MEASURING THE ACCESSIBILITY BENEFITS OF PUBLIC TRANSPORT: AN EVIDENCE FROM LAHORE ORANGE LINE METRO TRAIN (OLMT)

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ABSTRACT

Rapid urbanization and migration towards Lahore are causing inadequacy in the public service delivery; most notably the public transport The Lahore Orange Line Metro Train (OLMT) is the first light rail mass transit project of Pakistan to cater the need of growing population of Lahore. The current study is based on the ex-post evaluation by exploring the multiple accessibility benefits, willingness to pay of the passengers and social inclusion. The study also develops a case for accessibility improvement by identifying the gaps that may create hurdle for users or discourage non-users. Another key concern is heavy subsidization which is an undue burden on government resources. Some viable policy options are suggested to make this project financially sustainable.

Keywords: Accessibility, Mobility, Connectivity, Financial Sustainability, Rapid Mass Transit, Targeted Demand-side Subsidies, locational efficiency,

PREFACE

The goal of any public transport planning is to increase accessibility in terms of proximity, affordability, mobility, convenience, and connectivity as well as its social acceptability and inclusion. However, each of these accessibility goals cannot be achieved simultaneously and policy outcomes face a trade-off. Similarly, affordability and financial sustainability of a transport system are the two goals that cannot be met together. The transport service either end up relying on high levels of subsidies or charging transit fares that are too expensive for the city's poor. In the current scenario, a continuous decline in OLMT passengers is being observed which is fuelling the deficit and further cut in transit fee is not an appropriate solution to incentivize its usage. Therefore, a balanced financial sustainability approach is required in the case of OLMT to limit the fiscal burden and to generate revenue streams. The Lahore Orange Line Metro Train is the first mass transit project of Pakistan. Its ex-post evaluation might provide an appropriate case for policy makers regarding its suitability and replication in other major metropolitan cities of Pakistan. In addition, the analysis can also be useful for identifying the policy gaps for furthering the accessibility improvement as well as to promote passenger ridership.

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LIST OF ABBREVIATIONS

BRT	Bus Rapid Transit
HOV	High Occupancy Vehicle
JICA	Japan International Cooperation Agency
LOV	Low-Occupancy Vehicles
LTC	Lahore Transport Company
MTR	Mass Transit Rail
OLMT	Orange Line Metro Train
PKM	Passenger-Kilometers
PMA	Punjab Mass Transit Authority
PTC	Public-Transit Connectivity
TNC	Transport Network Companies
UNDP	United Nations Development Program

INTRODUCTION

1.1 Urbanization and Development of Cities: A Global Perspective

Developing economies are urbanizing rapidly which is creating both the challenges and opportunities for masses. Historically, urbanization has always been strongly correlated with high economic growth through generating employment opportunities and creation of more production activities. However, urbanization cannot be effective without the proper availability of infrastructure, incentives, and well-functioning institutions (Glaeser & Xiong; 2017). In the absence of these factors, societies cannot reap maximum benefits from the urbanization process. The economic progress in developed economies is occurring in tandem by infusing all these elements and the urbanization process is resulting in the growth of smart cities with more economic opportunities and high per capita growth of income. Since 1951 the percentage of population living in urban areas has increased manifold from 17.7 percent to 36.4 percent in 2017 (UNDP, 2018). However, it observed in the case of developing countries that the relationship between urbanization and growth has not been automatic. Absence of sound policies, no productivity and no job growth has resulted into unplanned and unmanaged urbanization that has given rise to urban slums, environmental degradation, poverty, and inequality (Ellis & Roberts, 2015).

Currently, Pakistan is facing rapid expansion of cities due to increased population, rural-urban migration, and investment in real estate. This urban sprawl has created many drastic issues like housing deficit, insufficient and inaccessible transport infrastructure and more importantly the reduction in the agriculture land due to increased built up areas. Cities are considered the hub of economic activities but due to rising growth rate of population, congestion is becoming an acute problem in the cities of Pakistan. This congestion has troubled mostly on roads in the form of ownership of more cars by migrants which has ultimately led to mismanagement and chaos in the lives of city commuters. Cities which have seen incredible growth rates are the ones having strong governance architecture. There is a need to build an empowered city government that could have the capacity and authority in generating its own revenue and manage the delivery of municipal and other services. These are the instrumental factors in the social development of cities. According to a recent estimate by UNDP (2018), cities contribute to the 80 percent of the global Gross Domestic Product and in case of Pakistan this contribution is about 55 percent of the total GDP. Interestingly, 95 percent of the federal tax is coming just from 10 big cities of Pakistan. Pakistan is urbanizing at a rate of 3 percent per annum which is the fastest in South Asia.

1.2 Urbanization and Transportation Challenges in Large Agglomerations

With the growing urban settlements, cities in large agglomerations are confronting the urban transportation issues. Transportation infrastructures are usually very complex in nature due to the involvement of various modes of transport, multitude of origins and destinations, and congestions on roads n peak hours. Urban transport systems also vary depending upon the urban spatial structure and forms of urbanization in cities. Cities are considered the locus of economic activities like production, consumption, and distribution. The urban transportation system plays an important role by facilitating the commute of people to reach their destinations, managing the commercial activities, and providing facilities for recreational activities. An efficient urban transportation system helps to increase mobility in high-density areas and boosts the urban

productivity. Moreover, better transport facilities increase the visibility of urban cities both at the regional and global level. On the other hand, inefficient transportation systems may cause many problems for cities. The foremost and major issue is the road congestion which has plagued many cities, caused problem for urban freight distribution, and resulted into environmental hazards. Congestion is usually the characteristic of large agglomerations with a threshold of about 1 million inhabitants. Congestion is particularly related to motorization and the diffusion of the automobile increases the demand for transport infrastructures.

The second most important issue is related to the commuting time between residence and workplace, which is also linked to residential affordability (Masoumi et al. 2021). The long commuting time results in several social problems, such as isolation i.e., less time spent with family or friends, and poorer health. Similarly, many other challenges like inadequate public transport facilities, difficulties faced under non-motorized immobility, loss of public space, high infrastructure maintenance costs, environmental impacts and land footprint, energy consumption, accidents and road safety are few other factors that cause hindrances for urban transport system in large agglomerations. Developing economies face greater difficulties in meeting the transportation requirements of masses due to severe constraint on public resources. Nevertheless, policy experts at United Nations and World Bank have suggested various solutions to mitigate the negative impacts of congestion in cities. Some of the solutions include traffic signal synchronization, ramp metering, car ownership restrictions, carpooling or sharing vehicle, high occupancy vehicle (HOV) lanes, congestion pricing, public transit, and non-motorized transportation.

Urban transit is often perceived as the most efficient transportation mode for urban areas, notably the large cities. Public transits are mostly considered as publicly owned, heavily subsidize and with lower economic returns. Public transit often serves the purpose of a social function (public service) as it provides accessibility and social equity but having limited relationship with economic activities. However, the most important challenges faced by this urban transit system are decentralization, fixity, connectivity, automobile competition, construction and maintenance costs, fare structures, legacy costs, and self-driving vehicles.

1.3 Transport Infrastructure and Urban Sprawl: A Tale of Lahore City

Lahore is a metropolitan city and second most populated city of Pakistan with an average population of 11 million as per the 2017 census. It has also been observed that highly educated people don't prefer to use public transport due to many concerns including time cost, inefficient infrastructure, and safety issues. Therefore, the city roads are becoming more congested with private cars. According to a recent estimate by Planning Commission of Pakistan, with an average population growth rate of 2.4%, Pakistani travel approximately 400 billion passenger-kilometers (PKM) per year which is expected to rise to 1,000 km by the year 2030 (Government of Pakistan, 2018). This will add pressure on the urban transport infrastructure demand. The urban population accounts for approximately 37% of the total population which is expected reach around 60% by 2025. Therefore, investment in road transport infrastructure and mass transit systems is the need of time. Transport itself contributes to 22.3% of the services sector GDP and accounts for approximately 6% of the nation's total employment. However, due to high growth rate of population, cities in Pakistan are facing two major challenges i.e., housing and transport infrastructure. Lahore city is more prone to these two issues being the second largest city of Pakistan. Government of Punjab is focusing on providing solutions within the realm of public sector, private sector as well as the public-private partnerships. Many public sector transport

projects have been undertaken by the government to facilitate its residents by reducing commute time and making public transport accessible for everyone at reasonable rates. The major transportation modes in Lahore include:

1) Rickshaws and Taxis (also include services of Uber and Careem using the hailing Apps)
2) Bus Services (the two major providers of such bus services are the Punjab Mass transit Authority (PMA) and Lahore Transport Company (LTC)
3) Metro Trains (Lahore Orange Line Metro Train service, a mass transit system of its own kind constructed on the lines of Turkish Model)
4) Motor bikes and Private Cars

To improve the transportation network system and use of transport services, a network of feeder buses is also introduced by the Government of Punjab to improve connectivity which is facilitating the residents to the use of new transportation service interventions. Moreover, the Lahore Transport Company (LTC) runs an array of High-Occupancy Vehicles (HOVs) as well as Low-Occupancy Vehicles (LOVs). The LOVs include wagons and minibuses which moves throughout the city. LTC has provided license to individuals for running such kind of transportation services which has made it convenient for public to reach metrobus stations. This connectivity has developed a unified system of transportation within the Lahore city.

However, the current public transportation system of Lahore is facing many issues like inappropriate operational timetables, inefficient use of road space and poor condition of public transport facilities (including bus terminals and buses) which collectively pose severe challenges to urban connectivity. The factors responsible are escalated travel demand, inadequate capacity, improper governance, and poor urban transport planning. Currently, the Bus Rapid Transit (BRT) system is becoming more popular among people as a mode of public which is saving the time cost of travelling (Batool et al; 2020). It is also estimated that 206 cities worldwide, including 42 Asian cities, are covering 5,569 km routes through BRT systems by catering the need of 34 million passengers per day.

Like other developing economies, investment in roads and highways has also been the major focus of Pakistan's urban policies. Nonetheless very little attention has been paid to make public transport more attractive and effective in its delivery. This is due to inefficient transport policies in terms of affordability and accessibility which has diverted passengers from high occupancy vehicles (buses and vans) to single occupancy vehicles (private cars and bikes). Resultantly, the use of personal vehicles has more than tripled over a decade which has triggered the issues of road congestion, fuel shortages, road traffic accidents and greater environmental pollution (Government of Pakistan, 2016). The private vehicle ownership also creates substantial externalities of congestion and pollution (Timilsina and Dulal, 2010).

1.4 The Lahore Urban Transport Master Plan and Lahore Orange Line Metro Train (OLMT)

The urban population is growing at an alarming rate and Pakistanis are moving towards cities faster than any other country in South Asia and more than half of Pakistan's projected population is expected to live in cities. An integrated urban development strategy for capacity building and upgradation of urban management is reflected in Pakistan's vision 2030 that targets a set of strategic areas for sustainable development. Cities are considered as an engine of economic growth and vision 2030 calls for an improvement in urban service delivery that targets the Lahore city as well (Government of Pakistan, 2007).

Lahore is the second largest urban city of Pakistan. The urban transport system of Lahore comprises of both the formal and informal modes of transport but rapid urbanization and migration towards Lahore is causing inadequacy in the delivery of public services and most notably is the public transport. Over the past few years, there has been a massive increase in motor vehicles in Lahore which is estimated to be around 6.2 million and makes 32% of the total vehicles in the Punjab.[1] Urban mobility in Lahore is facing serious challenges with every passing year which has caused the rising demand for private taxi services such as Albayrak, Uber, Careem, Swvl, Mylift etc. Nevertheless, the Government of Punjab has taken numerous measures over the past few years to overcome the transport issues in Lahore and the most recent addition to such projects is Lahore Orange Line Metro Train (OLMT).

The main objective of Lahore Urban Transport Policy is to reduce traffic congestion, increase accessibility, modernization, and capacity building through a well-integrated sustainable transportation system. The Lahore OLMT is a part of master plan of an integrated rapid mass transit rail (MTR) system which was first proposed in 1990's by Japan International Cooperation Agency (JICA) to resolve the transport issues in Lahore. The feasibility report by JICA was later reconsidered and upgraded by World Bank in 2003 and a further analysis was undertaken by the Punjab Government with the help of MVA Asia in 2006. Moreover, in 2008, Asian Development Bank (ADB) proposed the feasibility of this project under its technical assistance loan program but unfortunately the project lost its course and the loan lapsed in 2009.

Later, JICA was entrusted with the conduct of the Lahore Urban Transport Master Plan which comprised of both the Bus Rapid Transit (BRT) and urban rail (Rapid Mass Transit System) and the final report was submitted in year 2012. The Lahore rapid mass transit project is an attempt to provide a sustainable urban mobility based upon global practices. The project has identified four main corridors; the Green, Orange, Blue and Purple Lines, which are to be connected via feeder routes. The detailed plan is provided in Figure 1.

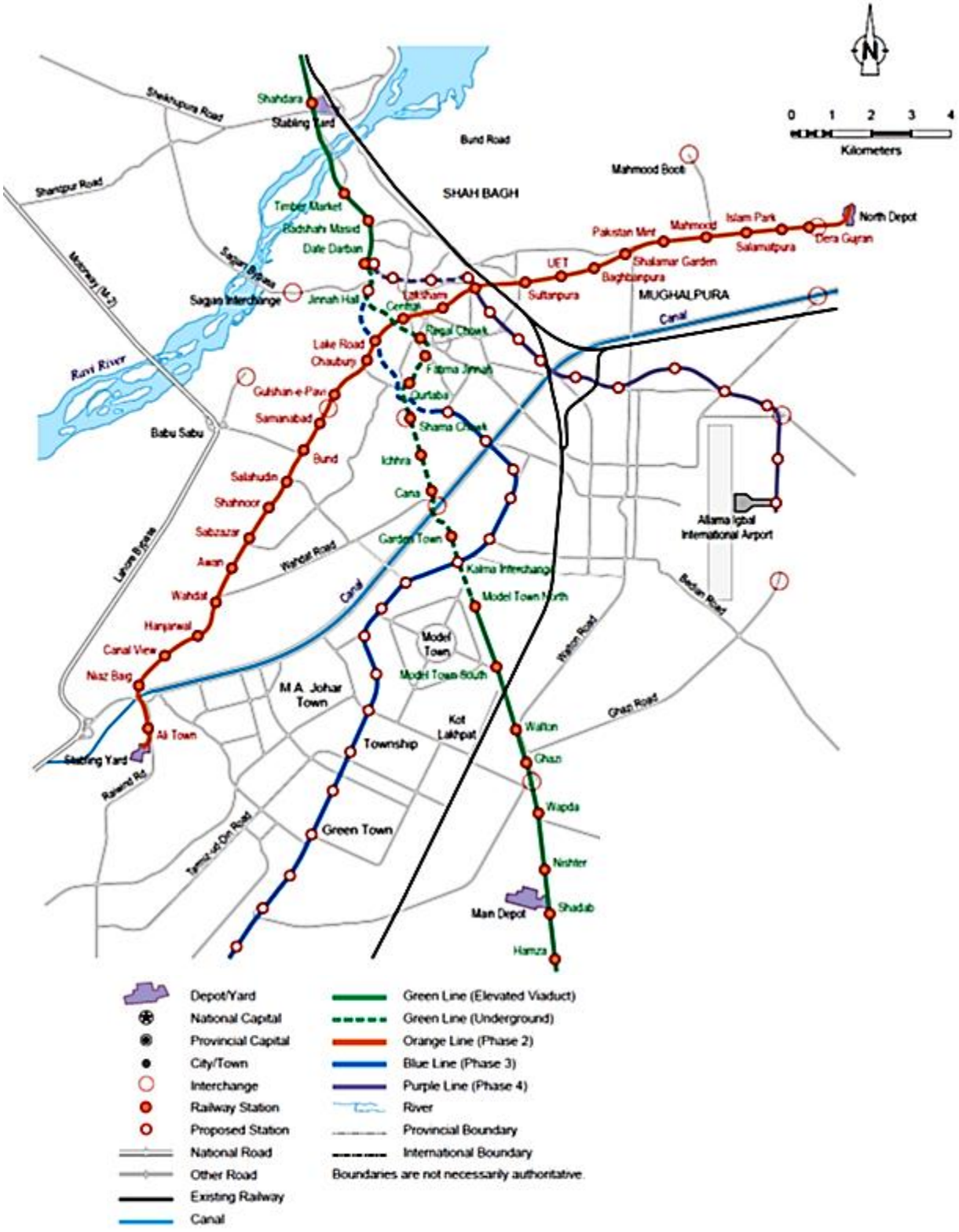
In the first phase of this project, the Green Line was the priority route, initially proposed as rail-based mass transit but replaced with a BRT formally known as the Lahore Metrobus System due to institutional and financial constraints. The project was executed by the Government of Punjab with Turkish assistance and completed in 2013. The second priority route under phase 1 was the Lahore OLMT, which is the first light-rail mass transit project of Pakistan, to cater the need of rising passenger demand and overcoming the heavy traffic congestion in Lahore. The project is jointly undertaken by China State Railway Group Co. Ltd. and China North Industry Co. Ltd. The second phase of the proposed plan for Lahore Rapid Mass Transit System constitutes the Blue Line and Purple lines, but the feasibility of these routes is still under debate. The OLMT mega project has seen a bumpy road to its completion and has been under controversial debate since its inception.

