also same between people which consequently shows the relationship between interaction and crime. While 26.2% and 13.8% of people responded the interaction and crime has increased respectively. When people were asked about the increased level of interaction they said that this is due to the factor that people from every class travel together, you meet a lot of people who belongs to your related circle and talk with them during travelling. Also, pocket snatching has increased after the construction of metro.

Privacy is also a main factor which is considered when any mega project is being constructed. Mega projects are always linked with privacy because transportation routes effects privacy of the people living along the area due to which it is considered valuable in local context. It not only

disturbs the social life of life but also effects their daily routine. According to the people living along the corridors of metro, diversion was made from the houses and all of the people used to go through the streets. Also, at some points due to the elevated metro road people travelling on metro can easily see into the houses of people as they are on the same eye level. One of the respondents said that it was only disturbed during the construction because the streets and roads adjacent to the community was packed with laborers and it became difficult for females to move through those streets. According to survey conducted in Rawalpindi region along the sides of metro 96.4% of people responded that their privacy was not disturbed while 3.2% responded that their privacy was disturbed but it was only during the construction. After the completion of the project it is same as before.

When people were asked about their perception about the safety of metro a large number of people expressed gratitude over the comfort they drive from the service. There was no problem of overcrowding like other public transports and they preferred to travel on metro instead of other means. According to one of the girls who lives in Rawalpindi region but daily travels to Islamabad for university said that however metro has given her relief from daily travel on public transport but also during peak hours bus is overloaded and the seats reserved for women are occupied by men. Capacity of buses is less which should be improved and overloading should be stopped. Also separate travelling area in the buses made women feel safer and gives them confidence boost.

Table 4: Safety and Privacy

Characteristics	Business n	Community n	Total n(%)
Reduction in No of Accidents			
Reduced	142	36	178(35.6)
Same	205	64	269(53.8)
Community Interaction			
Increased	82	49	131(26.2)
Same	247	89	336(67.2)
Increase in Crimes			
Increased	53	17	69(13.8)
Decreased	23	14	37(7.4)
Same	272	0	272(54.4)
Disturbance in Privacy due to Metro			
Yes	10	6	16(3.2)
No	340	142	482(96.4)

'Road safety' criteria are gauged as: "whether the transportation of city's inhabitants became safer in comparison to the situation before the BRT system integration".

For the assessment of the above-mentioned criteria four main indicators are going to be used.

- Reduction in number of road accidents
- Increase in Crimes
- Disturbance in Privacy due to Metro and Community Interaction

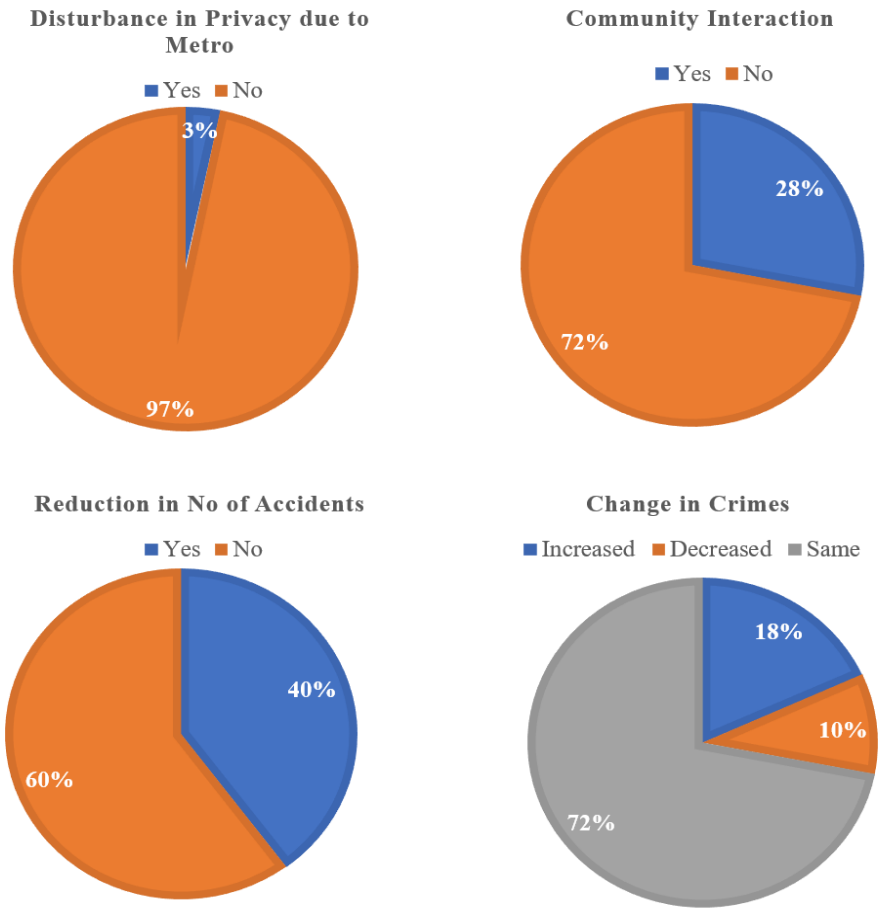

Figure 9: Safety and Privacy

4.3 Economic Impacts

Transportation developments that have taken place since the start of the economic revolution are connected to growing economic opportunities(Seyal, 2017)**.** Transport sector is vital part of the economy and a standard tool used for development because of intensive use of infrastructures(Rodrigues, 2017).When transport systems are proficient, they provide financial and social advantages and opportunities that lead to positive multipliers effects like higher accessibility to markets, employment and extra investments. At the point when transport systems area is

deficient in terms of capability or liableness, they can have a financial cost for example missed or reduced opportunities and lower quality of life (Rodrigue, 2017).

Transit is often seen as a catalyst for economic development. Benefits from transit corridors can include increases in property value, employment, and redevelopment of land. BRT corridors that benefit from transit-oriented development share some key characteristics: they improve connectivity between hubs, and have land available for development or redevelopment. Cleveland's Healthline BRT line is a major example of the impact's quality transit can have on a corridor. The line was constructed between 2006 and 2008, and transformed the corridor filled with vacancies on Euclid Avenue to bustling economic hub. The $200 million project, which included funds to redesign the street, have spurred nearly $6 billion in economic development, including the creation of 8 million square feet of commercial space, 13,000 jobs, and 4,000 new residential units. Within four years after opening, property values jumped between thirty and one hundred percent (Demery, 2004).

Table 5: Economic Impacts of BRT

Indicators	Increased	Decreased	Same
Change in No. of Customers	25.1%	8.6%	63.1%
Fuel Consumption	10.3%	40%	41%
BRTs impact on Income	25.7%	13.1%	57.7%
Change in Employment Rate	16.9%	_	78.3%
Impact of BRT on Property Rents	45.7%	9.1%	16.9%

There were few indicators on which Economic impacts of BRT were gauged (Table 7). These indicators were change in number of customers, decrease in fuel consumption, change in income

level of the people, change in employment rate and change in land values due to emergence of BRT along its corridors.

4.3.1 Change in Number of Customers

This survey illustrates that how metro impacted the amount of number of customers along its corridors. According to the survey, 63.1% of the people responded that no of customers before and after the metro remained same but 25.1% of people responded that no of customers increased after the construction because it has now become easier for people to travel who live far away (Table 7). They travel from different areas through metro bus transit easily and economically for recreational activities.

