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Impact of the Orange Line Metro Train (OLMT) on Social Aspects

Umer Mustafa [1], Habib Ullah [2] Muhammad Zeshan Ashraf [3], Muhammad Baqi Billah [4]

[1] Ph.D. Scholar, Department of Urban Planning, School of Architecture, Southeast University, Nanjing 211189, China. Email: umermustafa084@gmail.com
[2] Lecturer, Department of Architecture, University of Engineering and Technology Peshawar (Abbottabad Campus), Pakistan. Email: habibullah@uetpeshawar.edu.pk
[3] Assistant Professor/Coordinator, M. Arch Program, Department of Architecture, University College of Art and Design, University of the Punjab, Allama Iqbal Campus, Lahore, Pakistan. Email: zeshan.cad@pu.edu.pk
[4] Ph.D. Scholar, Department of Construction Management, School of Civil Engineering, Southeast University, Nanjing 211189, China. Email: baqibillah60@gmail.com

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ABSTRACT

This study Humanize the following text while keeping the original meaning, tone, and length. provides an insight into the social and environmental effects of large-scale infrastructure projects on urban areas; specifically, it assesses the impact of sustainable urban mobility and transit-oriented development (TOD). Rapidly expanding cities like Lahore require new strategies to reduce traffic congestion and pollution and improve the quality of life for their inhabitants. One of the most significant urban transportation projects in Pakistan is the Orange Line Metro Train (OLMT), created as part of the China-Pakistan Economic Corridor (CPEC). To evaluate the impact of the OLMT on social welfare, environment and travel behavior, this research collected data through survey questionnaires, field observations, and land use analysis. The effectiveness of OLMT on commuters is assessed in terms of disabled-friendly infrastructure, reduction in time and monetary costs, and future amenity value. However, the project also posed some disruptions and inconveniences to neighboring districts during the construction phase. This research aims to inform decision-making by offering evidence-based strategies to enhance social welfare and mitigate negative impacts of urban transportation projects in Pakistan. Overall, the findings of the study highlight the importance of integrating transportation planning with land-use policies and provide recommendations for adopting innovative urban transportation planning paradigm for sustainable urban development.

Corresponding Author's Email: zeshan.cad@pu.edu.pk

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1. Introduction

Public transport systems have been created to specifically help facilitate growth of our cities as humans continue to migrate from the suburbs into the city (Ogryzek, Adamska-Kmieć, & Klimach, 2020).. Maintain that these systems can be a means of alleviating urban traffic congestion and pollution and that they can assist in mobilizing low-income populations and improve social inclusion. Cities like New York City and Mexico City have heavily invested in systems like these, and it has paid off in population figures. New York's subway system, for example, has a ridership of 4.5 million people in an average day. These systems take many forms, but they all serve the same purpose, namely to generate commerce and create smoother ways for the population of the city to go about their daily lives. We need these systems to keep our cities flowing, and we also need them to advance our society (Ullah et al., 2024). Transit-Oriented Development or TOD is a strategy for planning cities. It combines transportation systems with land use (Suzuki, Cervero, & Iuchi, 2013).

TOD aims to create mixed-use areas around transit stations. This approach helps people access places easily and encourages walking and cycling. It also reduces the need for cars. Lahore Pakistan's largest city has grown rapidly. More people are moving in. Transportation demand is increasing. Pakistan looks to China for ideas with the China-Pakistan Economic Corridor. Many agreements have been made between governments and private companies. (Ullah, Zhang, & Iftikhar, 2024). To solve Lahore's transportation problems the Government of Punjab launched the Orange Line Metro Train project. This project is part of the Lahore Rapid Mass Transit System and the China-Pakistan Economic Corridor. (Rana & Bhatti, 2018). The Orange Line Metro Train is meant to provide reliable and affordable transportation. Although the project offers significant transportation benefits, large infrastructure developments often generate social and environmental impacts on surrounding communities (Khan, Jamil, & Malik). Construction activities may disrupt public utilities, alter traffic patterns, and affect local environmental conditions. It will help thousands of commuters. Improve city mobility. However big infrastructure projects like this can have social and environmental effects, on nearby communities. Construction can disrupt services change traffic patterns and harm the environment. So, it's crucial to study the impacts of the Orange Line Metro Train project. This study looks at the impacts of the project. It also evaluates how the Orange Line Metro Train supports urban development in Lahore (Shahid et al., 2020) .