The Lahore Orange Line Metro Train (OLMT) is a fixed-route mass transit system, and the ex-post evaluation of this project (OLMT) determines the passenger accessibility benefits and searches some viable policy options to make this project financial sustainable. The consumer-oriented benefits are explored through field survey by collecting passenger data on daily basis during the months of September and October. The demographic and economic profiles of the riders is collected and their likely association with accessibility benefits is examined. Usually, the policy outcomes of an urban transportation system face a trade-off among different aspects of

[1] Capital City Police Lahore website https://lahorepolice.punjab.gov.pk/city-traffic-police

accessibility.

Figure 1: Route Map of Green, Orange, Blue and Purple Lines under the Master Plan of Lahore Rapid Mass Transit System



Source: Asian Development Bank.

This study undertakes a post-completion performance assessment by exploring the impact of OLMT ridership on consumers' accessibility benefits. The main accessibility aspects taken into consideration include proximity, affordability, mobility, convenience, and connectivity as well as the social acceptability. So, the study outcomes also support the subsidization of OLMT as a rational approach from the perspective of social inclusion. -The OLMT project is a heavily subsidized project, and Pakistan is among those eight countries which is at the serious risk of its inability to repay the loan under China Belt and Road Initiative. The estimated cost per passenger of OLMT is approximately Rs. 130 against the per passenger fare of Rs. 40. On the other hand, there is a continuous decline in passengers' number (60% less usage as compared to the capacity) which is fuelling the deficit. To encourage its use, the Lahore Mass Transit Authority also suggested to reduce the OLMT fare by Rs. 10, but this is not the sustainable solution as it is already running a deficit. So, there is need to achieve financial sustainability of this project via generating additional revenue streams. This can be attained by improving upon the accessibility benefits that can incentivize the OLMT usage along with adopting a systematic approach for generating additional revenue streams.

In the light of current debate, this research report addresses some viable policy questions, such as, who is benefiting the most from Lahore OLMT in terms of demographics and the employment profile? To what extend the OLMT has brought accessibility benefits to its passengers and how further improvement can be made to incentivize its use? Does mass transit system such as Lahore OLMT play a role in increasing social inclusion? What are the contributing factors that have influenced the rider's decision in favour of OLMT against other competing modes of public/private transport? What systematic approach can be devised to generate additional revenue streams by introducing targeted demand-side subsidies i.e., who to subsidize and by how much? This aspect is considered by capturing the willingness to pay of OLMT commuters. Is there a connectivity gap among non-users of OLMT or discourages users (also called ex-regular users)? Does the transport policy instrument, such as mass transit, plays a role in overcoming the gender mobility gaps? What aspects of a transport accessibility must be given more weights in terms of priority to develop feasible study plans for similar projects in Lahore or other metropolitan cities of Pakistan?

THEORETICAL BACKGROUND

2.1 The Role of Transport Policies in Economic Development

There is a need for continuous upgradation and improvement in a nation's transportation policy due to steadily rising population, rural-urban migration, and increased consumption of vehicles. Other contributory factors leading to the rising demand for public transportation facilities are the growth of cities, changing economic structures and rising economic activities. The size and structure of urban as well rural economy is constantly evolving but mostly notably is the changing travel patterns and demand for urban transport which require strategic planning of urban transport policy.

There are numerous social objectives of a transport policy. First, to facilitate the growth of agglomeration economies (Graham, 2008; Selod & Soumahoro, 2018). This is achieved by reducing the transportation costs, increasing trade, improving connectivity and development of networks. Second, to enable social inclusion through improved access to transportation services, reduced costs, and easy access to economic opportunities for the marginalized and poor (Stanley & Stanley, 2017; Ricci, Parkhurst & Jain, 2016). Third, to attain sustained economic growth by reducing the negative externalities on health and environment (Dora, Phillips & Phillips, 2000). The extent to which these benefits could be fruitfully reaped from a transport policy depends upon the travel behaviour of the households and community responses at large.

However, there is always underinvestment in public transport system and lack of commitment for long-term solutions particularly in the case of underdeveloped nations. One of the main reasons is lack of capacity building and resources. The low- and middle-income countries face a serious backlog in transport infrastructure. Thus, transport policies have great potential for achieving sustainable and inclusive growth in these countries (Berg, Deichmann, Liu & Selod, 2017). But it also needs to be kept in mind that the impact of a transport intervention is not always certain. It varies with the needs of a society, the society's willingness to cost sharing as well as its economic structure. Some transport investments may not be cost effective both in terms of financial and social costs. Therefore, transport economists, engineers and policy analysts need to have a deep understanding of the strategic use of scare resources, in terms of the real costs and benefits, for the realization of sustained economic growth, development and social inclusion.

2.2 Transport Policy Instruments

The transport planners use a wide variety of policy instruments. According to May and Still (2000), the transport policy instruments can be defined into five broad categories i.e., the land use, the price incentives, infrastructure development, infrastructure management, and information provision. A recent study by Berg, Deichmann, Liu & Selod, (2017) has simplified the policy interventions by generalizing it into three main categories as investment in transport infrastructure, the price instruments, and the transport regulations. These policy interventions affect both the supply-side and demand-side of transportation. Each category is crucial for achieving the underlying key objectives of a transport policy as attaining one objective may compromise the others and most commonly the classic trade-off between efficiency and equity also prevails in the transportation policy.

Price signals in the form of taxes or subsidies are used to influence the consumer choice on mode of transport and the transport behaviour. These may include different forms such as toll taxes, parking fares, congestion taxes, fuel taxes, targeted demand side subsidies and subsides to promote clean environment. The transport infrastructure includes not only the construction of new capital (such as living streets, roads, walkways, bridges, tunnels, stations, railways, airports, and ports etc.) but also the upgradation of existing structures. The regulations side embraces rules on infrastructure construction, overall working of the transport sector, driving restrictions and the environmental impact of transport.

2.3 Utilities' Role in Transport Policy

There has been a paradigm shift in evaluating a transportation system (Litman, 2017). Earlier it was very narrow specifying to traffic-based analysis in terms of traffic efficiency and cost effectiveness, which later shifted to mobility i.e., transport-based efficiency. The first two concepts (traffic-based analysis and mobility-oriented analysis) are nested within the accessibility-based analysis which is a broader concept that evaluates a transportation system in terms of people's ability to reach the desired destinations (Litman, 2011) i.e., decreasing the mobility gap (Leigh, Scott and Cleary, 1999). Passenger accessibility is considered as the most important outcome of a public transport intervention, aimed to enhance social inclusion via increase connectivity and communication (Saghapour et al., 2016).

There has been a long debate among researchers regarding impact evaluation and appraisal of transport policy interventions. However, it is pertinent to note that the methodological considerations and impact may vary with the transport infrastructure (such as roads, bridges, railways, airports, seaports, waterways, terminals etc.) as well as the mode of public transport (such as buses, trains, light rails, trams, subways etc.). Thus, there cannot be comparability of the impact evaluation of different transport policy interventions based on common parameter/s. The impact evaluation is influenced by the definitions of cost and benefit as well as value judgment of the policy analyst (Nash, Pearce & Stanley, 1975). For example, an operator of public transport such as a rapid mass transit rail (MTR) would be interested only in revenue maximization whereas a social scientist or a policy analyst would focus on maximizing the utility for users in terms of accessibility (Lichfield, 1992). In the present context of Lahore Orange Line Metro Train (OLMT), the evaluation methods for a light rail can be classified into four types: i) financial analysis from the perspective of service provider/operator, ii) community impact analysis in terms of the societal benefits and costs in aggregates, iii) purely environmental impact assessments, iv) social cost-benefit analysis from the perspective of passengers/users (Table 1). In the light of main evaluation features, as mentioned above, the current study focuses not only on examining the multiple accessibility benefits and social inclusion but also develops a case for accessibility improvement by identifying the gaps that may create hurdle for users or discourages the non-users. Another key concern that the study aims to address is to reduce the subsidization costs. Therefore, willingness to pay of the passengers is also explored along with features that may increase the revenue streams.

Table 1: The Four Aspects of Impact Evaluation for a Light Rail Mass Transit

Evaluation Aspect	*Sector*	*Outcome*
Financial Analysis	Service Provider 	Capital costs, operational costs, revenue earned
Community Impact Analysis	Community 	Large scale spillover aspects such as employment generation, rise in property value, economic growth, and development
Environmental Assessment	Environment 	greenhouse gas emissions, land use and protection of heritage
Social Cost-Benefit Analysis	Passengers 	accessibility, service quality, user's satisfaction, and preferences

Source: Author's extraction from Lichfield (1992).

The transportation policy has a utility for humans as it provides a supporting role to the supply and usage of necessities of life along with an ease in livelihood and living. Without a good transportation policy, the fulfilment of basic human activities and needs are either delayed or sometimes not available. The congestion on roads and highways increases the opportunity cost in terms of wasted time as well as environmental damages. A well-planned transport system also plays a vital role in urban development through improved networks, and multimodal travelling. The community's point of view includes large scale aspects such as employment generation, rise in property value, environmental impact, and economic growth. The agency's perspective is the earnings from service provision and the passenger's perception includes benefits in terms of its accessibility and service quality. The environmental assessment focuses mainly on greenhouse gas emissions followed by land use and protection of heritage. However, from a public policy perspective, passenger accessibility is considered as the most important outcome of a public transport intervention which is aimed at enhancing social inclusion via increased connectivity and communication (Saghapour et al., 2016).

The passenger accessibility evaluates a transportation system in terms of people's ability to reach the desired destinations (El-Geneidy and Levinson, 2006; Ascher, 2007; Kenyon et al., 2002; Litman, 2011; Bocarejo and Oviedo., 2012; Fransen et al., 2015). The ableness to reach destinations includes the aspects of proximity, affordability, mobility, convenience, connectivity, and social acceptability. The literature further elaborates that accessibility-based analysis is a much broader concept that encompasses both the traffic-based and mobility-oriented analysis and is not just limited to ability to reach destinations (Lättman et al. 2016; de Oña et al. 2013; van Wee, 2016; Cheng and Chen, 2015; Yatskiv et al. 2017; Litman 2009). However, each of these accessibility goals cannot be achieved all at once and policy outcome faces a trade-off. Improved and efficient transportation system also enhances the well-being of the commuters by mitigating the stress causing factors such as traffic jams, discomforts, and missing connectivity among different modes of transport. The common measures of accessibility are summarized in Table 2.

Table 2: The Common Measures of Passengers' Accessibility

Accessibility type	*Measure*
Accessibility by demographic and economic profile	The transportation intervention must be non-discriminatory and socially inclusive
Accessibility by destinations	The benefits can be divided into three broad categories i.e., access to livelihood, access to key services (health/education] and access to better quality of life (shopping/recreational)
Accessibility difference	The difference between past and present mode among motor access and non-motor access individuals belonging to vehicle-lacking and vehicle-owning households
Physical accessibility	It captures the ease of travelling between/or among different locations of Lahore which is further divided into two aspects i.e., mobility and connectivity Mobility reflects the transit travelling speed, distance and time including the time to reach access point and change of stations Connectivity measures the transit coverage or catchment area within 60 minutes, distance from origin to access, distance to the end destination, availability feeder buses/car parking and bike stands.
Affordability	The cost of current mode of travelling as compared to other modes of transport relative to the commuter's income
Convenience	Factors that influence rider's decision in favor of current transportation mode against other competing modes such as availability of travel information, commuters' comfort, and safety etc.
Social acceptability	The social status of commuters i.e., measuring accessibility by different income groups
Temporal accessibility	This measure will capture the riders' perceptions about reliability of the transit service i.e., how often and for how long the transit is used

Source: Author's extraction from exiting literature (El-Geneidy and Levinson, 2006; Ascher, 2007; Kenyon et al., 2002; Fransen et al., 2015; Bocarejo and Oviedo., 2012; Lättman et al. 2016; de Oña et al. 2013; van Wee, 2016; Cheng and Chen, 2015; Yatskiv et al. 2017; Litman, 2009).

Defect that sometimes arises during the ex-ante feasibility analysis that produce different results in comparison to the ex-post evaluation is due to missing information of competing transportation modes or borrowed evaluation methods which may not be comparable. In addition, it is noteworthy that transportation is often considered as a means and not an end i.e., it is considered as a means of providing mobility. However, there are various additional user's benefits that can be observed at the end of the trip such as access to various urban facilities.

2.4 Government Interventions Specific to a Mass Transit: The 3S Elements

In modern times, for achieving the objective of viable and efficient urban mobility, the transportation policies should focus on designing such transit systems which are 'sustainable, safe and smart' (Haque et al. 2013). These are the three key elements (3S) which can increase the economic efficiency, social equity, and environmental justice in an economy. However, achieving an intergeneration equity is an essential element of a safe and sustainable transportation system.

Earlier the efficiency in transport strategies and policies was meant to increase the number of roads for ease of travelling. On the other side, this led towards many socio-economic issues like

urban sprawl and more use of private vehicles resulting into urban road congestion. Such transport-related policies further worsened the situation in the form of environmental degradation, noise pollution, fuel consumption, emissions, and depletion of natural resources. Therefore, the world development agenda at present is focusing on such transport policies and measures which are sustainable in nature and environmental-friendly as well. Many policies have been developed to tackle the transport-related issues like designing the compact-city plans (Sung and Choo, 2010), transit-oriented policy interventions (Sung and Oh, 2011), controlling motorization (Han, 2010), promoting public transport (Ibrahim, 2003) and increasing the trend of non-motorized mobility (Duduta et al., 2010). Moreover, policies like vehicle quota system (VQS) and congestion charging scheme, restriction on vehicle ownership and imposing road pricing are vital measures to encourage the use of public transport and mass transit system. For better utilization of public transport, there is a need to ensure proper service standards such as safety which can only be attained by promoting competition among public transport operators. Therefore, there is a need to focus not only on the development of transport infrastructure, but improvement should also be made in the quality-of-service delivery on the principle of sustainable, safe and smart transport.

2.5 Social Inclusion as Justification for Government Subsidies of Transportation Services

Public sector transport is one of the key elements in creating gender equality and inclusivity in a society as envisioned in 2030 Agenda for Sustainable Development. According to a recent report by United Nations (2020), public transport is a means of poverty alleviation by providing a supportive role for equitable social development via improving social mobility and enhancing connectivity[2]. Safe and inclusive transport plays a role in achieving social inclusion by bringing various socio-economic opportunities for citizens. A well-planned transportation policy integrates the society by providing basic mobility to the ends (Unite Nations, 2020). It is believed that transportation system causes a 'Domino Effect' by leaving no one behind and creating a participatory environment for everyone. The public transport interventions such as the light rail mass transit networks also support environmental sustainability and mitigating the road congestions by reducing the number of private cars (Ardila-Gomez & Sanchez; 2016).

The feminization of labour force is also not possible without the presence of urban public transit system. Women face 'forced immobility' as they are mostly motor-less and involved in trip-chaining for the accomplishment of their several roles between work, household, and family care. Therefore, the non-supportive and non-availability of affordable, safe, and well-connected transit system marginalize the women to a larger extent who may turn down many good economic opportunities. Provision of well-integrated mass transit networks along with shuttle bus services can enhance the gender inclusiveness and female workforce can be more productive to become a source of support for their families. Gender differences in mobility is also one of the reasons that force women to engage in informal sector or self-employed closer to their homes where they are either under paid or unpaid for their services. Therefore, there is a need to sensitize the transport and transit systems towards gender inclusiveness (United Nations, 2020). This can be done by creating awareness of the benefits reaped through public transportation facility and working on legislation. Legislation is the missing element in case of developing economies,

[2] United Nations report ESCAP/CTR/2020/4, "Safe and inclusive transport and mobility".

causing public mass transit systems less inclusive and unattractive for each segment of the society (United Nations, 2020).

Traditionally, the transportation policies and interventions usually aim to focus on economic impact in the context of connectivity, while the social benefits are assessed as a by-product of infrastructure development and the increase in volume of goods and passengers being transported. The social impact of public transport is assessed in terms of reaching a range of destinations within reasonable time frames and costs. However, in developing economies, 'transport poverty' is also a visible phenomenon causing transport-related deprivations and geographic isolation for vulnerable socio-economic groups, the individuals, and households alike. There is a need for government in developing economies to target such transport interventions which ultimately lead to social exclusion for individuals facing high physical immobility. In addition to mobility barrier, the availability of alternative transport options, fare structure and travelling environment are also some important issues that relate to 'transport poverty' (Lucas et al. 2016).