Only 8.6% of people responded that no of customers decreased after the construction, majority of them responded that this decrease in customer was during the construction because the shops were demolished and the metro construction disturbed the transportation due to which less customers visited their shops. Some people run whole sale business due to which there was no impact on their business.

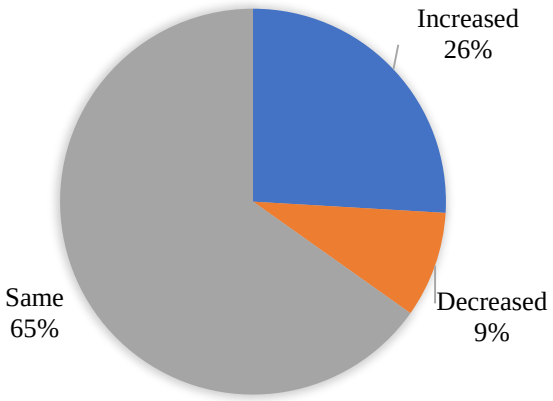

Figure 10: Change in Number of Customers

4.3.2 Fuel Consumption & traffic congestion

In many cities of the world traffic congestion on highways and streets has grown to a dangerous level and has turned into noteworthy issue with numerous damaging impacts including higher fuel consumption, lost time, more vehicle emissions, greater transportation costs and increased accident risk (Eugen, 2012)**.** Transportation system can result in advantages and disadvantages. It can improve the access of public to many opportunities but on the other hand can also result in difficulties related to greater traffic levels near or within a corridor (Forkenbrock, 2001).Additional cars can result in more traffic jams that will increase the level of accidents and pollution and decreases the efficiency of public transport(Cascajo, 2004). Fuel consumption is usually related to average speed, and average speed is often used as a traffic performance measure by the researchers (Eugen, 2012)**.**According to the survey, nearly 40% of the people who had personal vehicle said that BRT reduced their fuel cost as it replaced their personal vehicle usage either completely or partially because of its accessible and economical factor. While only 10.3% disagreed about fuel consumption reduction. Also, almost 41% of people responded that there is no impact of metro on the fuel consumption. It is same as before. They also don't face any kind of traffic congestion and noise pollution which consequently decreases the use of local vehicles and fuel consumption.

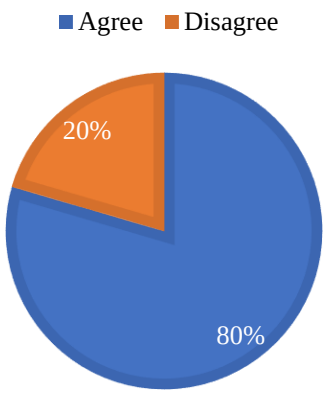

Figure 11: Fuel Consumption

4.3.3 BRT's Impact on Financial Loss and Income

Development is associated at enhancing the welfare of a society through acceptable social, political and economic conditions (Rodrigue, 2017). Economies are directly related with transportation(Korytarova, 2014)**.** Delay in transportation projects can cause huge financial losses to the residents especially living in the commercial areas and the same thing happened in Rawalpindi region. During the construction phase of metro which was almost 1 year hampered the financial position of business community. When this question was asked from the concerned business community, almost half of the respondents (42.9%) says that their business was disturbed during the construction which lead to decrease in income level. This loss was faced during the construction phase but after the completion of project the construction of metro has positive impact on local businesses and this is evident from the table that almost 25% of the people responded that their income has increased due to creation of metro line whereas 13% said that the income decreased during the construction phase.

4.3.4 Change in Employment rate

Public transportation services are essential from numerous points of view. They affect the economy in terms of wages, employment, and business financial gain (Weisbrod, 2014). Building a subway system can indorse employment and population density, thus discouraging conurbation and its negative consequences (Vinha, 2005)**.** A survey conducted along the corridors of metro shows that according to 78.3% of the people that employment rate is same before and after the metro construction whereas 16.9% of people responded that employment rate has increased after the metro construction.

From the survey it is concluded that this increment of employment rate is due to the reason that BRT created jobs for its management, it also created jobs for coordinators, managers, staff for ticketing offices and also for the guards and sweepers(Asma Mansoor, 2016)**.** Construction of new shops has also increased the rate of employment.

In multiple cases, BRT lines have increased employment along its corridor. In Pittsburgh, despite a declining population, the East Busway line was able to generate over $300 million in economic development. Eugene, Oregon began operating the Emerald Express Green Line in 2004, and in 2010 there had been a 5% decline in employment of all jobs further than a half mile from a BRT station, while jobs within a quarter mile of stations increased by 10%. BRT corridors across the United States have resulted in additional economic development. These projects benefited from land available for redevelopment along the corridor (Perk, 2017).

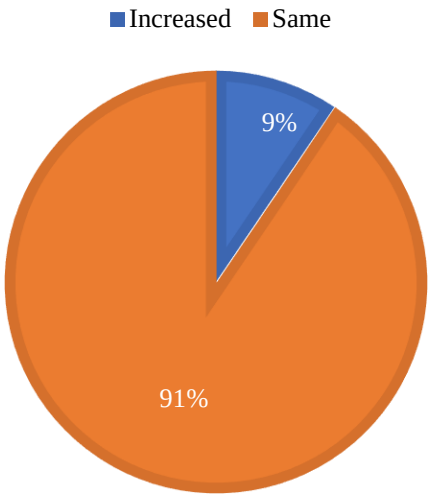

Figure 12: Employment rate

4.3.5 Impact on Operational Timings due to BRT

According to the survey, 94.6% of the people responded that operational time was same before and after the metro construction whereas only 3.7% of the people responded that the timings were changed due to the disturbance but there was a very little change. Usually the time change happened during the construction of metro but after its completion it is same as before.

According to one of the shopkeepers he had to close his shop for several months during the construction of metro because he was running a crockery store and due to dust, excavation and other reasons his all crockery items were covered with dust and it was difficult for people to come to his shop due to excavation of roads due to which his shop remained closed during construction.

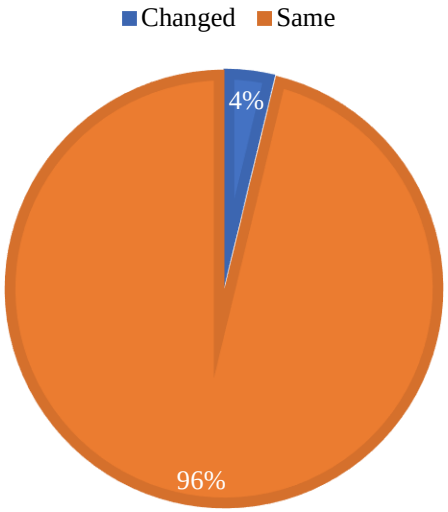

Figure 13: Change in Operational Timings

From the above figure it can be deducted that metro didn't affect the operational timings. It is same as before and has only impacted when the metro bus transit was under construction.

4.3.6 Business Effected due to BRT

50.6% of the people in the survey responded that their business was not affected and it remained same before and after the construction of metro while 39.1% of people responded that during construction business of shopkeepers was severely affected.

The reason to this was because it became difficult for people to move due to excavated roads. Some of the people have to keep their shops close for few months during the construction due to the disturbance created by the construction.