1.1. Problem Statement

In growing cities, rapid urban growth frequently leads to conflicts between environmental sustainability and infrastructure development. Due to massive infrastructural developments and fast population increases, Lahore, which was formerly renowned for its gardens and green areas, has undergone substantial urban change. Although mass transit systems like the Orange Line Metro Train are intended to enhance urban mobility and lessen traffic congestion, their development and operation may harm the environment and society. Large traffic corridors can affect the aesthetic qualities, green spaces, and land use patterns of nearby metropolitan areas. In view of these issues, it is essential to closely scrutinize the expansion of transportation infrastructure and the larger costs associated with it. These transportation impacts may be on public utilities, drainage systems, and transportation network. Additionally, the impacts may be directly felt in the environment and in sensitive habitat, thus affecting the sustainability of a region. New technology systems such as real-time information, intelligent mobility, and as well as other integrated approaches have helped create dynamic planners developed with the technology (Mustafa et al., 2025). In this context, this study determines the effect of the OLMT on the surrounding environment, and its potential disturbance to the adjacent communities located in it.

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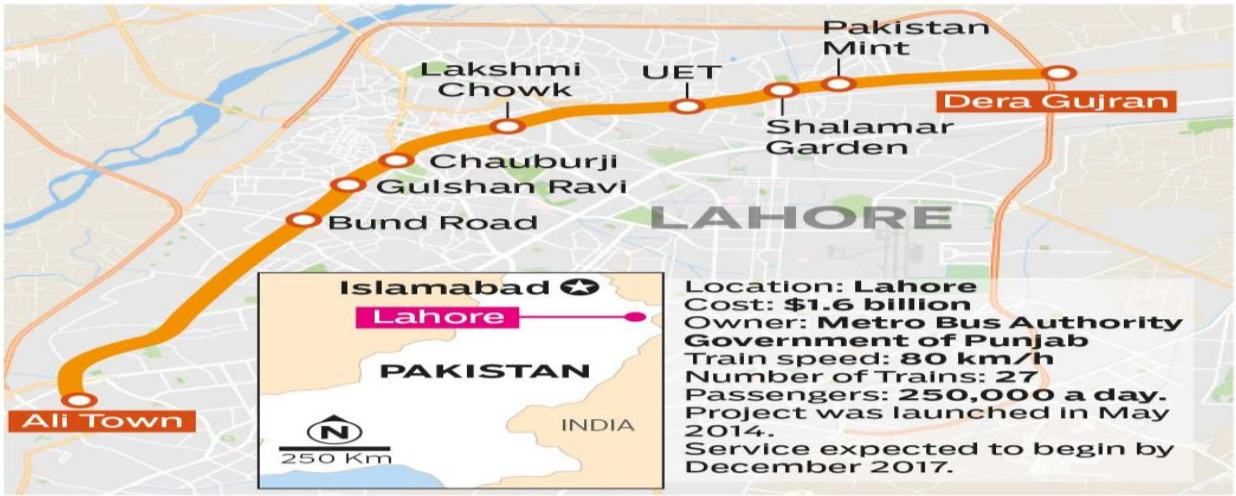
2. Literature Review

The experience of international metro systems provides useful insights for evaluating the Orange Line Metro Train (OLMT) in Lahore. By examining global examples of TOD and metro development, this research situates the OLMT project within broader academic discussions on sustainable urban mobility and the social impacts of large transportation infrastructure projects. In the last 50 years, most cities in the world have experienced rapid growth and urbanization. With increased populations, urban sprawl has been the consequence. Transit-Oriented Development or TOD is a phrase used often in urban planning. But there is not one definition of it that everyone agrees on. Many see TOD as compact, mixed use development around transit stations. The goal of this is to reduce dependency on cars and make getting around more convenient, especially in sub-urban and urban areas. Still, some researchers think of TOD as more than that. They see it as an effort to integrate land use planning with transportation systems, be it metro rails, bus rapid transit, or regional rail networks (Cervero & Murakami, 2009). Research has shown that many benefits can result from population and employment density, as well as location near transit stations and intermodal transfer facilities (Newman & Kenworthy, 2013). People living near public transportation systems like metro rails tend to use their cars less and have a better environmentally friendly lifestyle. Good public transportation is linked to less traffic con-gestion, lower greenhouse gas emissions and, better public health (Litman, 2012). Walkable neighbor-hoods that are close to transit stations must use the neighborhood more. These conditions generate a greater sense of community and well-being are suitable for cities that are growing quickly. Because of their capacity, reliability and lower environmental impact metro systems are key to sustainable urban transportation. The experience of metro systems worldwide can help us understand the Orange Line Metro Train in Lahore. By looking at examples of TOD and metro development this research places the OLMT project in a broader discussion, on sustainable urban mobility and the social impacts of big transportation projects (Still, 2002).