A well-planned urban transportation system has great impact on the labour market turnover by reducing the transportation costs and increased accessibility. The urban sprawl is detrimental to job search and job retention when there is poorly developed transport infrastructure. This is mainly due to restrictive availability of commuting services or high travelling costs (Gobillon, Selod & Zenou, 2007; and Gobillon & Selod, 2021). These factors may result into higher incidence of poverty. The poor, unskilled and the vulnerable group are unable to benefit from employment opportunities due to poor connectivity between job market and their place of residence (Berg er al. 2017) in addition to the increased traveling costs. Rospabe & Selod (2006) further explained on the spatial mismatch hypothesis that there is an adverse impact of residential segregation and commuting lengths on unemployment levels. On the other hand, the high commuting costs lowers the real wages which discourages the workers to retain their jobs. In addition to the impact on labour market, an improved transportation system also affects the educational choices and the demand for healthcare services. Therefore, the connectivity, mobility, and affordability of public transport play an important role in achieving social inclusion. The argument of social inclusion is considered a strong justification for subsidized public sector transport services.

2.6 Sources of Public Funding for Transportation

Urban transportation is an indispensable tool for economic development and raising the quality of life through provision of means to work, education, recreation, and other community services. It has been observed that transit systems provide 'compact development opportunities' by encouraging walkable communities. However, it is very rare especially in the context of government provision of mass transport services that successfully recovers the full cost through passenger fare. To establish 'affordable' as well as vibrant mass transit system, authorities need to ensure its financial sustainability i.e., rather than relying on government subsidies significant revenues must be generated to pay for new capital investments as well as to finance the maintenance and operational costs of existing facilities and services. Transit systems usually face recurring losses in their operational expenditures (Ubbels et al. 2001).

Nevertheless, worldwide experience highlights the importance of mass transits in reducing the road congestion by shifting the travel demand of car owners towards affordable public transport. The additional benefits are reaped in the form of lowering the environmental costs through

reduction in pollution, accidents, and auto fatalities. Above all, other observable benefit includes increased value of property near the transit stations and routes, preservation of fuel, availability of labour pool for businesses. Therefore, mass transits are always associated with large 'public benefit' and such policy interventions are deemed necessary despite its enormous capital and operational costs. Multiple ways are designed under an integrated transportation policy to finance such services. This is not only done by imposing direct/indirect taxations, but rather additional levies of various forms are also introduced. Nowhere in the world we can exemplify a mass transit service where costs are fully recovered by passenger charges. Hence, the biggest challenge in introducing such transit systems is 'how to pay for it'? Ideally the funding system for a transit should have all the essential qualities like enhanced market efficiency, low collection costs, reliability, and fairness[3].

The funding options need to be cost-effective, and each option must be evaluated through the lens of potential revenue, predictability and sustainability, horizontal and vertical equity, travel impacts, strategic development objectives, public acceptance, and ease of implementation (Litman, 2014). Transport system face a myriad of financing challenges. Starting from the basic fact, the mass transit fares can only cover a limited proportion of the operating costs, therefore, nothing remains spare with the managers and providers of the services to be available for further capital investment. The current revenue generation can be utilized only to keep the existing system running rather than to start new services and that expenses might also not be fully balanced.

The developing countries experience under investment in urban transport and cities are stuck in the 'underfunding trap'. The up-front investments for taking initiatives in new transport infrastructure are huge, which may be available from external sources if domestic resources are scarce, but revenue generation from poorly managed tax system, inadequate demand from poor quality transport and passenger fare is insufficient which fails to cover up the maintenance and operation expenses. This urban transport financing gap is largely found in developing economies which further widens by providing implicit subsidies. In addition, the users of personal vehicles are responsible for huge social costs in terms of congestion, sprawl, accidents, and pollution. Hence there is a need to address this issue by culminating the use of private vehicles and introducing new options of public transport to masses. All these measures are conditioned to 'funding opportunities' for such huge investments.

Financially viable and sustainable transportation projects are the need of times for developing economies which are overpopulated, and rapid urbanization is taking place. Literature provides guidance in this context by highlighting the concept of 'Who Benefits Pays' which is being formulated for achieving financially sustainable public transport system (Ardila-Gomez & Sanchez; 2016). Financial sustainability is determined in terms of permanency and stability, political recognition, and administrative ease in case of instrument implementation, while transport sustainability is defined in terms of economic efficiency, social equity, and environmental impact. The governments in developing economies must undertake such public transport investments that can help in decreasing the financing gap by reducing the burdens of existing expenditures over time along with additional benefits in terms of transport sustainability.

[3] For details, https://uspirg.org/reports/usp/why-and-how-fund-public-transportation

Public Transport system is funded through numerous ways both at federal, provincial, and local level. The different sources of funding include imposition of various kinds of taxes like sales taxes, property taxes[4], income taxes, discounted bulk transit passes[5] and fares and fair related income [6]. However major share always comes from federal sources and transit funding formula may vary year to year or budget cycle to budget cycle[7]. In many countries taxes on motor fuel is another significant source of financing the public transport services. The vehicle taxes can also be a source of funds generation in this regard.

The system-generated revenue from any a transit system also works as financial source but its share remains quite low and may not lead to financial sustainability. Therefore, there is need to probe into additional and sustainable sources of fund generation where burden must be shared by various entities and not solely by the commuters only. Literature suggests developing such an urban transport financing system which is based on an appropriate mix of complementary financing instruments, possibly involving multiple levels of government and different sectors. More appropriately, a combination of grants and loans from funding agencies combined with investments through public–private partnerships (3Ps) are also an attractive solution for financing large projects that benefit society at large.

2.7 Measures for Financial Sustainability of Public Transport Services

The financial viability of public transport infrastructure is one of the most important elements for attaining sustainable urban transport system. The reason is that these projects are subsidized, and the government's exchequer bears most of the burden. The running cost of Lahore OLMT project is far greater than its revenue generation. Therefore, it is necessary to devise strategies for achieving financial sustainability. The potential of new revenue streams is to be explored that can cut down the demand-side subsidy. These different possibilities are assessed through various measures as practiced by those nations where public transport is being made more attractive and user-friendly for passengers. This is important especially in the context of developing economies that replicate the transportation policies of developed economies to achieve the similar sustainable urban mobility.

The affordability and financial sustainability of a transport system are the two goals that cannot be met simultaneously. The transport service either end up relying on high levels of subsidies or charging transit fares that are too expensive for the city's poor. In the current scenario, the government is already bearing the cost burden and a continuous decline in OLMT passengers is being observed which is fuelling the deficit. To incentivize the OLMT usage, a further cut in transit fee is not an effective solution. Therefore, a balanced financial sustainability approach is required in the case of OLMT to limit the fiscal burden and to generate revenue streams. The past literature quotes 3 different evidence-based revenue enhancement measures, observed in the case of Colombia, Tokyo, Hong Kong and Singapore, as ways to achieve financial sustainability: Private-Public Partnerships, Cross-subsidization, and "Targeted" Demand-side Subsidies.

Private-Public Partnerships: It involves the development of commercial activities at stations and

[4] See Ardila-Gomez & Sanchez (2016) for more details. Property tax are considered as a key financing instrument for capital, operation, and maintenance expense in the context of urban transport funding. http://dx.doi.org/10.1596/978-1-4648-0756-5

[5] See Litman (2014), Evaluating Public Transportation Local Funding Options.

[6] See Litman (2021) for further details.

[7] See this for further details; https://utcm.tti.tamu.edu/tfo/transit/summary.stm

along the transit routes. In addition, the provision of exclusive rights to property development can also play a role in securing returns from capital investment. This is a solution from the community's perspective through public-private partnership of mass transit service provision. The further resource mobilization can be generated at a large scale by encouraging commercial activities and enforcing property related taxes due to value enhancement of the real estate.

Cross-subsidization: This caters to both the community and agency's perspective by providing a supply-side solution i.e., generating alternative sources of financing. This will transfer the burden of subsidization to non-users/or ex-users of OLMT such as increasing the parking fares, fuel tax, and congestion prices as adopted in the case of London Congestion Control Policy when many commuters switched to mass transit after being priced out of driving their personal cars. However, these measures have negative connotations as passing direct burden of service provision to non-users.

"Targeted" Demand-side Subsidies: To capture this aspect of financial sustainability, various policy options can be devised systematically by observing passenger's behaviour. This helps in targeting specific segments of the society according to their needs and accessibility benefits from public transport services. By answering who to subsidize and by how much, some burden of heavy subsidization can be relieved and optimal revenue generation strategies can also be planned. The policy outcome can be in the form of 'personalized smart cards' that will incentivize the OLMT usage. By increasing the number of passengers, revenue generation will help in recovering some operating costs.

REVIEW OF LITERATURE

3.1 Accessibility Benefits of Public

According to Litman (2017), there has been a paradigm shift in evaluating a transportation system. Earlier it was very narrow specifying to traffic-based analysis in terms of traffic efficiency and cost effectiveness, which later shifted to mobility that captures the transport-based efficiency. The recent literature in the field of transport economics is focusing pre-dominantly on improving the accessibility benefits. The first two concepts i.e., the traffic-based analysis and mobility-oriented analysis, are nested within the accessibility-based analysis which is a broader concept that evaluates a transportation system in terms of people's ability to reach the desired destinations (Litman, 2011). Leigh, Scott and Cleary (1999) observed that transit systems tend to decrease the mobility gap by increasing accessibility to vehicle-lacking households, but the analysis does not take into account the unmet demand of non-drivers of vehicle-owning households.

There are several mass transit accessibility measures which are commonly discussed in the literature. El-Geneidy and Levinson (2006) evaluated accessibility by undertaking a detailed analysis on travel behaviour. The information is collected on destination by activities, population demographics and how these behaviours change over time. Ascher (2007) characterizes mobility as a pre-condition to accessibility i.e., the ease of traveling to employment, education, home, leisure and other primary facilities such as hospitals and supermarkets (Kenyon et al., 2002; Fransen et al., 2015; Bocarejo and Oviedo., 2012). This aspect of accessibility is reflected through connectivity of a transport system with other modes of travelling (Cheng and Chen, 2015). Hawas, et al., (2016) defined accessibility as ease with which people can reach their destinations at lower cost and under reasonable time. Yatskiv et al., (2017) studied that reduced time and cost along with the ease of information availability are important factors to make public transport attractive for passengers' use. Litman (2009) has also indicated that people prefer a transportation mode which costs them lesser traveling time. Manaugh & El-Geneidy (2012) addressed an important aspect of transit infrastructure services considering the impact of social equity and accessibility. The potential effects of transport infrastructure in Montreal are explored by developing a social disadvantage index. The study modelled the impact of the newly proposed transport infrastructure using two indicators; 1) accessibility and 2) time of travelling. These two measures were used both at regional and personal scale for measuring the equity of the transport system. The findings showed that the transportation system in Montreal is relatively equitable but the benefits are not equally distributed. The policy implication of this analysis to consider a balanced economic, environmental and social development in the society.

Venter (2016) shared a narrative on transportation system by focusing on its accessibility component for society at large. Different set of indicators are provided which can be used for measuring the accessibility umbrella. The study highlighted that the societies which have kept accessibility at priority while designing transport infrastructures, are proved well-integrated both demographically and financially. A conceptual framework is developed describing the relevance of accessibility from mobility notion. Infrastructure-based measures related to travelling time and cost and utility-based measures related to land use, individual preferences and constraints have been floated by the authors to explain the economic value of accessibility. Similarly, Lättman et al., (2016) considered reliability, simplicity, information availability and subjective comfort as the key aspects to evaluate public transport accessibility.

On the other hand, de Oña et al., (2013), and van Wee (2016) measured the accessibility benefits in terms of passenger's perceptions about punctuality, payment options, travel time, number of departures, distance to the stop, and travelling environment and comfort. The comfort may include factors like cleanliness, space availability, air quality, temperature, lighting, noise, and staff behaviour etc. In addition, the different indicators of information access were also considered like mobile applications, webpage, information at the stops and onboard announcements. Conversely, Di Ciommo (2018) evaluated accessibility by developing an inaccessibility index. The index reflects the number of desired destinations that people cannot reach. The analysis is undertaken by considering different demographic profile. The specific factors included in the study are comfort and ease of traveling by a transit service, transit frequency, availability of information and perceived security. Inturri et al. (2021) explored the impact of site location and transit connectivity with the accessibility factors of public transport in Italy using the GIS mapping. Both active and passive indicators of accessibility were explored and linked with user's satisfaction using MCA statistical analysis to unveil the. The major finding of the study showed that the satisfaction level of students increased if universities are located in the center of cities and directly approached to metro line without reliance on the connected transport. It was concluded the accessibility is highly linked with the quality of transport services.

Saif, Zefreh and Torok (2019) undertook a detailed literature on the accessibility perspective of public transport. The authors concluded that only 'door to door mobility' can make any transportation mode attractive to the users and improve the quality of social lives of the citizens. Furthermore, it was also emphasized that a sustainable transport system is strongly linked to health care, social activities, job opportunities and social inclusion. Therefore, the policymakers need to take innovative steps to prioritize the betterment of social lives in terms of ease and comfort while planning and designing the transport facility in urban and rural areas.

Another important aspect that has been discussed with respect to accessibility of mass transit is the connectivity issue. Zho, Guo, Zeng and Zhang (2017) talked about the importance of feeder buses in promoting mass transit system for Shanghai community. The authors found that connectivity services can fill the gap in easy access to mass transit public transportation and contribute towards smooth flow of passenger traffic which is missing in other modes of transport like rail roads and urban bus services for smooth passenger flow. The findings of the study were based on the circular route model and the results showed that feeder service must be introduced to improve connectivity with mass transit system. Using the graph-based public-transit connectivity (PTC) index, Li et al. (2019) measured the accessibility of each building from the perspective of public transportation network. The findings suggested that equal accessibility and its equality are the key factors in making transport planning. The results showed that mass rapid transits (MRT) significantly increased the PTC index for areas near MRT routes which means that connectivity to the buildings really improved through the MRT network of transportation.

Considering the case of Orange Line Metro Train in Lahore, Shakeel & Liu (2019) expressed that this new transport intervention in Lahore can be helpful in reducing road congestion, creating new employment opportunities, and dealing with urban sprawl. According to the study, the commercial and residential areas along with the OLMT would promote sustainable, vertical and smart growth of the city. The study emphasized to consider station-wise planning of these mass transit systems for the re-development of existing potential of transit-oriented systems.

3.2 Financial Sustainability of Public Transport

Another most important aspect of public transportation system is the financial viability. According to Ubbels et al. (2001) financing of public transport other than subsidy can be achieved through various kinds of financing strategies as evident in many developed economies. These include employer tax (practiced in US), property tax (Canada and US), development levies (US), parking charges (England and Netherland), charges for the road space (US), local motoring taxes (US), consumption taxes (US) student surcharge and airport fee and funding through cross utility (US). Li and Tiong (2008) provided a detailed framework for financing, operations, and fare policies for sustainable urban rail transit in Singapore. For financial discipline of public transport, government must not provide the subsidies for service operations. However, 'price-cap' model is applied to regulate the transport sector monopolies to keep the travelling affordable. To create efficiency in fare revenue, the user charges can be divided into two components i.e., boarding charges and fare differentials based on distance. It is also suggested fare concessions must be targeted such as senior citizens, students, full-time national employees, and periodical concession such as monthly.

Farebox revenue and vertical equity are the two conflicting goals in the provision of transport services which has been explored in detail by Harmony (2018). Although reduction in user charges is more equitable for low-income earners but it also reduces income returns for the mass transit agency. The paper discussed two types of strategies from supply and demand side. It is concluded that organizational partnerships can considerably reduce the financial burden on government. Additionally, targeted demand-side subsidies must be introduced, and the ridership characteristics can be taken into account for designing smart cards. Similarly, Makino (2013) emphasized that diversity must be brought in financing public transport projects which is necessary for achieving sustainability. Private capital investment is considered an imperative tool in financing public transport projects. Various investment and business models have been designed by researchers to evaluate the societal impact of such private investment plans. A recent study by Xue et al. (2017) for Chinese economy, has confirmed that investment plans by private sector can enhance economic viability and financial sustainability of the public transport projects. It is suggested that by targeting the two aspects of public transportation system i.e., provision of quality service and passenger's return, can increase the efficiency of private investment in a public sector program.

However, many public policy economists also argue that using private sector as a service provider may not be an optimal choice from welfare perspective; mostly because private sector aims at profit maximizing and not in achieving overall societal gains. On the other hand, the private business and investment plans creates a win-win situation. Many economies of the world analyse the transport services from two perspectives. First, the cost-saving practices leading to maximizing profits but deterioration of services and second is the policy of competition in business growth leading to the improvement in quality of services. Tang & Lo (2009) has provided the example of Hong Kong for successfully running the public transit services by following the policy of privatization. With few exceptions all the mass transit facilities in Hong Kong are operated commercially and often taken as benchmark for its profitability and quality standards. The study also stated that user-pay principle and fare revenue alone cannot recover the full capital costs and other form of assistance via private sector is necessary.