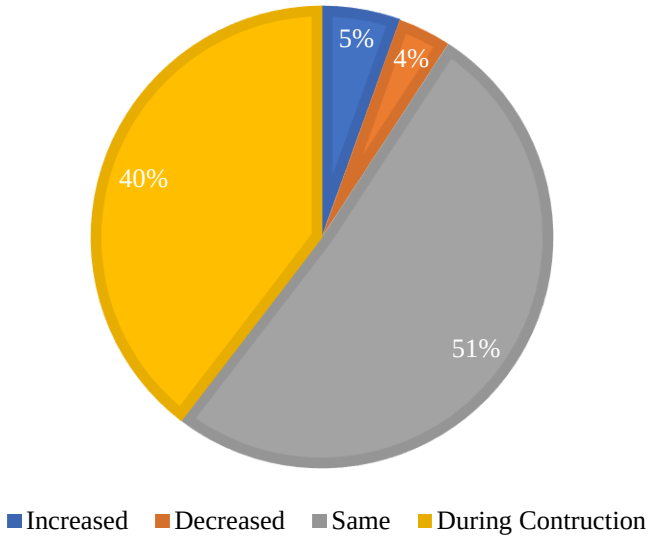

Figure 14: Business Effected due to BRT

4.4 Physical Impacts

4.4.1 Property Rents

Transport infrastructure development is usually perceived as impetus for economic process (Zhao, 2017). Making new roads or growing existing ones will increase the attractiveness of the land they undergo and encouraging new urban facilities. These facilities in this way increase the demand of

land use which therefore increases its value(Morimoto, 2013). Transportation cost verifiably includes the chance that urban infrastructures, like public transport, can form land and real estate prices. Location rent can be isolated using nearness to stations or mass transit lines, looking on the kind of public transportation. According to Burgess (2008), land values is one of the foremost sensitive indexes of mobility and increased mobility acts as a driving force of change in a city (Devaux, 2017). Public infrastructure impacts the urban patterns and spatial dissemination of urban property values (Damm, 1980), (Chakraborty, 2013). Reduction in land values and travel time are interconnected. Businesses and residents are always prepared to pay more price to be near to transportation stations(Carrigan, 2013).

Transportation development will have a positive result on the probability or timings of land developments. A high-quality transport system will greatly advance the accessibility of its catchment area by shortening time of travel. Thus, the locations which are close to transport stations usually have a high level of accessibility to a transit system and it tend to be necessary for new development or redevelopment. In common with alternative methods of Mass Transit systems, such as Subways, LRT and BRT systems tend to influence land development. A growing body of evidence suggests that BRT systems have a positive impact on property value uplift (Deng, 2010).

Survey was conducted to illustrate about the property rents along the corridors of metro. Real estate agents were chosen with good reputation in the market. It was easier to access them compared to Government officials and developers. They were approached by making direct contact to their workplaces around BRT stations. After they showed interest they were asked about the land values change along the corridors of metro from 2005-2018.

As per collected data from the survey, it illustrates that 45.7% of people responded that shop rents have increased after the metro construction. Also, there was a yearly increment of 10% in shop rents but now after the construction due to increased economic activity the owners have now increased the average yearly increment and experts believe that in future the rent will increase. Also, the shop rents immediately increased in the areas close to the metro station. According to 9.1% of the people rents has decreased. The rent mainly decreased in the area which is far from the metro station and is not much accessible while 16.9% of people responded that the shop rents are same and there is no impact of metro construction on the rents.

Table 6: Commercial Property values

Propertysize (sq.ft)	**Value(Million)**				**Rent(Million)**			
	2005	**2010**	**2015**	**2018**	**2005**	**2010**	**2015**	**2018**
1 Shop(900)	10	50	50	70	0.05	0.2	0.35-0.4	0.35-0.4
Commercial Unit(800)	16	32	50	50	0.15	0.35-0.4	0.6-0.7	0.6-0.7
Commercial Plot(272.3)	0.5	1	2	2	N/A	N/A	N/A	N/A

According to table 9, data collected from the real estate personals there is no big difference between the values and rents of property before and after the metro. The commercial enterprise is divided into three main categories which are single shop, commercial unit and commercial plot. The standard size of one shop is 900 sq. ft and the value of this was 50 million in 2015 and was increased to 70 million in 2018 whereas the rent almost remained same between 0.35-0.4 million. Furthermore, the value of commercial unit remained same in 2015 and 2018 which was 50 million where as in 2005 it was of 16 million which was increased to 32 million in 2010. Also, the rent increased from the period 2005-2018. The rent of a commercial unit was 0.15 million in 2005, 0.35-0.4 million in 2010 and increased to 0.6-0.7 million in 2015 and 2018. Commercial unit

usually consists of four floors with an area of 800 sq. ft. Finally, the commercial plot value also increased during this time period. The value of commercial plot was 0.5 million in 2005, 1 million in 2010 and 2 million in 2015 and 2018. The value of commercial plot in 2015 and 2018 remained same.

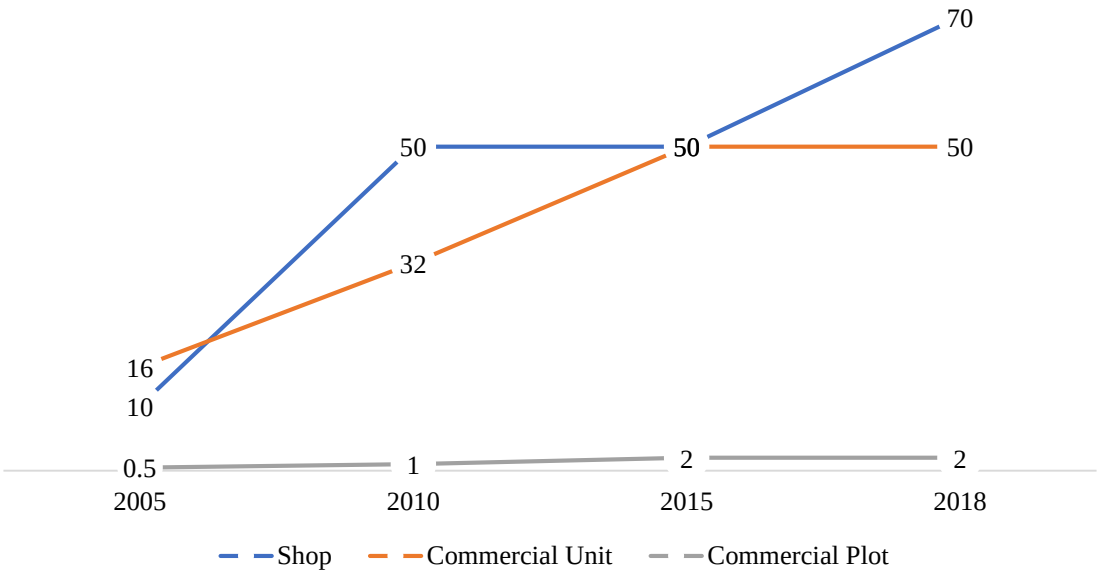

Figure 15: Commercial Property Values

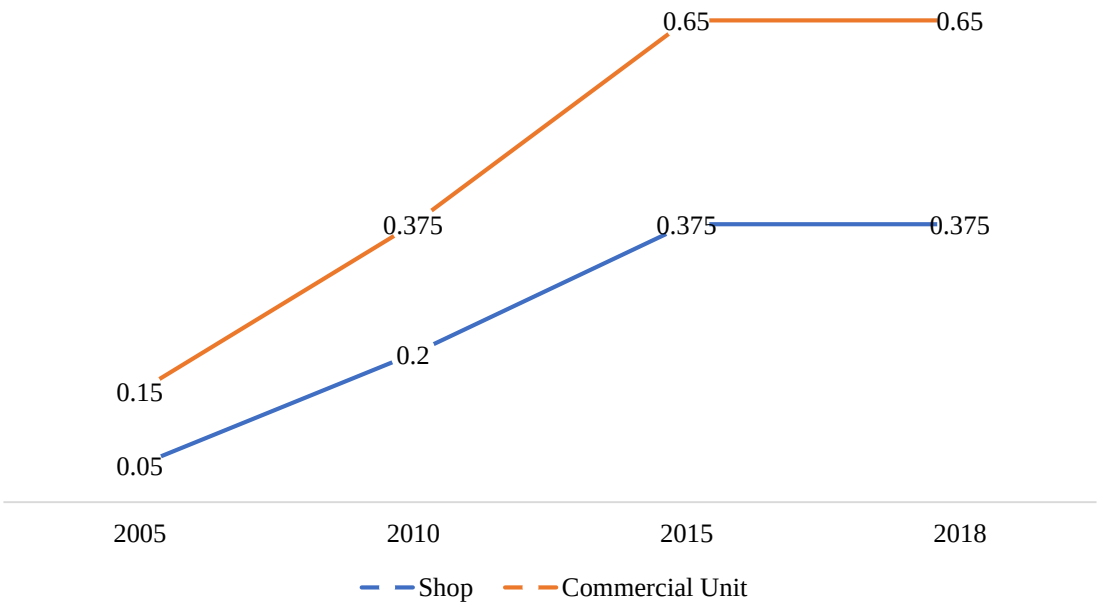

Figure 16: Commercial Property Rents

Following are the primary findings collected from discussion with local real estate agents:

- The rise in property value due to BRT mostly occurred after its emergence and happened with within distance of 500m from the BRT station
- Accessibility was enhanced in the properties adjacent to BRT station.
- BRT was important to many customers interest in the local area. From the real estate agent's perspective, majority of the people would like to pay a premium for land near the BRT corridor.
- According to 77% of respondents, BRT has become a driver for property development along its corridor.

Property values increase as a result of improved accessibility to employment hubs and economic centers. People are willing to pay a premium for access to goods, services, employment, education and recreation, and studies have shown premiums for both residential and commercial properties.

It is thought that BRT has a considerable impact on transit-supportive land development. Travel time savings has made lands near BRT more desirable for development. Due to accessibility enhancement many commercial projects were built after the execution of the BRT.

4.4.2 Parking spaces

According to the survey, 39.7% of the people responded that parking spaces are same before and after the construction of metro while 36.9% of the people responded that parking spaces increased after the metro.

According to some people it only increased on few places like murree road area because murree road region was one of the congested areas along the Rawalpindi metro corridor which has now improved a lot after the construction of metro.

On the other hand, 23.1% people responded that parking spaces were reduced due the metro construction which is mainly due to the area conversion of that area into shops and roads. Also, some people think that encroachment land has increased which therefore decreases the parking spaces.

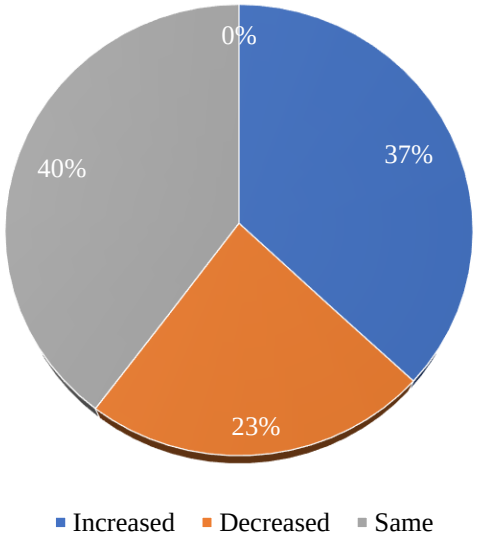

Figure 17: Increase in Parking spaces

Thus, the above pie chart concludes that parking spaces are almost same or increased after the construction of metro. In addition, reducing on street parking has not resulted in diminished revenues. Reports in Toronto and Vancouver have shown that businesses consistently overestimate the percentage of customers who drive to their stores. Automobiles occupy significantly more space per customer than other modes of transit, which have much smaller footprints. Fewer parked cars on roadways also increases the visibility of storefronts to pedestrians. Another advantage to transit users is their transportation costs decrease, providing them with more disposable income to spend elsewhere.

4.4.3 Impacts of BRT on Land Use

This table of land use addresses different components of land which includes land effected, land mark and land use type. According to the survey, only 2.8% people responded that their land was affected due to the construction of metro whereas 96.2% of the people responded that there was no impact of metro on their land. This is because of the reason that during construction it was

considered that minimum land should be affected during the construction of metro so people should face less difficulty and trouble. Some people also responded that they don't own land in that area, they come only for business purposes and live in some nearby area. Secondly, no landmark or heritage structure was lost during the construction of metro. It was considered by the construction authority to preserve the heritages and land marks coming in the way of metro. Finally, the last component discusses about the land use type that how the property type changed before and after the construction of metro.

Table 7: Impacts of BRT on Land Use

Characteristics	Business n	Community n	Total n(%)
Land Acquired			
Yes	14	0	14(2.8)
No	334	147	481(96.2)
Land Mark			
Yes	14	0	14(2.8)
No	334	149	483(96.6)
Land Use Type			
Yes	324	130	454(90.8)
No	18	9	27(5.4)

Majority of people (almost 90.8%) responded that property type remained same before and after the construction. There was no change in type of land because already the area along the metro in Rawalpindi region is much crowded and congested that there is no land available for more construction. Whereas, only 5.4% responded that property type changed after the metro.

Mainly, the changed type was commercial which is due to the reason that the area along the sides of metro is commercial and the people who have constructed their new shops were already running business their but due to constructed their shops were relocated by giving compensation. So, after

the completion of the project they again build their shops which therefore increases the land use type.

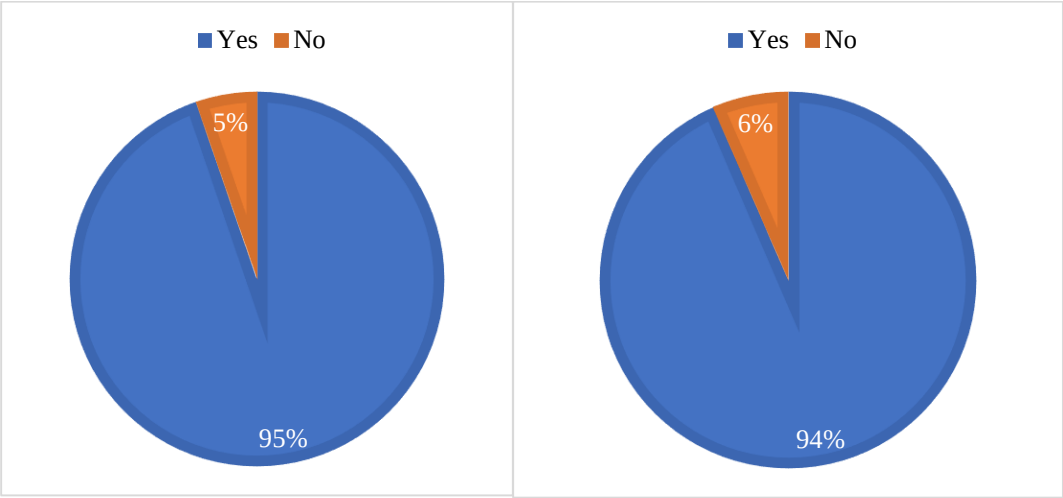

Figure 18: Land Use Type change

To better understand the land use and its different components along the corridors of metro, a comparison is drawn in above Figure between the community and business enterprises. This comparison shows the clear picture of the land use along the sides of metro.