Ellis & Douglas (2015) by developed a link between funding options and investment decisions in public transport development. The authors highlighted that the choice of the transport related

projects based on Cost-Benefit analysis does not show the right decision because that analysis is independent of funding options. Therefore, there is a need to develop such a framework which could incorporate multiple funding aspects. The marginal deadweight loss must also be included which occurs when the government imposes social cost upon masses in the form of increased tax base for meeting the expenses of new projects.

Budiarto (2019) explored that it is very difficult to maintain financial stability of mass transits operations unless the government provides the subsidize. There is no possible way to reduce the operating costs of public transportation except to raise revenues. The possibility of fare increase is not a solution as fare is usually set by the government. Hence, attempts should be made to incentivize the passenger use. So, government must take policy measures to switch the users of personal vehicles towards public transport. Most recently, Yusoff, Ng and Azizan (2021) provided the case of railway development in Malaysia. According to the study, a sustainable transportation is guided by multiples factors such as technological improvements, infrastructure development, regulations, awareness, pricing, and taxation. The Malaysian rail transit system is run by the government and public has failed to shift from personal vehicles to transit services to a larger extend. It was also argued that government run mass transits essentially aim for seeking social returns rather simply the return on investment.

METHODOLOGY

4.1 Questionnaire Design

The primary data is be collected through researcher administered questionnaire. A separate questionnaire is designed for non-users to find out the connectivity gap to explore the factors that can incentivize the OLMT usage. In addition, the study also explored if some proportions of the non-users are ex-regulars and the possible reasons of leaving the OLMT usage. This will help to determine the potentials of returning to OLMT service. The questionnaires for users and non-users are attached in appendix A and B.

The questionnaire is designed by keeping in view the potential linkages of public transport accessibility benefits with sustainable future revenue streams. The data is collected on current and expected travel patterns such as proportion of income spent, number of motorized trips taken per day, nature of travelling by destinations, desirability in favour of OLMT, as well as physical accessibility in terms of mobility and connectivity. The data is analysed to explore the prospects of workable solutions for sustainable revenue generation. One of the solutions is through introducing personalized smart cards in the form of bundled commodity which may incentivize the OLMT usage.

The socio-economic profile, demographics and travelling behaviour of the users is added in the questionnaire to explore the viable solutions devising targeted subsidies for specific age group, gender, as well as the socio-economic status of the commuters by zoning out the users who can afford greater travelling costs. Therefore, the questionnaire is designed to capture such prospects along with the inclusion of determining the willingness to pay of the commuters. Similarly, data on employment status is also gathered to propose employer-based subsidies by linking it to the livelihood destinations and their economic status. The questionnaire also aims to collect information on multiple features related to comfort and convenience along with data on temporal accessibility. The respondents were also asked about station of entry and exit so that zone-wise fares could be devised such as subsidies for trips that begin and end with certain pre-determined stations. Furthermore, it will be probed with the help of questionnaires if monthly, quarterly, or biannually concessionary smart cards can be devised. A renewal fee of such smart cards can also help in generating additional revenue streams. In addition, the study also captures the willingness to pay indirectly so that it can be linked with demographic and socio-economic profile of the OLMT commuters. The differences in travel costs among vehicle-owning and vehicle lacking passengers along with the OLMT travelling behaviours is also observed through questionnaire.

4.2 Sampling Design

For conducting OLMT passenger survey, the multi-stage sampling is adopted keeping in mind the time and resource constraints. In the first step, the cluster sampling is adopted. The universe for analysis is the OLMT passengers. For a particular day, the OLMT ridership is divided the into three clusters according to the time. The day is divided into clusters to cover the peak and off-peak hours among three parts of the day i.e., morning (07:00am to 12:00pm), afternoon (12:00pm to 05:00pm) and evening (05:00pm to 10:00pm). Sajjad et al. (2017) mentioned the peak hours into morning, afternoon, and evening.

There are a total of 27 train sets with 5 bogies in each train. After clustering the population based

on timings, one cluster (for instance, morning) is randomly selected by choosing one train at a time and the passengers in that cluster are surveyed along the complete route of OLMT (Dera Gujran to Ali Town and vice versa) irrespective of his/her destination route. Similarly, for second cluster (for instance, afternoon) again one train will be randomly selected for survey and the same process will be repeated for the third cluster (the evening timings). Henceforth, the three clusters are surveyed in a day. In this way, both the peak and off-peak hours are included for the OLMT ridership. The train sets for each cluster will be based on random selection. This process is repeated each day.

The common method adopted by many researchers is the single-stage cluster sampling using the census approach i.e., to survey all units within the chosen cluster. However, this approach is not feasible in the given case. Even if maximum efforts are to be made to survey every boarding passenger from all stations along the Dera Gujran-Ali Town route there will be constraints on our resources in terms of limited time, field staff and finance. Therefore, the multi-stage sampling is adopted whereby in the second step, the convenient random sampling approach is applied to select respondents in each cluster. During the survey, some passenger refused to willingly participate in the survey and few cases of repetitive passengers were also observed who commute on daily basis. Such non-used questionnaires were counted as non-respondents. The no response rate was 4.6 percent.

The main objective of present study is to measure accessibility benefits and devise strategies for financial sustainability of this mass transit service through targeted demand-side subsidies; therefore, the target population were passengers who commute through OLMT. Since existing literature quotes accessibility measure from the passenger's perspective, as there is no accessibility gains for those who are not directly involved in its consumption. Secondly, the targeted demand-side subsidies can only be applied to the OLMT users and not the non-users.

However, a small sample of 500 non-users, of which some might be ex-users, is also selected to undertake a comparative analysis with users to explore the reasons that discouraged them to become users. The target population for this survey round are the commuters who travel along the roads parallel to the route of OLMT. The mode of these commuters is rickshaw or minivans. For this purpose, simple random sampling is adopted. To undertake comparative analysis of users and non-users, a subset of 500 respondents is extracted from the total sampled dataset of 4900 OLMT commuters. The subset is created by excluding case by case missing value for any of the item for which the respondent did not provide a response which trimmed the data to 3000 cases. Furthermore, systematic sampling was used to select every sixth case. Out of 500 non-users, 67.5 percent were the ex-users of OLMT, and 32.4 percent have never travelled via OLMT.

4.3 Sampling Frame

The field survey was conducted over a period of two month starting from 1st of September 2021 to 28th of October 2021. The micro-level primary data is collected by conducting an on-site rider survey who commute via Lahore OLMT. Nevertheless, few challenges were faced during the conduct of filed survey such as repetitive OLMT passengers, refusal to voluntary participation in survey forms and public holidays (such as 9th and 10th Muharram, Eid Milad-un-Nabi, and PTLB protests that suspended the OLMT service for few days). The Sunday was excluded from the time framework because it was observed during pilot survey that majority of the Sunday commuters were one-time riders consisting of groups of families or friends that took the OLMT ride solely

for the purpose of entertainment and joy ride. Thus, their travel behaviour would not provide fruitful insights in achieving the research objectives. A small sample size in the case of non-users is also collected to find out the mobility gap that discourages the non-users. The field survey of non-users consisted of one and half month from 30th November 2021 to 13th of January 2022.

4.4 Scale of Analysis and Survey Design

The scale of analysis is the complete OLMT route starting from the station Dera Gujran to station Ali Town and vice versa. At first, the pilot survey was conducted. During the pilot run, the researchers observed only minor adjustments and the questionnaire and mode of conduct was modified thereafter. The research ethics were also taken into consideration by taking verbal consent from the respondents before the administration of questionnaires. The survey was conducted through researcher-administered questionnaires on OLMT commuters during the time of their ridership. The rational of not choosing the individual OLMT stations (26 in total) was severe time constraints on data collection. Since the time duration between arrival of consecutive trains on any OLMT station is roughly 5 minutes and OLMT commuters had no incentive to willingly participate and stay back for the completion of questionnaire as opposed to catching their OLMT ride. Thus, questionnaires would have remain partially filled or the non-response rate would have been very high. Therefore, it was more feasible to conduct the survey on OLMT route on-board during the ride as respondents was more willing to participate in the survey by overcoming the time constraints.

Secondly, the OLMT is efficient in terms of speed which has reduced the travelling time by considerable amount. This was again a problem in the form of time constraints on the part of survey completion. On the first few days of pilot survey, it was observed that self-administered questionnaires also posed serious challenge in terms of missing information. This was because the respondents took considerable amount of time in reading and understanding the survey form before filling it out. Hence, before they could complete the questionnaire, they had to get off the train by either leaving behind the partially filled questionnaire or taking it with them. In both the cases, the questionnaire was considered a waste. In the light of these observations, the survey design was modified to researcher-administered questionnaires. Apart from OLMT passengers, the non-users of OLMT are also surveyed to identify the accessibility gap that discourages them to use OLMT. The non-user respondents are searched out along public roads that are running parallel to the OLMT route (Dera Gujran to Ali Town and vice versa) who commute via minivans and rickshaws.

4.5 Analysis

The analysis is done by using descriptive statistics, frequency distribution, multiple charts, stacked bar charts, pie charts, contingency table/cross-tabulations. A comparison is also undertaken between the two independent samples of users and non-users. The independent variable is categorical, either nominal or ordinal, but the categories must be dichotomous such as the users and non-users. The nature and datatype of dependent variable determines whether to use parametric or non-parametric. The parametric approach is applied when the dependent variable has a continuous scale (ratio or interval) and have normal distribution. The non-parametric approach is used when the dependent variable is continuous but skewed i.e., does not have normal distribution or the dependent variable follow an ordinal scale.

The current study has used ordinal scale for most of the items in the questionnaire except for few variables which are in continuous scale such as approximate daily expenses using public or private transport and willingness to pay for pick-and-drop service between place of residence to destination location. The Shapiro-Wilk normality test is applied on the scale variables since the dataset is small consisting of 500 users and 500 non-users. A significant p-value rejects the null hypothesis of normal distribution (see Table 6, appendix C). Therefore, the study employs non-parametric approach to undertake comparison of two independent samples of users and non-users.

The Mann-Whitney U test is used to test the hypothesis whether the two independent groups are significantly different or not. The Mann-Whitney test converts the scores of ordinal scale into ranks for the complete sample without grouping and mean rank of the two groups are then compared. The null hypothesis is rejected if there is significant difference in the ranks of two groups (users and non-users). An insignificant test result shows that both groups are drawn from the same underlying population i.e., there is no sizable difference between the users and non-users. In addition, the odds ratio is also calculated to determine the travel demand and behaviour of the users and non-users with respect to connectivity and willingness to pay. The odds ratio measures the effect of one unit change in independent variable in the predicted odds ratio by keeping other variables in the model constant.

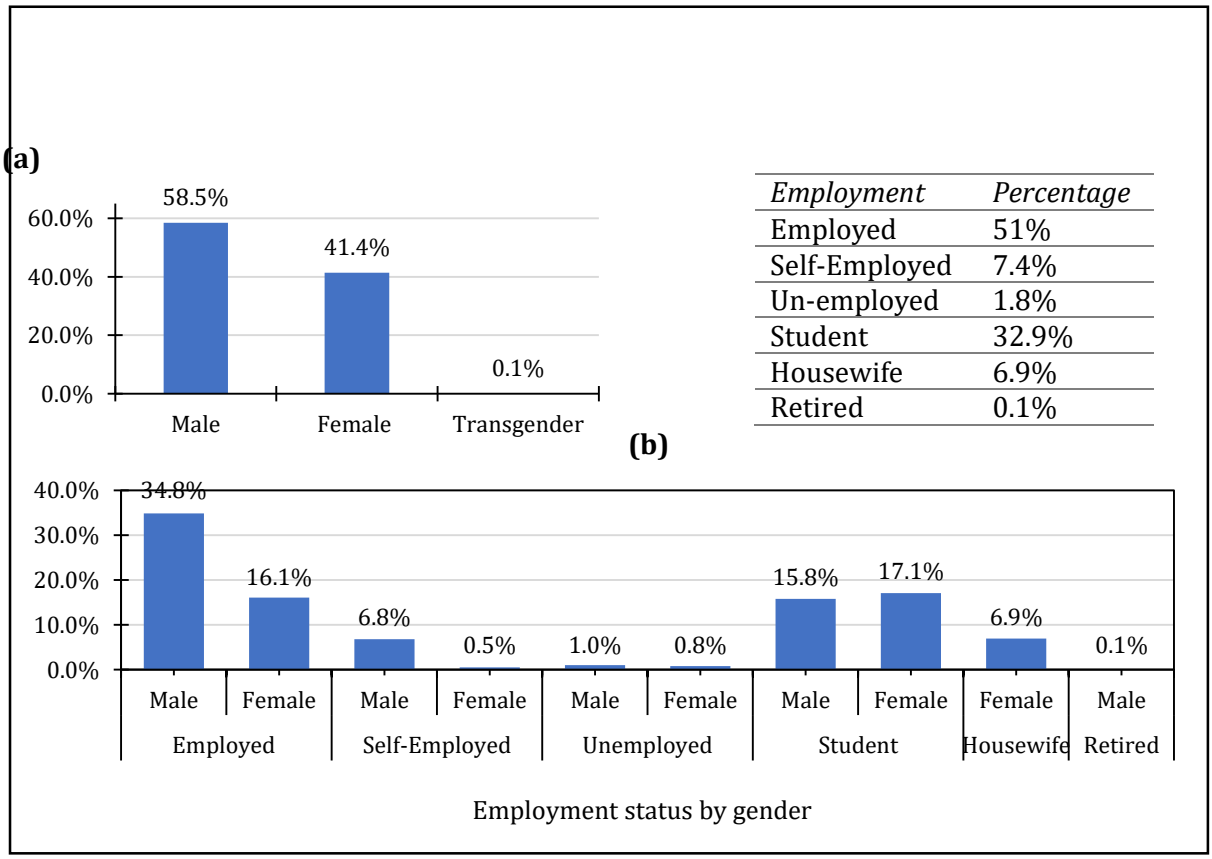
RESULTS AND FINDINGS

This section provides the outcome of study. The notion that a successful public transport system fully pays for itself through passenger fare revenues is a common myth; rather, it delivers vast external benefits in the form of social inclusion. Social inclusion for vehicle-lacking individuals belonging to motor-less households provides economic justification for government intervention and subsidies. However, to reduce the burden of government subsidies, the 'targeted demand-side subsidies' is a viable policy option rather than uniform user charges. The public-private partnership can also generate additional revenues through commercial activities.

To fully reap the benefits, there is a need for well-integrated plan of action to make transport policy compatible with new service provision and infrastructure development especially the mass transit interventions. The most important aspect is supplementing the rail mass transit with a network of connectivity to encourage its use. Additionally, public awareness about Lahore transportation network can also help to increase the OLMT ridership as information gap is found to have restricted the non-users to shift towards OLMT from present mode of travelling despite facing discomfort and inconvenience. The detailed analysis is provided below:

Figure 2 shows the distribution of OLMT commuters by gender which is representative of both male and female population. Furthermore, the breakdown of sample by employment status is also provided. It is revealed that Lahore OLMT has contributed towards 'gender inclusive' transportation mode by improving the transportation access to female students as depicted by 17.1 percent passenger share compared to male students (15.8 percent).

Figure 2: Gender Profile of OLMT Commuters and Distribution by Employment Status



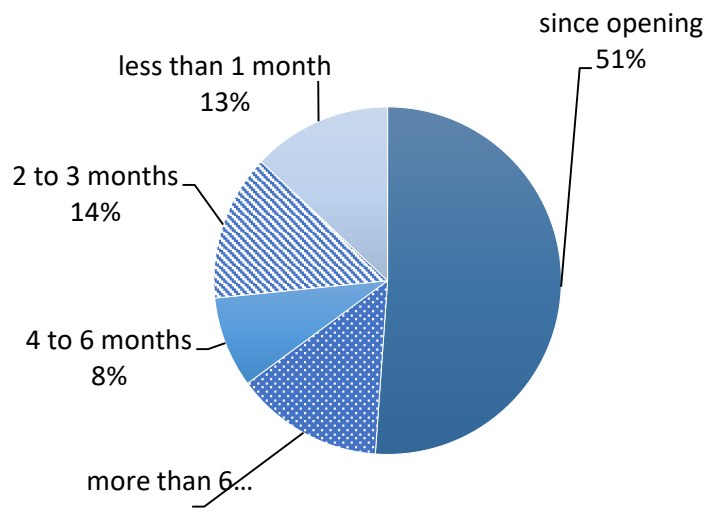
Employment	*Percentage*
Employed	51%
Self-Employed	7.4%
Un-employed	1.8%
Student	32.9%
Housewife	6.9%
Retired	0.1%

Source: OLMT ridership survey.