4.4.4 Change in Construction Activity

Table 8: Change in Construction Activity

Characteristics	Business n	Community n	Total n(%)
Construction Activity			
Yes	46	62	108(21.6)
No	213	68	281(56.2)
Same	82	14	96(19.2)
Commercial	40	32	72(14.4)
Residential	-	2	-
Plazas	-	45	-
Multistory	-	2	-

This table illustrates that how construction activity changed after the construction of metro and what is the nature or type of that construction activity. Majority of the people (almost 56.2%) responded that the construction activity didn't change after the metro bus transit whereas 21.6% responded that changes occurred after construction of metro and those changes were mostly commercial buildings and plazas.

Most of the area that was affected during the construction of metro was commercial area because mostly business community is situated along the roadsides, and was directly affected during the construction. So, after the completion of metro people rebuilt their shops.

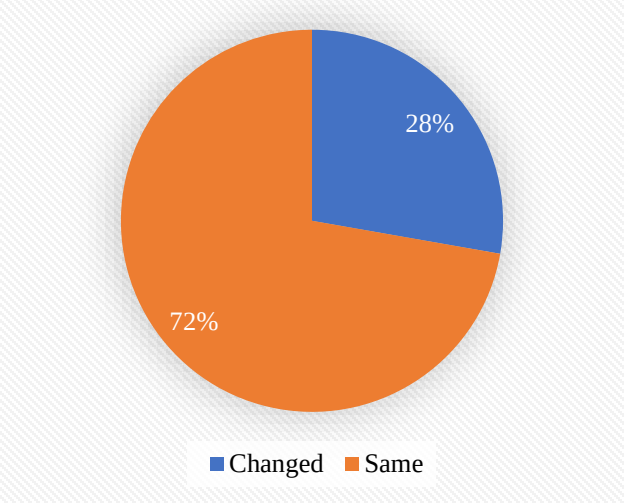

Figure 19: Change in Construction Activity

4.4.5 Impact of BRT on Encroachment Land

Encroachment is a situation in real estate where a property owner interrupts the property rights of his neighbor by building on or extending a structure to the neighbor's land or propertyor beyond the building-line of a road or street. Encroachment of land or property is illegal and in most of the cases land owned by the person is usually the victim of mass-encroachment from small-scale

businesses and dwellings. The main reasons for encroachment are that Pakistan is a third world country and have minimum wage rate per which consequently makes more difficult for people to purchase land on their ow. Also, the land prices have gone up significantly in the last few years, which consequently results in encroachment.

Table 9: Impact of BRT on Encroachment Land

Characteristics	Business n	Community n	Total n(%)
Encroachment Land			
Increased	19	11	30(6)
Decreased	173	100	273(54.6)
Same	148	21	169(33.8)

This table outlines that how the metro bus transit impacted the encroachment land before and after its construction. According to the survey, 54.6% of people responded that encroachment land has decreased after the construction of metro which reflects that the amount of land which was illegally occupied by the shop owners and stalls is now reduced while only 6% of the people responded that encroachment land has increased.

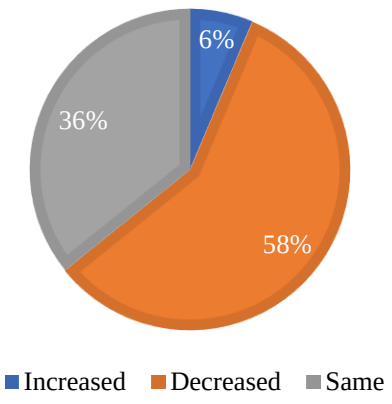

Figure 20: Impact of BRT on Encroachment Land

Furthermore, almost 33.8% of people responded that encroachment land is same before and after the metro construction which shows that there is no impact of metro on encroachment land.

This is because the engineers of NESPAK who were involved in the construction of metro and were the main stakeholders of this project considered this thing that minimum land should be encroached during this project which is clearly seen and the collected data also reflects the same thing.

Comparison of Rawalpindi BRT system with other BRTs around the World

The results evaluated from Rawalpindi Islamabad Metro Bus Transit BRT was then compared with other BRTs around the world using different indicators which were considered during the study. The results are formulated in the form of table to give a better comparison of BRTs performances.

Reduction in travel time due to Rawalpindi metro was 10 mins each way while in Johannesburg BRT the travel time reduction was calculated 13 mins. Also, Trans Jakarta BRT saves almost 10-20 mins of the commuter compared to other public transportation systems used by the residents. When road safety improvements were assessed it showed that in Rwp BRT 36 percent of the respondents said that number of accidents have reduced after the emergence of metro whereas in Latin America 40 percent of the fatalities were reduced after the execution of BRTs. However, change in land values almost remained same in Rwp BRT but it somehow impacted the people residing along the corridors by increasing the rents and land worth's near to the stations whereas in Beijing BRT according to 85.7 percent of the people responded that it has become a driver for property development along its corridors. Employment rate was also

increased after the emergence of the metro because new staff is required for the BRT and also some new businesses were started along the corridors after its emergence while in Delhi BRT this indicator was evaluated as high which means that large number of people were employed after the BRT operation.

Almost 50 percent of the respondents shifted to BRT in Rwp from private cars due to availability of metro stations near to their homes. It takes almost less than 10 mins to reach the nearest metro station in Rwp BRT while in Trans Jakarta BRT modal shift was almost 13 to 14 percent while shows a positive change. feeder route and parking facilities are the most important indicators considered during the evaluation of transportation project. In Rwp BRT lack of feeder route availability was evaluated while in Trans Jakarta, Delhi and Beijing BRT availability of feeder services and parking spaces were very less which consequently causes traffic congestion problems.

Indicators	Rawalpindi BRT, Pakistan	Johannesburg BRT, South Africa	Istanbul Metrobus, Turkey	TransJakarta, Indonesia	Delhi, India	Beijing, China	Latin American	Bogota's TransMilenio, Colombia
Reduction in Travel Time	Rwp BRT users saves on average 10 mins each way	Joh BRT users saves on average 13 mins each way	Metrobus passenger in Istanbul saves 52 minutes per day	It saves around 10-20 mins than bus users	0n average 35% of the travel time was reduced	Travel time of the commuters was reduced on average of 40%		
Road Safety Improvements-Reduction in fatalities and Crashes	36% of the people responded that Rwp BRT contributed to a reduction in fatalities			For pedestrian's and bus commuter's safety issues were improved	This indicator's contribution was high in Delhi BRT	This indicator was evaluated high in Beijing BRT	Over 40% of the fatalities were reduced after the implementation	TransMilenio has contributed to reductions in injuries and crashes on two main corridors of the systems
Land Value Changes	Land Values almost remained same					85.7% of respondents believed that BRT has become a driver for property development along its corridor		
Creation of new job market	Only 17% of the people responded that job market has increased after the metro construction			This indicator was not evaluated.	This criterion was moderate in BRT Delhi	This indicator was not evaluated.		
Traffic Congestion	Reduction in congestion			TransJakarta's contribution to	'Congestion reduction' in	Reduction in congestion		

	was moderate in Rwp BRT	'reduced congestion' was 'moderate'	this case was 'moderate'	contribution reduction' was 'high'
Availability of nearest metro station	It takes less then 10mins to reach the nearest metro station			43.4% of passengerslived near a BRT station
Modal Shift	Modal shift from personal cars to BRT is almost 50%	Modal shift from personal cars to BRT is 13-14%	This initiated people shift of mode from cars to BRT	This BRTplayed an important role in modal shift from cars to BRT
Feeder Services	No feeder services available.	No feeder services available.	No feeder services available.	No feeder services available
Parking Facilities	According to 37% of the people parking spaces have increased after the metro emergence.	No parking facilities available	No parking facilities available	No parking facilities available

CHAPTER 5

Conclusions and Recommendations

Conclusion

Identifying and determining transportation issues is one of the main tasks confronting governments in developing countries like Pakistan**.** Transportation is one of the main problems faced by many developing countries. This is mainly because of the economic activities in the cities and the growing population. It has now become a main concern of Pakistan's public policy and life. Due to this problem it has now become very difficult to work and live in the cities of Pakistan because of congestion and overpopulation. Urban transport problems in Pakistan are managed by building larger and better roads. Therefore, the initiative of Rawalpindi-Islamabad Metro was taken by Pakistani Government in collaboration with Punjab Authority and Turkish Government to overcome this situation of traffic congestion in twin cities. As the Rawalpindi is the central business district and number of people travel daily from other areas for recreational activities. A survey was conducted to know the transportation problems the people are facing after the metro and majority of the people responded that Rawalpindi metro solved the transportation problems in general due to increased level of service, greater mobility, less consumption of resources such as petrol, diesel and shifting of people from private vehicle to metro bus transit. Also, reduction in number of accidents played a major role in solving transportation problems. A lot of people now prefer to use metro because of lower fare, good transportation services, comfortable journey and accessibility. It almost helped everyone including students and daily wedge workers to reach their destination economically and on time. Time saving is one of the main factors to use metro instead of other local transport. It has now become much easier for the people living far away from the Rawalpindi region to travel due to metro bus transit. People can now more easily travel to and from other areas. They think that introduction of feeder route can help metro become more popular

towards the people because it will enhance its linkage facilities to the metro stations. Some of the people stated that more frequency of the buses is needed during peak hours. They also pointed out the necessity of park and ride service and proper parking spaces. According to some people living along the corridors of metro said that metro has destroyed the beauty and greenery of the residential area. Also, they are disappointed with too much closeness of metro track towards residential buildings which also increases noise pollution in that area.

Based on the outcomes attained from the analysis of Rwp-Isl BRT, it can be concluded that this in twin cities, BRT has improved the transportation system, guaranteeing a quicker transmission of common cities residents. The implementation of BRT has been shown to have positive economic impacts. Effects can include increases in property values, the creation of new jobs, increasing business revenues and the redevelopment of land. Corridors greatly benefit from high-density use and mixed-use of land, allowing for compact development which can capitalize on the premium proximity to transit offers. Higher concentrations of people along a BRT corridor also provide an increased customer base and a larger labor pool. BRT offers increased accessibility to key economic and employment hubs, and combined with lower transportation costs, provides the opportunity to have more money spent in the local economy.

At last, in these cities BRTs have played an important role in development of the transportation system, guaranteeing quicker transmission of a majority of the residents of city. It was also found during this study that transportation behavior of people may have a substantial influence on the performance of transportation system. Hence, while executing a new BRT or any other transport policy in a specific city, it is significant to take transportation behavior of people into consideration and perform detailed research for understanding how several factors such as travel time, convenience and comfort can impact the performance.

Recommendations

The assessment results of the selected BRT case study discovered positive aspects and current problems of these BRT system's operation, and may be useful for the enhancement of system' s operations and also for the stages such as executing and planning of the new BRT systems. The main objective e of this study was attained in this way.

It is suggested to perform a research with similar evaluation on other BRT systems. Also, similar evaluation should also be performed for other transport policies besides BRT. Introduction of feeder route can help metro become more popular towards the people because it will enhance its linkage facilities to the metro stations. Main barrier during this research was the availability of data on BRT system performance. Therefore, monitoring phase of the BRT needs more attention. This might significantly decrease the time spent on search of the relevant data, also to improve the quality of the results attained from the evaluation. Some of the people stated that more frequency of the buses is needed during peak hours. People also pointed out the necessity of park and ride service. There is also observed lack of proper parking spaces.

Lastly, it is recommended to outspread this research and perform field-study research, interviews of the commuters and BRT stakeholders to make it more complete.

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ANNEXURE A

Questionnaire for Community

Profile of Respondent

1. Gender

   Male ☐ Female ☐

2. Age

10-20	21-30	31-40	41-50	>50

3. Education level

Illiterate	Primary	Inter	Graduation	Post Grad	Diploma	Others

4. Occupation

Unemployed	Student	Retired	Self employed	Govt employee	private employee	Others

5. Place of residence(lives in same community or not)

   _____

Socio-Economic

6. For how long are you residing in this community?

   _____

7. How many household members?

   _____

8. How many children are school/college going?

   _____

9. Which of the following means do you use to travel?

Bus	Car	Bike	Metro	Others

10. How many daily trips you make?

0	1-2	3-4	4-5	>5

11. How many trips you travel daily on metro?

0	1-2	3-4	4-5	>5

12. What is the length of that trip?

Within 5km	5-10 km	10-15 km	15-20 km	>20 km

13. How much is the reduction in travel time due to metro?

    _____

14. How much time do it takes to reach the metro station?

>10 min	10-15 mints	15-20 mints	20-25 mints	>25 mints

15. Was your land affected during the construction of metro? Y/N. If YES then what compensation was given by metro bus transit authorities?

_____

_____

16. How much time was taken for the compensation process?

_____

17. How much cost was given to you? Was that cost appropriate? Y/N. If No, then how?

_____

_____

18. How is your privacy disturbed due to construction of metro line?

_____

_____

19. What are the problems you are facing after the construction of metro?

_____

_____

20. Is there any increase or decrease in the land prices alongside before and after the metro? Y/N. If YES then how much is the increase or decrease in the land prices alongside?

_____

_____

21. What type of benefit are you getting from the construction of metro?

_____

_____

22. Do you think rwp metro solved the transportation problems? Y/N. If YES then How? Give reasons?

_____

_____

23. What is your perception about safety of metro? How it can be improved?

_____

_____

24. Is there any reduction in number of accidents before and after the construction of metro? Y/N. If YES then how much is the decrease in number of accidents before and after the metro?

_____

_____

25. Does the interaction between the people increased or not? Y/N. If YES the How?

_____

_____

26. What is the effect of metro on crimes? Do they increased or decreased?

_____

_____

27. Do you think rwp metro is contributing in solving the traffic congestion problem? Y/N. If YES then how it is contributing in solving the traffic congestion problem?