Out of the total sample size, 51 percent have been the OLMT passengers since its opening followed by 14 percent passengers who have been using the mass transit facility for more than 6 months. It is also observed that the transit train has brought 'locational efficiency' through easy access to destinations (Figure 3). Sustainable accessibility to city residents in terms of job access, education and living are among the various objectives of an urban transport policy as highlighted by Haque and Rizwan (2020).

The greater proportion were those commuters whose ultimate destinations were workplace and education in terms of access to school, college, and university. In terms of the reach to local community services and hospital, the regular passengers were only 7 percent whereas 80 percent passengers never used it for this purpose. Hence, 'targeted demand-side subsidies' can be offered to office workers and students in the form of special smart cards which might induce more people to shift towards OLMT use, causing an increase in revenues. Harmony (2018) has also emphasized on designing smart cards specific to users' characteristics. An expiry date and renewal fee of smart cards can be an addition source of revenue for this mass transit service.

Figure 3: Accessibility by Destinations and Duration of Passenger's OLMT Use



Destinations	*Percentage share of OLMT commuters*
Workplace (A)	44%
Education (B)	27%
Both (A+B)	3%
Recreational activities (C)	16%
Shopping (D)	6%
Both (C+D)	20%

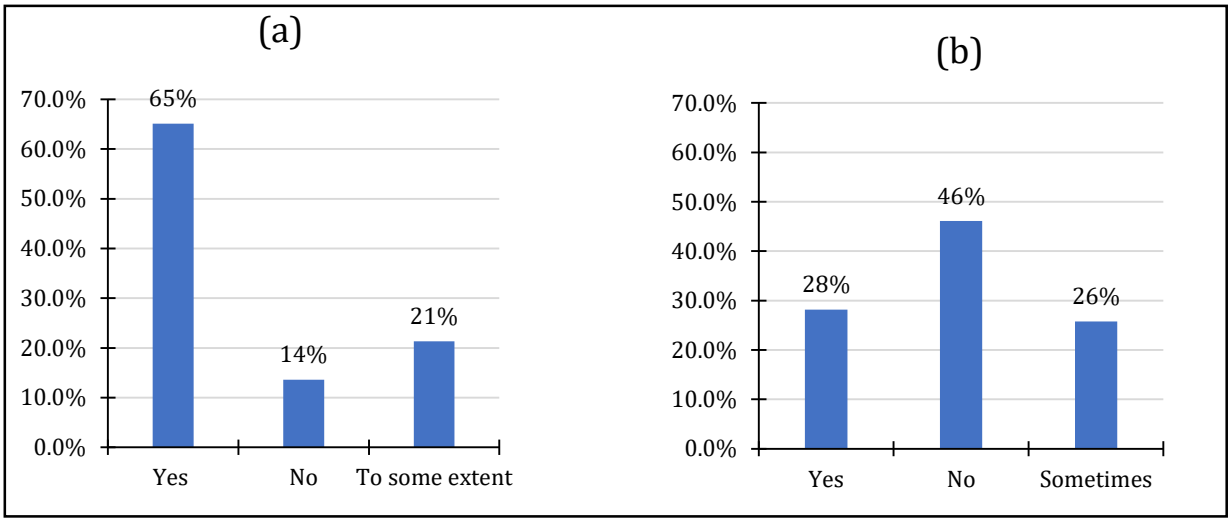
Source: OLMT ridership survey.

Out of the total sample size, 56 percent respondents were the residents of Lahore since birth and 12 percent have been residing in Lahore for more than 10 years. When asked about their experiences with Lahore transportation, 78 percent passengers responded that transportation options are adequate in Lahore i.e., they have easy access to public transport in terms of ease to reach their destinations. This indicates that the past policy interventions in Lahore transportation system have brought improvements to larger extent in overcoming the discomforts and increasing utility for the citizens.

Further breakdown of the sample revealed that among the permanent residents of Lahore, 78 percent respondents found transportation system of Lahore as adequate means whereas 17 percent were dissatisfied in terms of inability to reach their destinations with ease. On the other hand, 17 percent passengers have been residing in Lahore for less than 5 years who responded

affirmatively on adequacy of transportation. The travel experience of OLMT commuters is provided in Figure 4.

Figure 4: Travel Experience of OLMT Passengers with Respect to Lahore Transportation System in Terms of A) Overall Satisfaction and B) Observable Travel Restrictions



Source: OLMT ridership survey.

The comparison of daily expenditure costs of travelling and alternative modes of transportation of the passengers before shifting towards OLMT is provided in Figure 5. The previous mode of transportation of majority commuters was rickshaw followed by the use of personal vehicles. Moreover, the users of personal vehicles were mainly the owners of two-wheelers. So, the passenger shifting towards OLMT from these two alternative modes (rickshaws and two-wheelers) can greatly contribute towards greener transport in Lahore. Extant literature has also mentioned that one of the important aspects of light rail mass transit, other than commuters' accessibility, is to achieve environmental sustainability in the long run. This is achieved by lowering the green-house gas emissions, using renewable energy as in light rail transits and reduced trip length of private vehicles through improved connectivity.

Lahore is among one of the severely affected cities of the South Asia by smog. According to 2002 report of the World Bank, Pakistan and India has remained the main culprits of green-house gas emissions and suspended particulate matter in South Asia.[8] The report also highlights that motorcycle and rickshaw usage were the major factors behind such environmental degradation, especially as no environmental standards have been issued on these transportation modes.[9] In addition, such factors may also have an influence in reducing the space footprint and road congestion. Another shift factor in favor of OLMT was the past daily travel expenses as 36 percent commuters were previously experiencing more than Rs. 200 followed by 21% between the daily expenses of Rs. 150 to Rs. 200. Only a small proportion of commuters (5 percent) were facing the per day travel cost of Rs. 40 or less which is equivalent to the OLMT fare (see Figure 5).

Furthermore, it was observed that 32 percent passengers were previously spending daily expenditure of more the Rs. 70 on rickshaw (informal public transport mode) which has forced them to shift to OLMT usage. On the other hand, 22 percent OLMT commuters who were

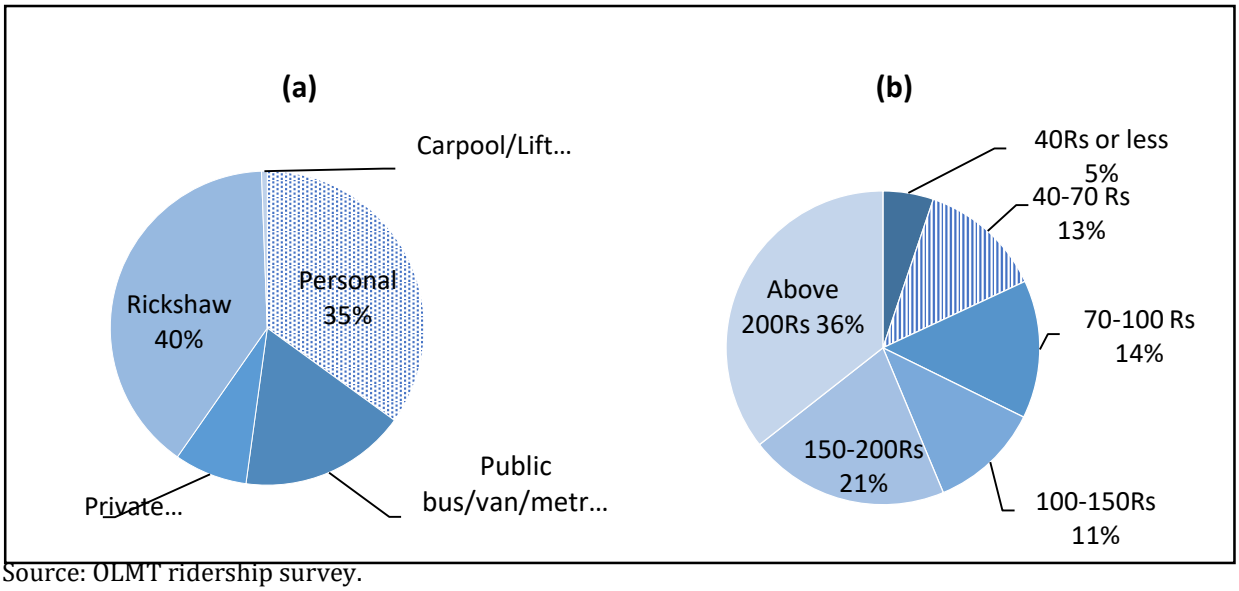
[8] World Bank (2002).

[9] United States, European Union, Singapore, Shanghai and Japan are the lead countries of the world who are following stringent vehicle emissions standards along with pursuing the technologies for further reducing emissions from new vehicles such as electric cars and 'E-powered' mass transits.

previously using personal vehicle were the bikers with average cost of less than Rs. 200 and 13 percent were the car users with travel expense of more than Rs. 200. See Figure 6 for detailed breakdown of daily travelling cost against alternative transportation mode.

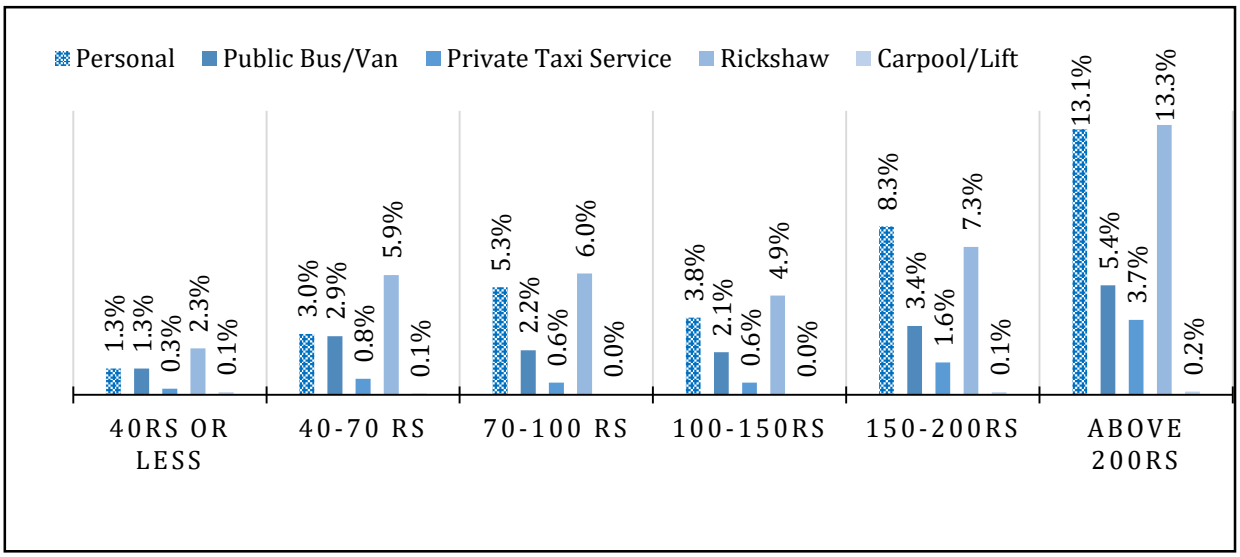
Although, public has strong inclination to be free riders by not revealing their true preferences but still majority showed acceptance of fare increase. Thus, OLMT fare can be increased without a considerable fall in demand. The future demand along with the willingness to pay and acceptance of price increase is depicted in Figure 7.

Figure 5: Passengers' Characteristics Before Shifting Towards the OLMT Use in Terms of A) Alternative Transportation Mode and B) Daily Travelling Cost in Alternative Mode



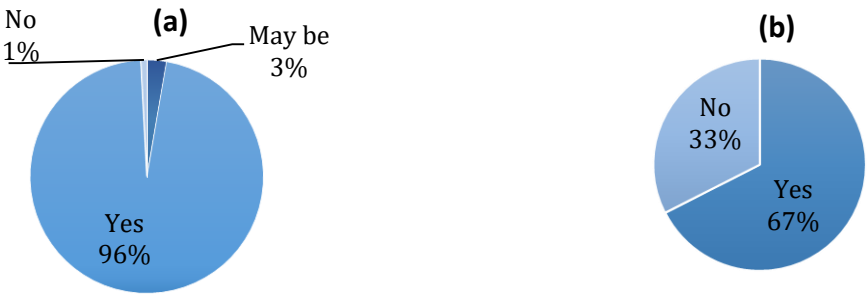
Source: OLMT ridership survey.

Figure 6: Comparison of Daily Cost under Alternative Transportation Mode



Source: OLMT ridership survey

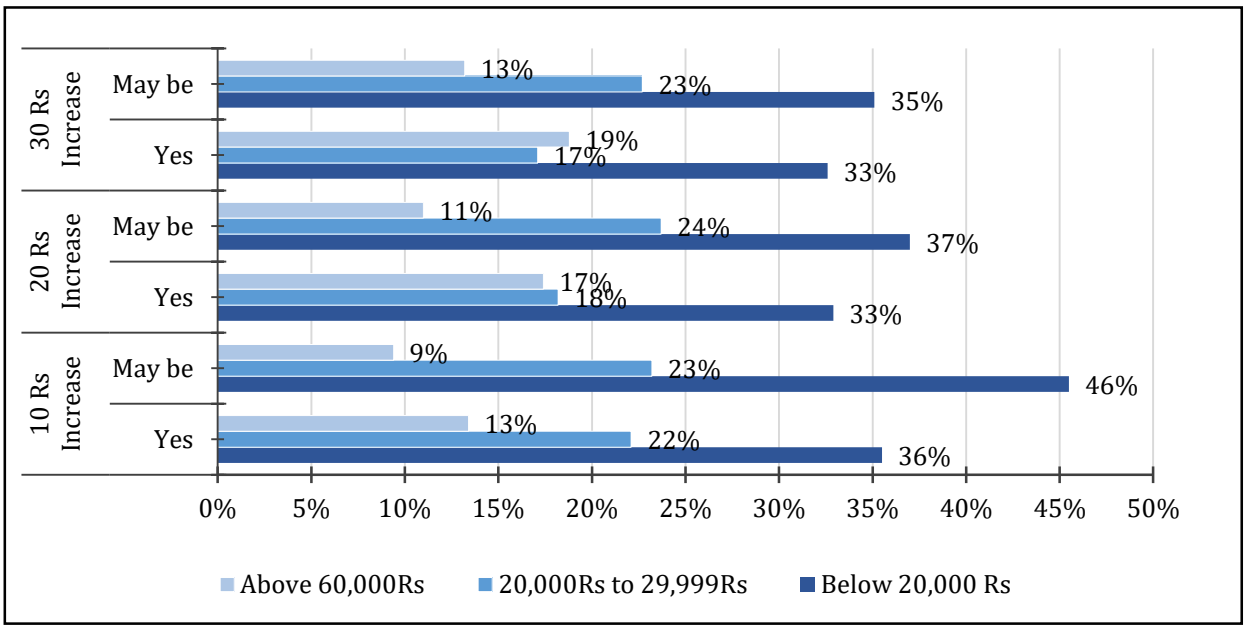
Figure 7: Future Demand for OLMT Ridership A) Without Fare Increase and B) With Fare Increase



Willingness to pay in terms of price increase	*Rs.10*	*Rs.20*	*Rs.30*
Yes	74%	39%	25%
Maybe	5%	9%	7%

Source: OLMT ridership survey.
Note: The passengers were provided a hypothetical situation of price increases by Rs. 10, Rs. 20 and Rs. 30.

Figure 8: Willingness to Pay by Income Profiles for Additional Rs. 10, Rs. 20 And Rs. 30

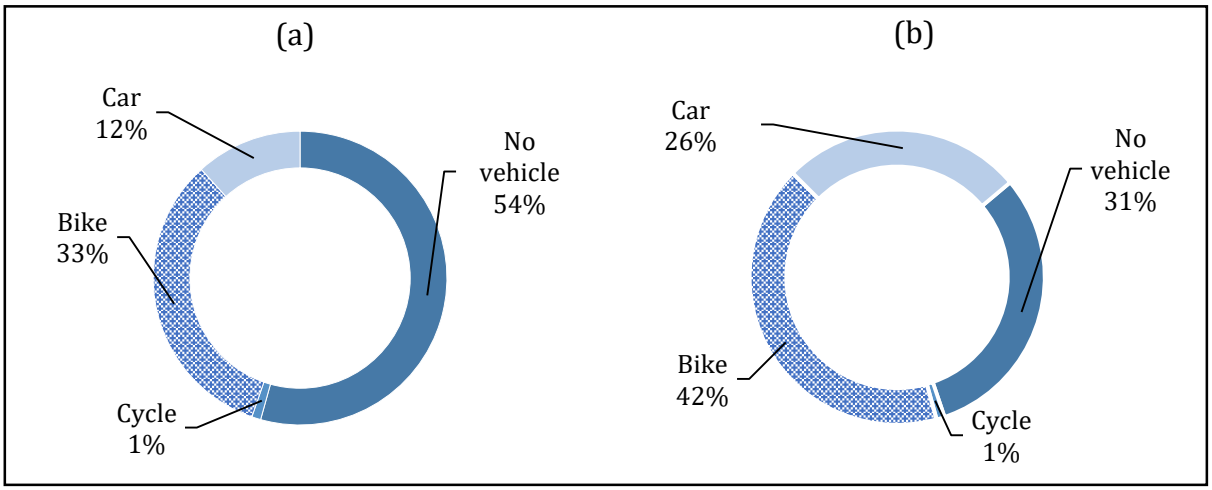


Source: OLMT ridership survey. Note: The income groups were classified into six categories (i) below Rs. 20,000 (ii) Rs. 20,000 – Rs. 29,999 (iii) Rs. 30,000 – Rs. 39,999 (iv) Rs. 40,000 – Rs. 49,999 (v) Rs. 50,000 – Rs. 59,999 Rs (vi) Above Rs. 60,000. In the Figure above, statistics of only those income groups are included that show considerable variability.