_____

_____

28. Do you suggest any other safety measures at metro stations?

_____

_____

Physical

29. Any landmark/heritage structure was lost in your locality? Y/N. If YES the name the landmark?

_____

30. Do you feel metro helps in reducing the noise pollution? Y/N. If YES the How?

_____

_____

31. What is the population density of the area along the metro line?

_____

32. What is the scenario of traffic congestion before and after the construction of metro?

_____

_____

33. Is there any construction activities increased after the metro? Y/N. If YES then what is the nature of those construction activities?

_____

_____

34. Is the land use type of property is same or not? Y/N. If NO then how is the land use type changed?

_____

_____

35. Is there any impact of metro line on sewer system? Y/N. If YES then How?

_____

_____

36. How much is the encroachment land increased or decreased before and after the construction of metro?

_____

_____

ANNEXURE B

Questionnaire for Business Community

Profile of Respondent

1. Gender

   Male ☐ Female ☐

2. Age

10-20	21-30	31-40	41-50	>50

3. Education level

Illiterate	Primary	Inter	Graduation	Post Grad	Diploma	Others

4. Occupation

Unemployed	Student	Retired	Self employed	Govt employee	private employee	Others

5. Place of residence(lives in same community or not)

   _____

Socio-Economic

6. For how long are you working here?

   _____

7. How much distance are you travelling to reach your workplace?

Within 5km	5-10 km	10-15 km	15-20 km	>20 km

1. Which of the following means do you use to travel?

Bus	Car	Bike	Metro	Others

2. How many workers are employed in your shop?

0	1-2	2-3	3-4	>4

3. What are the working timings?

   _____

4. Do other areas customers come to your shop or not?

   _____

5. How often do you travel on metro?

Daily	Weekly	Monthly	Never

6. How many trips you travel daily on metro?

0	1-2	3-4	4-5	>5

7. What is the length of that trip?

Within 5km	5-10 km	10-15 km	15-20 km	>20 km

8. How much time do it takes to reach the metro station from your home?

>10 min	10-15 mints	15-20 mints	20-25 mints	>25 mints

9. Is there any reduction in travel time due to metro? Y/N. If YES then How much?

_____

_____

10. Was your land affected due to the construction of metro? Y/N. If YES then what compensation was given by metro bus transit authorities?

_____

_____

11. What compensation was given metro bus transit authorities?

_____

12. How much time was taken for the compensation process?

_____

13. How much cost was given to you? Was that cost appropriate? Y/N. If No, then how?

_____

_____

14. How is your business affected before and after the construction of metro project?

_____

_____

15. Do you feel metro helps in reducing the noise pollution before and after the construction of metro? Y/N. If YES the How?

_____

_____

16. Is your privacy disturbed due to construction of metro line? Y/N. If YES then How?

_____

_____

17. What are the problems you are facing after the metro line construction?

_____

_____

18. Does your business faced any issue due to metro? Y/N. If YES then what type of issues?

_____

_____

19. Is there any change in number of customers before and after the construction of metro? Y/N. If YES then how much is the change in num of customers before and after?

_____

_____

20. Does the employment rate changed due to metro? Y/N. If YES then how much does employment rate changed due to metro? Increased or decreased?

_____

_____

21. Is there any financial loss faced? Y/N. If YES then How much financial loss you faced due to metro line? (Approximately)

_____

_____

22. How much your income increased or decreased due to metro line?

_____

_____

23. Is there any change faced in the business activities? Y/N. If YES then what are the changes you faced before and after the metro?

_____

_____

24. Is there any economic crisis faced by the people living along the corridors of metro line? Y/N. If YES then what sort of economic crises they faced?

_____

_____

25. Is there any increase or decrease in the land prices alongside? Y/N. If YES then How much?

_____

_____

26. What is the nature of economic activity along the sides? (observations)

_____

27. Does the shop rents increased or decreased before and after the metro? Y/N. If YES then how much does the shop rents increased or decreased before and after the metro?

_____

28. What type of benefit are you getting after the construction of metro?

_____

_____

29. What is the scenario of traffic congestion before and after the construction of metro?

_____

30. Is there any reduction in number of accidents before and after the construction of metro? Y/N. If YES then how much?

_____

_____

31. How much is the change in operational timings before and after the construction of metro?

_____

32. Does the interaction between the people increased or not? Y/N. If YES then How?

_____

_____

33. What is the effect of metro on crimes? Do they increased or decreased?

_____

34. Do you suggest some safety measures at metro stations?

_____

Physical

35. What is the effect of metro on parking spaces? Do they increased or decreased?

_____

36. The amount of fuel consumption increased or decreased before and after the metro? If they use vehicles?

_____

37. Any landmark/heritage structure was lost in your locality? Y/N. If YES then Name?

_____

38. What is the population density of the area along the metro line? (observations)

_____

39. What is the scenario of traffic congestion before and after the construction of metro?

_____

40. Is there any construction activities increased after the metro? Y/N. If YES then what is the nature of those construction activities?

_____

_____

41. Is the land use type of property is same or not before and after the metro? Y/N. If NO then how is the land use type changed?

_____

_____

42. Is there any impact of metro line on sewer system? Y/N. If YES then how is the sewer system affected due to the metro line?

_____

_____

43. How much is the encroachment land increased or decreased before and after the construction of metro?

_____

_____

ANNEXURE C

Table 10: Indicators for Primary Data Collection

Sr. No	Indicator	Study	Author
	SOCIAL		
1	Social equity	Assessment of economic social and environmental effects of rail urban projects. Istanbul metrobus: first intercontinental bus rapid transit.	Rocio cascajo Pelinalpkokin, muratergun
2	Increase in the use of PT, Urban regeneration	Assessment of economic social and environmental effects of rail urban projects.	Rocio cascajo
3	The origin, destination and purpose of movement	Impact of metro station to the land use and transport system: the Thessaloniki metro case	Roukouni A, Basbas S, Kokkalis A.
4	Means of transport	Impact of metro station to the land use and transport system: the Thessaloniki metro case. Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion.	Roukouni A, Basbas S, Kokkalis A. Asma mansoor, iqrazahid, Laila shahzad
5	Frequency of use, Educational level, Intention to use or not the metro line	Impact of metro station to the land use and transport system: the Thessaloniki metro case	Roukouni A, Basbas S, Kokkalis A.
6	Accessibility	The socio-economic effects of metro line "U3" in Vienna (Austria) evaluated under the European research project *TranSEcon.* Exploring the factors that impact on transit use through an ordered Probit model: the case study of metro of Madrid. A bus rapid transit line case study: Istanbul's metro bus system. The socio-economic benefits of roads in Europe.	Oliver roider, Dr roman klementschitz Laura eboli, Carmen forciniti, gabriellamazzulla, Francisco calvo M. AnılYazıci, Mustafa Ilıcalı, NilgünCamkesen, Camille Kamga November 2007 edition
7	Female gender	Exploring the factors that impact on transit use through an ordered Probit model: the case study of metro of Madrid.	Laura eboli, Carmen forciniti, gabriellamazzulla, Francisco calvo