Figure 8 shows that majority of the passengers who revealed their willingness to pay additional Rs. 30 and Rs. 20 belonged to income group of above Rs. 60,000 (19 percent in the case of Rs. 30) or less than Rs. 20,000 (33 percent in the case of Rs. 30 and Rs. 20). On the other hand, majority of passengers who agreed to pay additional cost of Rs. 10 earned less than Rs. 30,000. It is interesting to note that low-income earners have shown greater willingness to bear the extra burden of fare increase despite having limited income. This public transport service has contributed greatly toward social inclusiveness for low-income earners as they are more willing

to bear an increase in fare. The is because these commuters either do not own private vehicles or belongs to motor-less households. Therefore, third degree price discrimination on the concept of progressive taxation can be applied by issuing 'smart cards' for different income groups by further categorizing then into regular and non-regular commuters. This may increase the revenue streams for the mass transit authority.

Figure 9: Distribution by Vehicle Ownership and Availability In Terms of A) Personal Ownership and B) Household Ownership



Source: OLMT ridership survey.

Figure 9 illustrates that many of the commuters did not have access to either personal vehicles or household ownership of vehicles. However, there were 12 percent commuters who owned personal cars and 33 percent were the owners of two-wheelers which reflects the proportion of 'choice riders' i.e., the availability of personal vehicle at the time of ridership. Although OLMT is benefiting those who ride OLMT by choice, but larger proportion are those who have shifted from non-availability of the alternatives. These riders consist of mainly those commuters who either don't own a vehicle or must rely on a family member for shared travelling via common ownership of vehicles. There were 48 percent OLMT commuters with no personal and household ownership of vehicles who were using rickshaw prior to the use of OLMT, and 7 percent were using the private taxi service using TNCs. Thus, this mass transit has been very crucial for a large segment of the society by providing basic mobility for whom it would have been difficult to make trips to their destinations and have also faced higher travelling costs by using alternative modes mainly the rickshaw. Interestingly, it was also found that most of the motor-less commuters but belonging to vehicle-owning households were the females. Upon further inquiry during the survey, it was found that their alternative mode of travelling was a bike which was personally owned by a male member of their family. Hence, female faces 'forced immobility' in terms of non-access to personal vehicles and dependency on a family member for shared ridership and this mass transit service has contributed considerably to overcoming this barrier for females as this service is considered safer and convenient.

Table 3 provides the distribution of OLMT passengers by different income profiles and majority (59.2 percent) falls below the income level of Rs. 30,000. Correspondingly, equivalent ratio (60 percent) was also found for that of non-users under the similar income level who were commuting via alternative public transport like minivan or rickshaw instead of OLMT. The non-users found less ease at travelling via alternative modes as 59.4 percent non-users responded to

face large traffic congestion on road on daily basis. However, further exploration of the reasons as to why they have not preferred Lahore OLMT over their current mode was the lack of knowledge and awareness about the connectivity networks. This information gap has induced them to use alternative transportation mode especially the informal public mode (such as rickshaw) that could easily take them to places without being fully aware of the whole transportation network of the city. The proportion of these non-users was 67.7 percent.

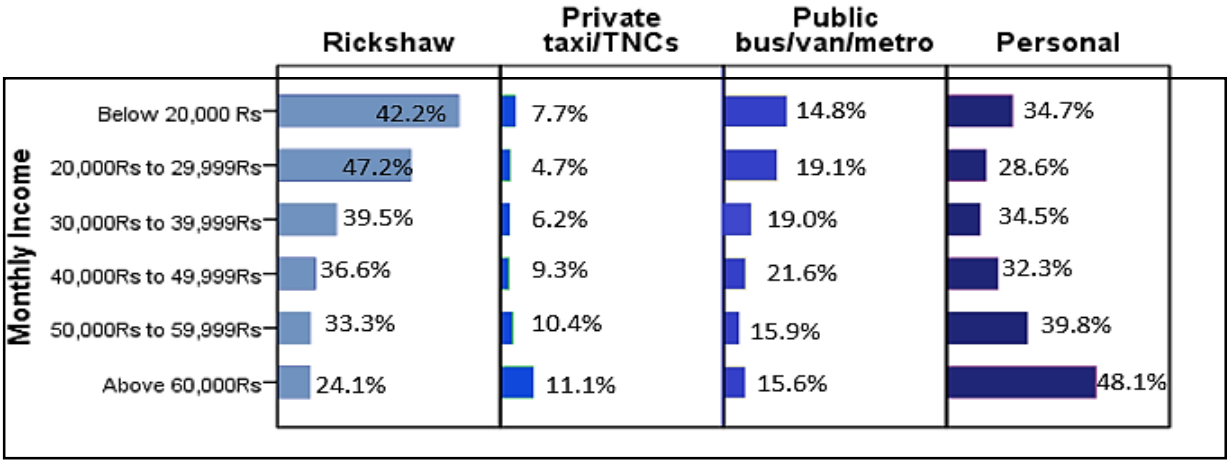
Table 3: OLMT Passenger Distribution by Income Groups

Income Range	*Percentage share*
Above Rs. 60,000	11.4 %
Rs. 50,000 - Rs. 59,999	8.3 %
Rs. 40,000 - Rs. 49,999	8.7 %
Rs. 30,000 - Rs. 39,999	12.4 %
Rs. 20,000 - Rs. 29,999	23.5 %
Below Rs. 20,000	35.7 %

Source: OLMT ridership survey.

Additionally, it is noteworthy that 35 percent respondents, commuting via OLMT, were satisfied completely or to some extend with the transportation system of Lahore. These passengers were previously rickshaw users and 30 percent were users of personal vehicles who have now shifted towards the OLMT service.

Figure 10: Comparison of Monthly Income and the Proportion of Passengers Using Alternative Transportation Mode before Shifting to OLMT

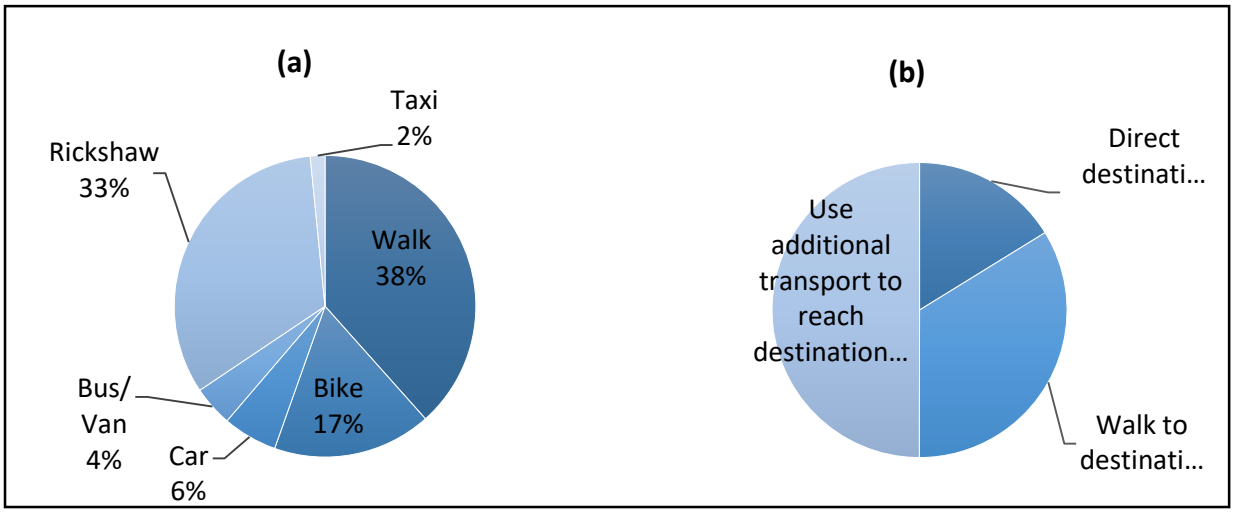


Source: OLMT ridership survey. Note: The percentage values provided in the above figure (row-wise) present the share of OLMT passengers under each category of the alternative transportation mode by income group, separately. A minimal share (less that 1 percent) was that of carpool/ or shared transport but not reported in the graph.

Out of the total sample size of OLMT passengers, 40 percent passengers used additional transport with OLMT (both entry and exit station). 10 percent passengers reached directly to OLMT entry station but used additional public transport from exit station to reach destination. 5.9 percent used personal vehicle (such as bike and car) and 4.4 percent passengers used public transport (both formal and informal such as public bus, rickshaw, or taxi service) to reach OLMT station but no additional transportation was used from exit station. On the other hand, 28.5 percent passengers did not require any additional transport with OLMT service (from both sides i.e., entry and exit station). Therefore, the overall cost of travelling increased due to additional burden

of 'multi-modal' commuting to and from OLMT stations as compared to travelling via OLMT service only. This shows that improving the connectivity gap can induce more people to use OLMT. Network connectivity is considered as one of the important aspects of improved mobility (Venter, 2016). Haque and Rizwan (2020) has identified that the gap between supply and demand of mass transit systems in Pakistan are filled by inferior transportation mode such as rickshaw and motorbikes.

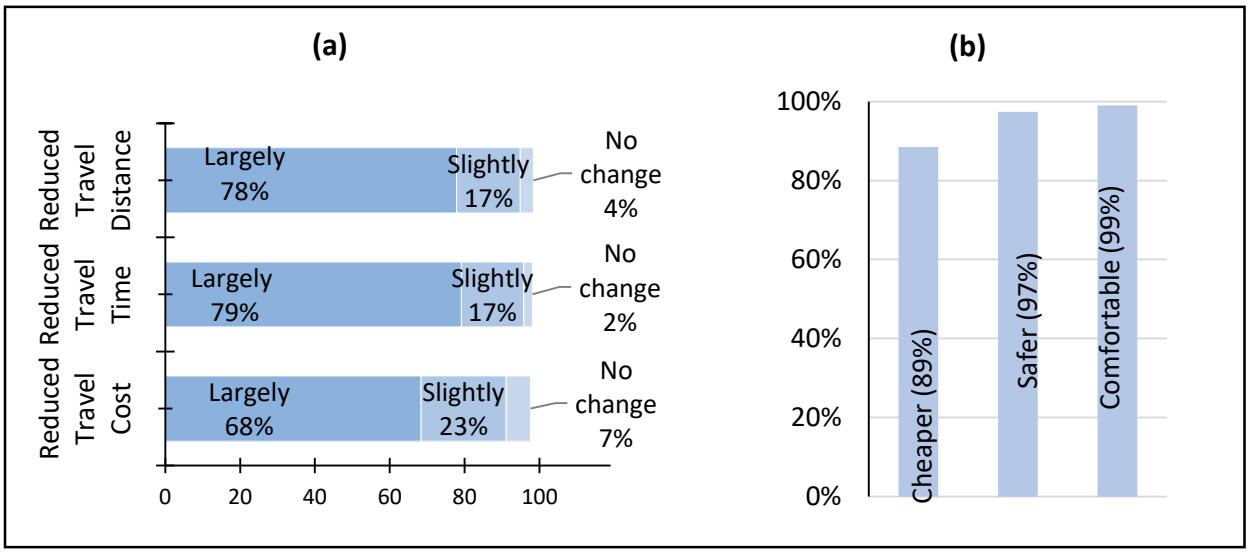
Figure 11: Representation of Connectivity Gap A) from Residence to OLMT Entry Station and B) from OLMT Exit Station to Destination



Source: OLMT ridership survey.

The OLMT passengers have observed considerable reduction in mobility gap in terms of speed, distance, and travel cost. Also, a large proportion of passengers found OLMT cheaper, safer, and comfortable as compared to competing modes of transport. Furthermore, it is observed that majority of the users had to face greater distance of more than 2 km to connect to the OLMT stations in comparison to the non-users who faced 1 km or less if they need to reach the nearest OLMT station. This shows that rather than the proximity of OLMT, improved physical accessibility by means of convenience (cheap, safe, and comfortable) and mobility (speed, distance, and time) have been the contributing factors for derived demand for OLMT mass transit. The contribution of OLMT in improving the physical accessibility is provided in Figure 12.

Figure 12: Physical accessibility by means of a) mobility and b) convenience



Source: OLMT ridership survey.

Those who responded as OLMT to be cheaper mode of travelling, 63 percent experienced small expenses and 29 percent experienced moderate expenses and only 7 percent respondents faced higher share of travel expenses out of their total monthly income. Besides, the small proportion of travelers who did not find OLMT as a cheaper mode, 50 percent commuters faced small expenses and 35 percent faced moderate expenses out of their total monthly income and 15 percent were those who experienced the greater burden of travelling.

The main reason that the passengers were considering high travelling cost associated with OLMT was the additional transportation required by them to get connected to the OLMT stations. Those commuters who faced higher expenses, 49 percent passengers had to use rickshaw and 3 percent used taxi services (TNCs such as Uber/Careem etc.) to reach their entry station of OLMT and 62 percent had to used additional transport from their exit station to reach their desired destinations.

Likewise, 70 to 75 percent OLMT users were those who required additional transport at both ends of OLMT i.e., entry and exit station in terms of either rickshaw or taxi services. On the other hand, OLMT ride was cheaper for those who did not require any additional transport, as the mass transit was within the walking distance of their place of residence and commuters' destinations. Thus, the transport policy of Lahore needs to be made more compatible with the mass transit by improving the connectivity to induce more people by reducing the travel burden of additional travel cost attached with it. The provision of feeder buses would be more cost effective in this regard in reducing the overall additional burden of travelling. Literature has also quoted running a free-feeder lines under 'first generation subsidy' for improving connectivity especially with poor neighborhoods[10] (Mehndiratta, Rodríguez, & Ochoa, 2014; Harmony, 2018).

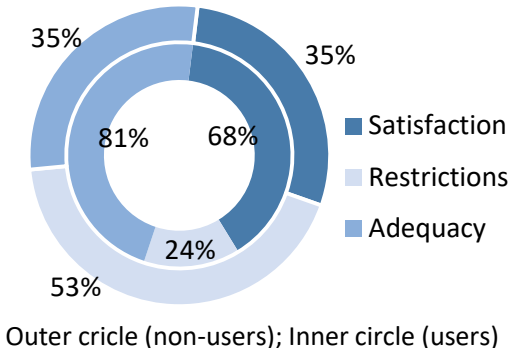
The significant p-values in (see Figure 13) indicate the rejection of null hypothesis concluding that there is a significant difference between users of OLMT and non-users regarding their experience with Lahore transportation system in terms of adequacy in travel options, travel restrictions and overall satisfaction. The users of OLMT were majorly satisfied with Lahore transportation system (68 percent) and found the transport options adequate (81 percent)

[10] Examples can be seen in the case of Colombia, Brazil, and Rio de Janeiro.

followed by only 24 percent who found discomfort and restrictions during travelling. On the other hand, a large proportion of non-users were dissatisfied due to inadequate travelling options; and experienced travel restrictions and discomfort arising from traffic congestions and inability to reach destinations timely.

Figure 13: Travel Experience (Users and Non-Users)

Independent-Samples Mann-Whitney U Test	
Outcome variable	p-value
Satisfaction from Lahore transportation system	0.000
Travel restrictions	0.000
Adequacy of travel options in Lahore	0.000



Source: Authors calculations. The significance level is 0.05. The rank distribution is provided in Figure 15, appendix C. Field survey of OLMT ridership and non-users of OLMT.

Regarding the traffic congestion on roads, 59 percent non-users always faced road congestion and 35 percent faced congestion only sometimes. This shows that non-users of OLMT experienced immobility and inconvenience in competing modes of travelling as compared to the regular users of OLMT. Hence, it needs to be further explored as to why the non-users have not changed their travel behaviour in favor of OLMT. Further exploration revealed that majority of non-users (68 percent) were unaware and did not have complete information on Lahore transportation network whereas 99 percent OLMT users were confident about being well equipped with travel information. So, information gap is also one of the reasons that have restricted the non-users to substitute from present travelling mode towards OLMT despite facing discomfort and inconvenience. Therefore, overcoming this 'information asymmetry' might increase the OLMT ridership and raise revenues.

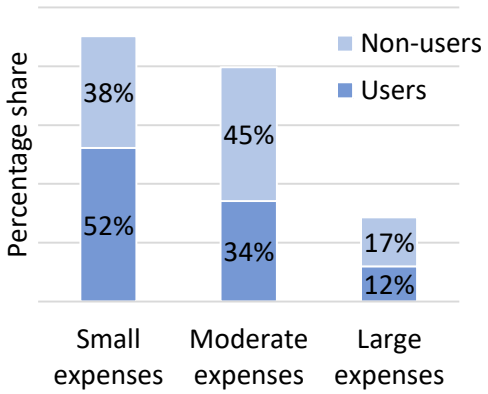
The maximum willingness to pay for daily travelling was also captured for users and non-users. In both cases, the distribution was positively skewed since there is always an incentive to reveal less than the actual benefit attached with the consumption when chances of benefiting from government subsidy is large. On average, the daily expenses that non-users and users were willing to spend were Rs. 28 and Rs. 146, respectively. However, the median value of willingness for total sample, users and non-users was Rs. 40, Rs. 100 and Rs. 20, respectively. The current price of OLMT fare during the conduct of field survey is Rs. 40 and when the passengers were presented with a hypothetical situation of fare increase, 67 percent users revealed its acceptability (Figure 7).

The significant p-values in (Figure 14) indicate the rejection of null hypothesis, concluding that daily travel expenses in terms of public and private transport and travel burden relative to income are significantly different between user of OLMT and non-users. The users of OLMT were spending an average daily expense of Rs. 138 and Rs. 356 while using public transport and private vehicle, respectively. Whereas the non-users faced an average daily travel cost of Rs. 91 and Rs. 141, respectively. Furthermore, the breakdown of travel burden shows that the percentage of users was greater in comparison to non-users with respect to smaller travel burden. On the other

hand, the greater proportion of non-users' responded to experience moderate and higher travel burden.

Figure 14: Travel Burden with Respect to Income (Users and Non-Users)

Independent-Samples Mann-Whitney U Test	
Outcome variable	p-value
Daily expenses using public transport	0.000
Daily expense using private vehicle	0.000
Travel burden on income	0.000



Source: Author's calculation. The significance level is 0.05. The rank distribution is provided in Figure 15, appendix C. Field survey of OLMT ridership and non-users of OLMT.

The outcome of the study indicates that even though the users of OLMT are experiencing more average daily costs as compared to non-users, but users responded to have smaller travel burden relative to income when commuting via OLMT. As explained earlier, the OLMT passengers are facing additional travel cost due to the 'connectivity gap' (see Figure 11) which is causing them to spend additional expenses to that of OLMT fare. Therefore, by bridging the connectivity gap in terms of provision of feeder buses can be play an important role in raising revenues through increase in OLMT ridership. The transportation network must be well integrated and feeder buses play an important role to supplement the rail mass transit system by improving the efficiency of the later (Deng, Gao, Fu, and Zhou, 2013). Although, there will be again an issue involved with the funding of feeder buses as OLMT is already running a loss with heavy burden on supply-side subsidization. The solution is to focus on system-generated revenues by incentivizing the passenger use through providing connection via feeder buses. The feeder buses and OLMT must be commonly connected through a discounted smart card which will increase the overall demand for public transport services. Also, both these services must be run by a single service provider to make it more efficient, provided the feeder routes are free from contestability of potential entrants (minivans/rickshaws/ride hailing service such as uber/careem etc) through government regulations. Moreover, there was almost equal representative of users and non-users (64 and 66 percent) who revealed demand for feeder buses to connect to the OLMT stations. [11]

[11] There has always been debate by policy analysts to make the cities more walkable and no doubt it is the most efficient solution. However, to make city more walkable, the accessibility to destinations would greatly depend on if vertical growth of cities take place. However, the actual town planning and cities' growth are an outcome of urban sprawl with horizontal spread which makes the walkability less of a solution. Besides, when non-users were asked about why they do not travel via OLMT despite being at walkable distance. Majority responded that they can more easily hail a rickshaw ride rather than walking to an OLMT station or using the stairways to board the train. Typically, the people are lethargic and less receptive to walkability; and the informal values are mainly responsible for such attitude.

The odds ratios are also calculated to predict how much is the influence of expected change in travel time and absence or presence of connectivity with OLMT station on the willingness to pay for feeder buses. The results are provided in Table 4. The commuters who expected an increase in travel time as opposed to no change had 66.4% (1-0.336) less chance or had 0.336 times the odds of paying additional travel cost for feeder buses in comparison to no payment. On the other hand, the odds of paying additionally for feeder buses was 12.19 times higher than no payment for commuters who expected a decrease in travel time with the use of feeder buses as opposed to no change in travel time. With reference to the observable connectivity gap, there was 60.3% (1-0.397) and 58.9% (1-0.411) less chances of paying additionally for feeder buses by those commuters who could either directly reach their destinations or walk without using additional transport as opposed to those who needed additional transportation. Similarly, those who can directly walk or use a motor bike to reach OLMT entry station has 60.3% (1-0.397) and 50.5% (1-0.495) less chances, respectively, to pay additionally for feeder buses in comparison to those who required taxi service (such as Uber/Careem) to reach the OLMT entry station. The car users, bus passengers and rickshaw users showed insignificant results.

Table 4: Odds Ratio on Willingness to Pay by OLMT Users for Additional Feeder Buses

Willingness to pay for additional cost of feeder buses (YES)[a]	B	Std. Error	Sig.	Exp(B)	Likelihood ratio test (Sig.)[e]
Expected change in travel time[b]					0.000***
Increase time	-1.091	0.170	0.000	0.336***	
Decrease time	2.501	0.157	0.000	12.19***	
Connectivity gap from OLMT exit station to destinations[c]					0.000***
Direct reach to destination	-1.030	0.130	0.000	0.357***	
Walk to the destination	-0.704	0.117	0.000	0.495***	
Connectivity gap from to reach OLMT entry station[d]					0.000***
Walk to the entry station	-0.923	0.441	0.036	0.397**	
Use of motorbike	-0.889	0.447	0.047	0.411**	
Use of car	-0.743	0.471	0.115	0.476	
Use of bus	-0.532	0.499	0.286	0.587	
Use of rickshaw	-0.352	0.442	0.424	0.702	
Model fitting likelihood ratio test (Sig.)			0.000***		
Pseudo R-square			0.386		

Source: Author's calculations.
Number of observations: 4900 OLMT users
Method of estimation: Multinomial logistic regression.
*** and ** indicate the 1% and 5% significance level.
Notes: a) Reference category: 'NO'. The third category is 'MAY BE' for which the results are insignificant and not provided in the table. b) Reference category: No change in time. c) Reference category: Use of additional transport to reach destinations. d) Reference category: Use of taxi service. f) Null hypothesis: all parameters of the effect are zero

Table 5 provides the odds ratio predicting the difference in demand for feeder buses between user and non-users of OLMT. The results show that users of OLMT had 0.368 times the odds of fully supporting the feeder buses in comparison to non-users of OLMT, whereas 84.1% less chances that users might reveal demand for feeder buses as against no demand when compared with non-users' demand. On the other hand, the demand for feeder buses shows higher odds ratio by the non-users of OLMT. The odds of fully or partially supporting the feeder buses by non-users was 2.717 times and 6.291 times higher, respectively, in comparison to OLMT users as against not supporting the government provision of feeder bus connectivity. These results indicate that provision of feeder services can induce the non-users to shift towards OLMT use which can play an important role in increasing the passenger ridership and generation of fair-return revenues.

Table 5: Odds Ratio on Comparison between Users and Non-Users of OLMT for Additional Demand of Feeder Bus Connectivity

Support for government policy to improve connectivity via feeder buses[a]	B	Std. Error	Sig.	Exp(B)
Comparison of users with non-users				
YES				
Users	-0.999	0.186	0.000	0.368***
MAY BE				
Users	-1.839	0.204	0.000	0.159***
Comparison of non-users with users				
YES				
Non-users	0.999	0.186	0.000	2.717***
MAY BE				
Non-users	1.839	0.204	0.000	6.291***
Model fitting likelihood ratio test (Sig.)			0.000***	
Pseudo R-square			0.046	
Source: Author's calculations. Number of observations: 3565 (3065 users and 500 non-users) Method of estimation: Multinomial logistic regression. *** and ** indicate the 1% and 5% significance level. Reference category: 'NO'				

Other than the feeder buses, another way to improve the connectivity with OLMT can be through the introduction of 'Digital App'. The App can work on the similar bases as Transport Network Companies (TNCs) i.e., the ride hailing service by involving rickshaws (the name can be suggested as *orange rickshaws*) with information about routes, timings, and expenses per kilometer in connection with OLMT stations. Moreover, the App can make the additional travel expenses cheaper and more affordable for users by pooling the riders heading in same directions. This may further create a spillover benefit in terms of employment creation for those involved in providing the 'connectivity service'; especially compensating the rickshaw drivers as majority of the OLMT passengers' past mode of transport was rickshaw.[12]

[12] Although, there will be a concern by environmentalists on negative impact of pollution caused by rickshaws and survey of OLMT users have shown that many passengers who were previously commuting via rickshaw have shifted towards OLMT. Nevertheless, the survey of non-user also depicts that there is considerable amount of people who still commute via rickshaw through shared fare. Therefore, policy

CONCLUSION

The current study undertakes the ex-post evaluation of Lahore Orange Line Metro Train which is the first light rail mass transit service of Pakistan. The study sets to explore various aspects of accessibility, identify the gaps that discourage non-users and to develop viable strategies for achieving financial sustainability. The study found considerable difference in daily travelling expenses between users and non-users of OLMT in terms of public and private vehicle travelling. The extra costs are incurred due to missing connectivity either from OLMT exit stations to their location of destination or between OLMT entry station to their location of residence. Thus, even if these commuters pay a uniform fare of Rs. 40 per OLMT ride the additional travelling adds to their costs. Even though users are experiencing greater daily average travel cost as compared to the non-users, but the users responded to bear lesser burden as compared to non-users in terms of relative share of travel expenses in total income. Also, substantial proportion of the users showed positive attitude towards acceptance of marginal increase in OLMT fare by Rs. 10 followed by Rs. 20 and Rs. 30 fare increase.

The major reason of greater average travelling cost for users was the connectivity gap with the mass transit service due to which the travellers required additional transport. So, provision of connectivity can greatly contribute to an increase in ridership and revenue generation. Similarly, missing connectivity is the reason for non-users not to substitute their present mode with OLMT usage. The non-users wanted to avoid 'time poverty' caused from delays in reaching the OLMT station first before being taken to their actual place of destination when they could take short-cuts by travelling directly to their destinations. However, these non-users have been experiencing discomfort and time cost by facing traffic congestion on roads. The traffic congestions, on the other hand, have been causing the implicit delays in comparisons to the delays that non-users expected experience while connecting to OLMT stations from their residence or destinations. Another reason that discouraged them to use OLMT was the information gap regarding the routes, timings, nearest OLMT stations and the used of OLMT.

makers can move toward 'allocative efficiency' by formally bringing the rickshaw service providers under the connectivity net.

RECOMMENDATIONS AND FUTURE DIRECTION

The current study has some useful policy implications to devise strategies compatible with the OLMT mass transit service. One of the important policy mediations is to increase the transit coverage and catchment area through connectivity. The future direction for policy makers is to conduct a survey for developing an optimal design of feeder-bus network system to improve connectivity with OLMT vis-à-vis a mobile App need to be devised with information on OLMT service and connectivity routes to overcome the information gap. In addition, the mobile App can also be worked upon provision of TNCs type service to improve upon the connectivity. Such measures can induce more people to shift towards OLMT and prevent the present users to discontinue by making the additional travel expenses cheaper and more affordable as compared to prevailing multimodal arrangements of connectivity.

On the other hand, the burden of government subsidies can be reduced by replacing the uniform user charges with special targeted smartcards for regular users by grouping them into different income profiles and as per the requirement of working class, students, and the females. In addition, the zoning of ridership fare between peak and off-peak hours and the coverage of distance along the OLMT route is another way of generating addition revenue streams.

Lastly, the burden of government subsidy can also be eased out through alternative sources of revenues other than targeting the ridership only. The public-private partnerships (3Ps) can play an important role in this regard by promoting commercial activities on the OLMT. The OLMT stations are economically valuable for small businesses (such as food kiosks by selling on-the-go snacks) and revenue sharing can be a source of additional finance for the mass transit. The mass transit rail can also be used as advertisement and marketing medium to generate additional revenue streams. The most immediate intervention is to use the train's display screens for advertisement purposes. This can generate considerable amount of non-commuter revenue source for the OLMT service. Similarly, the digital screens can also be installed at each OLMT station which can not only save the stations' own running costs of lightening but provide revenue through provision of platform for advertisements. Static ads can also be a source of additional revenue for this mass transit. Conversely, rather than just focusing on mobility in isolation, there is need to follow the global practice with strong collaboration of partnerships. The MTR service in Shanghai and Tokyo has substituted the fare-setting strategy from affordability to service quality. Whereas in Hongkong and Singapore the provision of MTR is through private partnership and land development scheme is adopted to capture the land value to recover the costs.

With respect to the feasibility of purple and blue lines, it must be kept in mind that introducing a mass transit service without a support of well-knitted network and awareness cannot maximize the welfare gains. The 'accessibility-by-destinations' is also a necessary element for chalking out the routes for a mass transit service i.e., the location of employment and access to health and education institutions need be considered for penetration of full benefits of transit service. These factors must be given considerable weightage while devising the feasibility study for purple line/blue line or replication of similar mass transit in other locations or cities. Since transportation demand is 'derived demand' and ridership of mass transit cannot be increased without access to destinations. Moreover, such service provision is not financially viable in the long run if supported by government subsidies. Being a developing country and facing huge fiscal constraints, it will never be feasible for Pakistan to introduce such innovative public transport interventions solely based on government support. Pakistan needs to follow the footsteps of Singapore, China (Shanghai), Japan (Tokyo) and Hongkong where the mass transits are

commercially operated rather than depending solely on fare revenue or transferring the burden on government resources. Therefore, public-private partnership is necessitated for generating additional revenue streams or further advancement in rail mass transit systems in Pakistan.