8	Availability of metro station	Exploring the factors that impact on transit use through an ordered Probit model: the case study of metro of Madrid. Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion.	Laura eboli, Carmen forciniti, gabriellamazzulla, Francisco calvo Asma mansoor, iqrazahid, Laila shahzad
9	No car ownership, Worker, Land use prevalently residential	Exploring the factors that impact on transit use through an ordered Probit model: the case study of metro of Madrid.	Laura eboli, Carmen forciniti, gabriellamazzulla, Francisco calvo
10	Daily travel purpose	Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion.	Asma mansoor, iqrazahid, Laila shahzad
11	Satisfied with bus system	Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion. Summary of the application effect of bus rapid transit at Beijing south center corridor of china. A bus rapid transit line case study: Istanbul's metro bus system.	Asma mansoor, iqrazahid, Laila shahzad LING Zheng, WU Jiaqing M. AnılYazıci, Mustafa Ilıcalı, NilgünCamkesen, Camille Kamga
12	Passenger time saving	Socio economic impact of Jaipur metro project-A case study	R. Sathish Kumar
13	Reduction of travel time	Assessment of economic social and environmental effects of rail urban projects.	Rocio cascajo
14	Location factors, Distance to nearest bus stop	Bus rapid transit impacts on land uses and land values in Seoul, Korea.	Robert cervero, changdeokkang.
15	Social acceptability	Istanbul metrobus: first intercontinental bus rapid transit.	Pelinalpkokin, muratergun
16	Private comfort	Istanbul metro bus system	Busra buran

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1	Reduction of travel time	Assessment of economic social and environmental effects of rail urban projects. Effects of new bus and rail rapid transit systems – an international review.	Rocio cascajo Jasper blafossingvardson, ottoankerneilson.
2	Economic efficiency	Assessment of economic social and environmental effects of rail urban projects.	Rocio cascajo
3	Employment generation	Assessment of economic social and environmental effects of rail urban projects. Socio economic impact of Jaipur metro project-A case study Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion.	Rocio cascajo R. Sathish Kumar Asma mansoor, iqrazahid, Laila shahzad

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4	Economic growth	Assessment of economic social and environmental effects of rail urban projects. The socio economic effects of metro line "U3" in Vienna(Austria) evaluated under the european research project *TranSEcon*	Rocio cascajo Oliver roider, Dr roman klementschitz
5	Transportation and business issues, Tourism, Growth of real estate	Socio economic impact of Jaipur metro project-A case study	R. Sathish Kumar
6	Financial loss faced, Economic crises faced due to metro, Business activities destroyed or not, ncome increased or decreased, Number of customers increased or decreased	Effect of mega metro project on rawalpindi's socio economic and cultural life.	Humerabibi, saba Yasmeen, abidghafoor Chaudhry and syedaaimenhadi
7	Urban regeneration	The socio-economic effects of metro line "U3" in Vienna (Austria) evaluated under the european research project *TranSEcon*	Oliver roider, Dr roman klementschitz
8	Land prices (values)	Environmental and socio-economic impacts of mass rapid transit using GIS Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion. Effects of new bus and rail rapid transit systems – an international review.	Rajiv Gupta, R Srinivas, swathi Asma mansoor, iqrazahid, Laila shahzad Jasper blafossingvardson, ottoankerneilson.
9	Speed	Impact of bus rapid transit lanes on traffic and commuter's mobility. Summary of the application effect of bus rapid transit at Beijing south center corridor of china	Vaishali M, patankar, rakeshkumar, geetamtiwari LING Zheng, WU Jiaqing
10	Travel time	Impact of bus rapid transit lanes on traffic and commuter's mobility Summary of the application effect of bus rapid transit at Beijing south center corridor of china. Istanbul metro bus system	Vaishali M, patankar, rakeshkumar, geetam Tiwari LING Zheng, WU Jiaqing Busra buran
11	Delay time, Fuel consumption, Stop time, Traffic flow	Impact of bus rapid transit lanes on traffic and commuter's mobility	Vaishali M, patankar, rakeshkumar, geetamtiwari
12	Population density	Bus rapid transit impacts on land uses and land values in Seoul, Korea.	Robert cervero, changdeokkang.
13	Land use	Bus rapid transit impacts on land uses and land values in Seoul, Korea. The socio-economic benefits of roads in Europe.	Robert cervero, changdeokkang. November 2007 edition

14	Floor area ratio	Bus rapid transit impacts on land uses and land values in Seoul, Korea.	Robert cervero, changdeokkang.
15	Land attributes	Bus rapid transit impacts on land uses and land values in Seoul, Korea.	Robert cervero, changdeokkang.
16	Property development, Travel behavior change, Traffic environment	Bus rapid transit implementation in Beijing: an evaluation of performance and impacts	Taotaodeng, john D. Nelson
17	Service level	Istanbul metrobus: first intercontinental bus rapid transit. Summary of the application effect of bus rapid transit at Beijing south center corridor of china	Pelinalpkokin, muratergun LING Zheng, WU Jiaqing
18	Regional accessibility impacts	Istanbul metrobus: first intercontinental bus rapid transit.	Pelinalpkokin, muratergun
19	Modal shift	Istanbul metrobus: first intercontinental bus rapid transit. Effects of new bus and rail rapid transit systems – an international review.	Pelinalpkokin, muratergun Jasper blafossingvardson, ottoankerneilson.
20	Transit efficiency	Summary of the application effect of bus rapid transit at Beijing south center corridor of china. Istanbul metro bus system	LING Zheng, WU Jiaqing Busra buran
21	Productivity	The socio-economic benefits of roads in Europe.	November 2007 edition
22	Urban development	Effects of new bus and rail rapid transit systems – an international review.	Jasper blafossingvardson, ottoankerneilson.


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1	Air pollution	Assessment of economic social and environmental effects of rail urban projects. The economic evaluation of mega projects-social and economic impacts. Environmental and socio-economic impacts of mass rapid transit using GIS. (NO2, CO, RSPM) Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion. Istanbul metro bus system The state of ambient air quality in Pakistan—a review. The Effect of Metro Rail on Air Pollution in Delhi. Ambient air quality with emphasis on roadside junctions in metropolitan cities of Pakistan and its potential health effect.	Rocio cascajo Jana korytarova, vit hromadka Rajiv Gupta, R Srinivas, swathi Asma mansoor, iqrazahid, Laila shahzad Busra buran Ian Colbeck & Zaheer Ahmad Nasir & Zulfiqar Ali Deepti Goel, Sonam Gupta Majid H, Madl P, Alam K
2	Noise	Assessment of economic social and environmental effects of rail urban projects.	Rocio cascajo

		The economic evaluation of mega projects-social and economic impacts	Jana korytarova, vit hromadka
3	Greenhouse effect	Assessment of economic social and environmental effects of rail urban projects.	Rocio cascajo
4	Safety improvements, Secure way of transportation	Assessment of economic social and environmental effects of rail urban projects. Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion.	Rocio cascajo Asma mansoor, iqrazahid, Laila shahzad
5	Traffic congestion	Socio economic impact of Jaipur metro project-A case study. Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion.	R. Sathish Kumar Asma mansoor, iqrazahid, Laila shahzad
6	Water pollution	The economic evaluation of mega projects-social and economic impacts	Jana korytarova, vit hromadka
7	No of accidents	Evaluation of social and environmental aspects of Lahore metro bus transit through public opinion. Istanbul metrobus: first intercontinental bus rapid transit	Asma mansoor, iqrazahid, Laila shahzad Pelinalpkokin, muratergun
8	Environmental sustainability	Istanbul metrobus: first intercontinental bus rapid transit	Pelinalpkokin, muratergun