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APPENDICES

APPENDIX A Questionnaire for OLMT Users

1	Day: Monday Tuesday Wednesday Thursday Friday Saturday Sunday
2	Date: Month:
3	Time: Morning (07:00-12:00pm) Afternoon (12:00pm to 05:00pm) Evening (5:00pm to 10:00pm)
4	OLMT ENTRY Station 1.Ali Town 2.Thokar Niaz Baig 3.Canal View 4. Hanjarwal 5.Wahdat Road 6. Awan Town 7. Sabzazar 8. Shahnoor 9.Salahudin Road 10.Bund Road 11.Samanabad 12.Gulshan-e-Ravi 13.Chauburgi 14.Lake Rd/Anarkali 15.GPO 16.Lakshmi Chowk 17.Railway Station 18. Sultanpura 19. UET 20. Baghbanpura 21. Shalamar Garden 22. Pakistan Mint 23. Mahmood Booti 24. Salamat pura 25. Islam Park 26. Dera Gujran
5	OLMT EXIT Station 1.Ali Town 2.Thokar Niaz Baig 3.Canal View 4. Hanjarwal 5.Wahdat Road 6. Awan Town 7. Sabzazar 8. Shahnoor 9.Salahudin Road 10.Bund Road 11.Samanabad 12.Gulshan-e-Ravi 13.Chauburgi 14.Lake Rd/Anarkali 15.GPO 16.Lakshmi Chowk 17.Railway Station 18. Sultanpura 19. UET 20. Baghbanpura 21. Shalamar Garden 22. Pakistan Mint 23. Mahmood Booti 24. Salamat pura 25. Islam Park 26. Dera Gujran
6	Respondent Age: ……..
7	Residential area: ……..
8	No. of dependents in household: ……..
9	No. of income earners in household: ……..
10	Gender: 1. Male 2. Female 3. Transgender
11 12	Employment Status and Occupation 1. Employed 2. Self Employed 3. Unemployed 4. Student If employed/self-employed then write the occupation ……
13	Are you a person with disability? Yes No
14	What is your education? Uneducated Primary Secondary Matric Intermediate Undergraduate Post-Graduate Diploma
15	What is your monthly income? Below 20,000 Rs . 20,000 Rs - 29,999 Rs 30,000 Rs - 39,999 Rs 40,000 Rs - 49,999 Rs 50,000 Rs - 59,999 Rs Above 60,000 Rs
16	How many years you have lived in Lahore? Less than 1 year 1- 5 years 6 - 10 years 4. 11 - 15 years 16 - 20 years 21 - 25 years 26 - 30 years 8. More than 30 years Always

17	Select your age group 20 years and less 21 -30 years 31-40 years 41-50 years 51-60 years 61 years and above
18	Approximate number of motorized trips you take in one day (Total including all transportation mode and destinations): ……
19	Approximate expense of travelling per day (if public transport is taken): …… Rs
20	Approximate expense of travelling per day (if private transport is taken): …… Rs
21	Approximately how much of your income is spent on monthly travelling? No expenses Small expenses Moderate expenses Large expenses
22	Are you satisfied with transportation system of Lahore? Yes No To some extent
23	Does Lahore transportation system restrict your life? (e.g., traffic congestion, discomfort, time cost, inability to reach destinations etc) Yes No Sometimes
24	Are transport options in Lahore adequate? (i.e., you have easy access to reach your destinations) Yes No To some extent
25	How often do you use public transport against personal transport in week? (1) (2) (3) (4) (5) (6) times or more never
26	How often do you use OLMT in day? (1) (2) (3) (4) More than 4 (Other)……..
27	How many days in a week you use OLMT? (1) (2) (3) (4) (5) (6) (7)
28	Since how long you have been using OLMT? Since opening More than 6 months 4 to 6 months 2 to 3 months Less than 1 month
29	Do you use OLMT to reach the following destinations? workplace/office school/college Both none
30	Do you use OLMT to reach local services (hospitals/community/library etc)? Always Occasionally Never
31	Do you use OLMT for the following activities? Shopping Recreational activities (parks/family visit etc) Both none
32	Do you own a personal vehicle? No vehicle Cycle Bike Car
33	Does your household own a vehicle? No vehicle Cycle Bike Car
34	Would you prefer (or wish to prefer) your personal vehicle over OLMT for convenience? Yes No May be
35	Would you prefer (or wish to prefer) your personal vehicle over OLMT for affordability? Yes No May be
36	What was your alternative mode of travelling before OLMT? Personal Public Bus/Van/Metro Private Taxi/Uber/Careem/Swvl etc Rickshaw Carpool/Lift

37	**How do you reach OLMT?** Walk by cycle/bike by car by bus/van by rickshaw by taxi
38	Do you directly reach your destination from OLMT station? Yes No but can walk to my destination No and use additional transport to reach destination
39	Is there availability of bike stand/Parking lot near your OLMT Station? No Bike Stand (Yes) Parking lot (Yes) Both (Yes) Both (Limited)
40	How much time it takes to reach OLMT station? Less than 5 minutes 5-10 minutes 10-15 minutes 15-20 minutes More than 20 minutes Other ……
41	Distance of OLMT from your home 0.5 km 1 km 1.5 km 2 Km More than 2km
42	Distance of OLMT from your destination 0.5 km 1 km 1.5 km 2 Km More than 2km
43	I will support the policy if government provides feeder buses (connectivity) to my OLMT Stations Yes No May be Connectivity is available
44	How much will be the increase in your travelling cost if feeder buses are provided to connect with OLMT stations? less than the alternative mode of travelling Greater than the alternative mode of travelling
45	Do you think provision of feeder buses will increase/or decrease your travelling time as compared to alternative mode of travelling? Increase time Decrease time No change
46	I am willing to pay additional cost of feeder buses to connect OLMT, if provided Yes No May be
47	If a public service for pick and drop is provided to commute between your residence and destination, then how much the highest you would pay? ……
48	Has OLMT reduced your traveling distance? **No change** **Reduced Slightly** **Reduced Largely** **Increased** **Don't know**
49	Has OLMT reduced your travelling time? No change Reduced Slightly Reduced Largely Increased Don't know
50	Has OLMT reduced your travelling cost? No change Reduced Slightly Reduced Largely Increased Don't know
51	Is OLMT cheaper than other transport modes? Yes No Sometimes Don't know
52	What was your daily cost of travelling before using OLMT? 40Rs or less 40 - 70Rs 70 - 100Rs 100 – 150 Rs 150 - 200Rs Above 200Rs
53	Will you use OLMT if fare/ ticket charges are increased slightly?
	yes no

	If YES why? ……
54	Is it comfortable to use OMLT compared to alternatives? Yes No
55	Before using OLMT you had to face large traffic congestion on roads? Always Sometimes No
56	Is OLMT a safer means of traveling as compared to alternatives modes? Yes No To some extend
57	The travel information (time/routes/fee/ticketing etc) available is easy to understand Yes No No and should be available.
58	Is it easy to get to the places with OLMT use? Always Sometimes No
59	Do you prefer using OLMT over other modes of public transport? Yes No Indifferent
60	Does your friends/family use OLMT? Yes No don't know If yes/no, provide reason: ……
61	Your companion passengers on OLMT are of same socio-economic status as yours? Always Sometimes No
62	Your companion passengers on OLMT belong to which socio-economic status? mostly lower income status mostly middle-income status mostly high-income status Mixed
63	What change has occurred in your socio-economic status after travelling by OLMT? No change Improved Deprived
64	Will you continue to use OLMT in future? May be Yes No
65	Will you continue to use OLMT in future if ticket price increases by 10 Rs? May be Yes No
66	Will you continue to use OLMT in future if ticket price increases by 20 Rs? May be Yes No
67	Will you continue to use OLMT in future if ticket price increases by 30 Rs? May be Yes No
68	Would you recommend others to use OLMT? May be Yes No
69	Do you think that OLMT will play an important role in reducing urban congestion on roads in future? May be Yes No

APPENDIX B: Questionnaire for Public Transport Passengers but Non-Users/Ex-Users of OLMT

1	What is your current mode of traveling? 1. Car 2. Motor Bike 3. Van 4. Rickshaw 5. Both Car and Bike 6. Van and Rickshaw 7. All of the above
2	Which OLMT station is nearest to your residence? 1.Ali Town 2.Thokar Niaz Baig 3.Canal View 4. Hanjarwal 5.Wahdat Road 6. Awan Town 7. Sabzazar 8. Shahnoor 9.Salahudin Road 10.Bund Road 11.Samanabad 12.Gulshan-e-Ravi 13.Chauburgi 14.Lake Rd/Anarkali 15.GPO 16.Lakshmi Chowk 17.Railway Station 18. Sultanpura 19. UET 20. Baghbanpura 21. Shalamar Garden 22. Pakistan Mint 23. Mahmood Booti 24. Salamat pura 25. Islam Park 26. Dera Gujran
3	Mention Distance 1. 0.5 km 2. 1 km 3. 1.5 km 4. 2 Km 5. More than 2km
4	Which OLMT station is nearest to your destination? 1.Ali Town 2.Thokar Niaz Baig 3.Canal View 4. Hanjarwal 5.Wahdat Road 6. Awan Town 7. Sabzazar 8. Shahnoor 9.Salahudin Road 10.Bund Road 11.Samanabad 12.Gulshan-e-Ravi 13.Chauburgi 14.Lake Rd/Anarkali 15.GPO 16.Lakshmi Chowk 17.Railway Station 18. Sultanpura 19. UET 20. Baghbanpura 21. Shalamar Garden 22. Pakistan Mint 23. Mahmood Booti 24. Salamat pura 25. Islam Park 26. Dera Gujran
5	Mention Distance
	1. 0.5 km | 2. 1 km | 3. 1.5 km | 4. 2 Km | 5. More than 2km
6	Respondent Age:
7	Residential area:
8	No. of dependents in household:
9	No. of income earners in household:
10	Gender: 1. Male 2. Female 3. Transgender
11	Employment Status and Occupation 1. Employed 2. Self Employed 3. Unemployed 4. Student
12	If employed/self-employed then write the occupation ……
13	Are you a person with disability? Yes No
14	What is your education? Uneducated Primary Secondary Matric Intermediate Undergraduate Post-Graduate Diploma
15	What is your monthly income? Below 20,000 Rs 20,000 Rs to 29,999 Rs 30,000 Rs to 39,999 Rs 40,000 Rs to 49,999 Rs 50,000 Rs to 59,999 Rs 6. Above 60,000 Rs

16	How many years you have lived in Lahore? Less than 1 year 1- 5 years 6 - 10 years 11 - 15 years 16 - 20 years 21 - 25 years 26 - 30 years More than 30 years Always
17	**Select your age group** 20 years and less 2. 21 -30 years 31-40 years 41-50 years 51-60 years . 61 years and above
18	Approximate number of motorized trips you take in one day (Total including all transportation mode and destinations): _____
19	Approximate expense of travelling per day (if public transport is taken): …… Rs
20	Approximate expense of travelling per day (if private transport is taken): …… Rs
21	Approximately how much of your income is spent on monthly travelling? No expenses Small expenses Moderate expenses Large expenses
22	Are you satisfied with transportation system of Lahore? Yes No To some extent
23	Does Lahore transportation system restrict your life? (e.g. traffic congestion, discomfort, time cost, inability to reach destinations etc) Yes No Sometimes
24	Are transport options in Lahore adequate? (i.e. you have easy access to reach your destinations) Yes No To some extent
25	How often do you use public transport against personal transport in a week? (1) (2) (3) (4) (5) (6) times or more Never
26	Have you travelled by Lahore OLMT? Yes No If Yes then what was the purpose of using OLMT? 26a) To reach: 1. workplace/office 2. school/college 3. Both 4. None 26b) To reach: 1. Community Service 2. Shopping 3. Recreation all of them 5. None If YES what was your experience about OLMT usage? 26c) Time consuming: 1. Yes 2. No 26d) Costly: 1. Yes 2. No 26e) Is OLMT near your residence? 1. Yes 2. No 26f) Is OLMT near your destination? 1. Yes 2. No 26g) It is not convient to reach OLMT 1. Yes 2. No
	If NO the why you do not used OLMT frequently? 26h) Time consuming: 1. Yes 2. No 26i) Costly: 1. Yes 2. No 26j) Is OLMT near your residence? 1. Yes 2. No 26k) Is OLMT near your destination? 1. Yes 2. No 26l) It is not convient to reach OLMT station 1. Yes 2. No
27	Do you own a personal vehicle? No vehicle Cycle Bike Car
28	Does your household own a vehicle? No vehicle Cycle Bike Car
29	Do you directly reach your destination using the current transport mode? Yes No but can walk to my destination No and use additional transport to reach destination

30	How much time it takes to wait or access this current mode of public transport? Less than 5 minutes 5-10 minutes 10-15 minutes 15-20 minutes More than 20 minutes
31	Distance of your current public transport from your home 0.5 km 1 km 1.5 km 2 Km More than 2km
32	Distance of your current public transport from destination 0.5 km 1 km 1.5 km 2 Km More than 2km
33	I will support the policy if government provides feeder buses (connectivity) to OLMT Stations from my home/destinations Yes No May be Connectivity is available
34	How much will be the increase in your travelling cost if feeder buses are provided to connect with OLMT stations? less than the alternative mode of travelling Greater than the alternative mode of travelling
	Do you think provision of feeder buses will increase/or decrease your travelling time as compared to alternative mode of travelling? **Increase time Decrease time No change**
36	I am willing to pay additional cost of feeder buses to connect OLMT, if provided Yes No May be
37	If a public service for pick and drop is provided to commute between your residence and destination, then how much the highest you would pay? ……
38	What is your daily cost of travelling? 40Rs or less 40 - 70Rs 70 - 100Rs 100 – 150 Rs 150 - 200Rs Above 200Rs
39	Is it comfortable to use the current public transport mode as compared to OLMT? Yes No No difference
40	Do you face large traffic congestion on roads? Always Sometimes No
41	Is your current transport mode safer means of traveling? Yes No To some extent
42	Do you have awareness and complete information about Lahore transport network? Yes No No and should be available.
43	Is it easy to get to the places by using the public transport of Lahore? Always Sometimes No
44	Do you prefer using the current public transport over OLMT? Yes No Indifferent Provide reason……..
45	Does your friends/family use OLMT? Yes No don't know If yes/no, provide reason: ……
46	Do you think that OLMT will play an important role in reducing urban congestion on roads in future? May be Yes No

Appendix C: Supplementary Tables

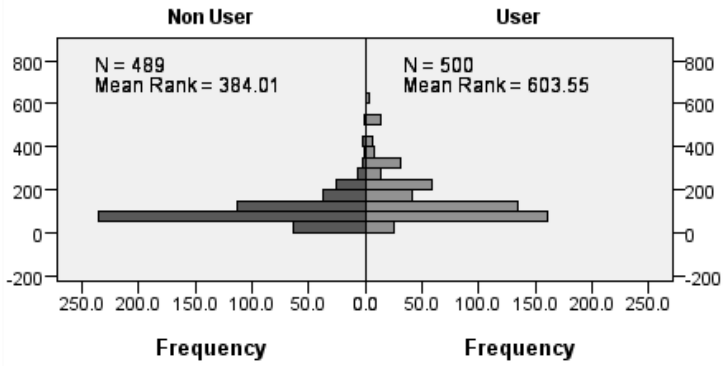
Table 6: Shapiro-Wilk Normality Test

Variable	Total Sample	User	Non-user
Daily travel expenses using public transport	(0.000)	(0.000)	(0.000)
Daily travel expenses using private transport	(0.000)	(0.000)	(0.000)
Willingness to pay for public service pick and drop service	(0.000)	(0.000)	(0.000)

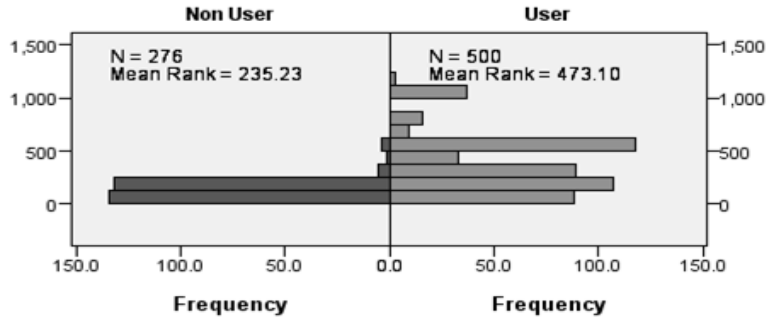
Note: The significant p-values provided in ( ) indicates the rejection of null hypothesis of normal distribution.

Figure 15: Independent Mann-Whitney Test

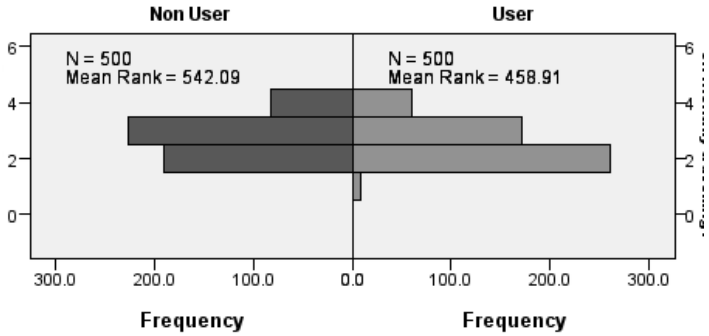
a) Rank distribution for daily travel expenses using public transport



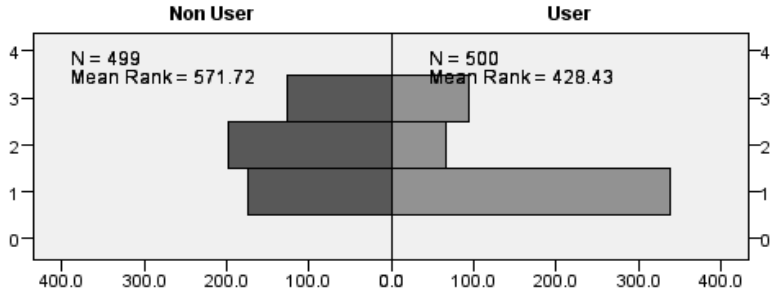
b) Rank distribution for daily travel expenses using private transport



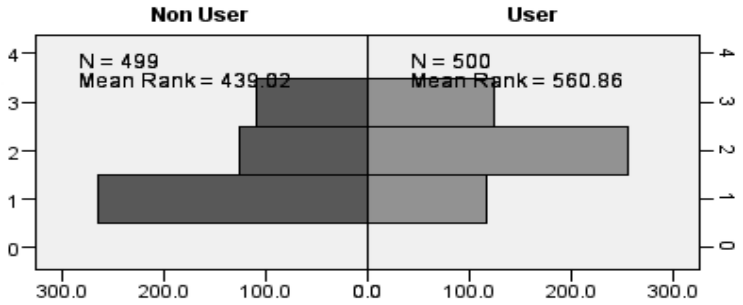
c) Independent Mann-Whitney Test: Rank distribution for daily travel burden



d) Rank distribution for satisfaction from Lahore transportation system



e) Rank distribution regarding travel restriction and discomfort



f) Rank distribution regarding adequacy of transport options