Figure 1: Proposed Route of OLMT



2.1. Omnibus use in France (International Studies)

The big bus used in France in 1828 let 25 or 50 people ride on city streets. Private traders wanted to use the city's streets. In 1832 this idea started in New York City to make it easier to stop trains built by road operators for people who commute. In 1873 a cable car, a train pulled a cable from a steam-powered station to go up steep hills in San Francisco. The idea spread to Chicago and other cities to avoid problems caused by horses in urban areas. Buses on rails, cable cars and eventually steam and electric trains mostly used fixed tracks. Building more tracks was a significant and long-term investment. The need for transportation

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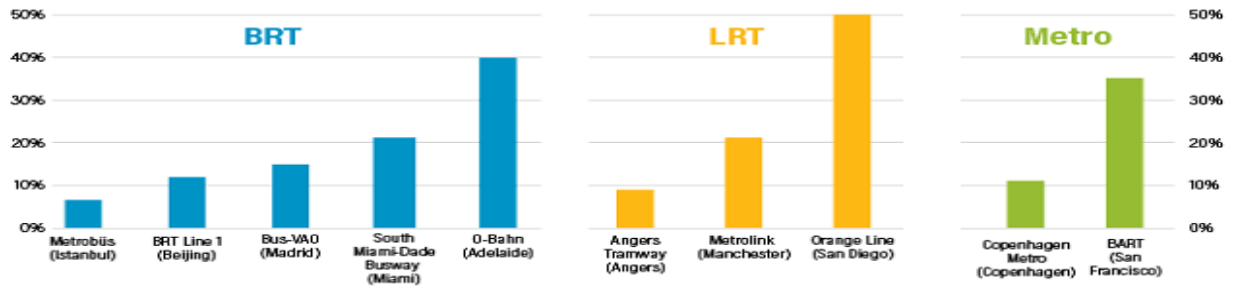
was high. The rail-based system was reliable because it had friction, which allowed many trains to run on the same track where there was a high demand, for travel. The trains could carry passengers because many trains could run on the same track every day and there was no need to hire more staff. A motorman or technologist could drive a train with cars with the help of one or two drivers. In the mid-1800s cities started using steam engines to power big transport systems. These engines could pull cars and move fast. Steam engines could go distances than cable cars and they were stronger and faster because they didn't rely on just one weak cable. Starting in Berlin in 1879 power plants began switching to steam. This steam was clean and quiet. A tunnel was needed to build rail lines under roads and buildings in cities. The tunnel helped build rail lines that didn't damage existing buildings. It also made it easy to move people through city streets where animals lived. The streets were filled with trucks, people on foot and carts. For big transportation systems to succeed it was crucial to find the route. The route had to be different from transportation and activities in the city. Special vehicles for rail transport didn't have delays and dangers, like mixed-traffic vehicles did. They provided more reliable transportation. The rise of cars made rail transports strategic advantage more important (Nawaz et al., 2019).

2.2. Social issues

Social issues are about how development projects affect the structure of communities and the wellbeing of residents.(Parsons, Everingham, & Kemp, 2019). These changes can include things like how it takes to get to work how much money people spend on transportation how easy it is to get to public services how people move around their community and the overall quality of city life. The development of metro systems usually makes it easier for people who live in cities to get around by providing more reliable transportation. When people can get where they need to go quickly and easily it can help them find better jobs get a good education and go to the doctor when they need to. When they are building these big projects, it can be a real hassle for a while. There can be a lot of traffic, noise and problems with things, like electricity, gas, water and phone service (Shahid et al., 2020). The social impacts are closely connected with the environmental impacts. The construction work can impact the ecosystems, public spaces, and neighborhood environments and influence the lifestyle of the people living in the designated areas. For these reasons, longer-term or bigger infrastructure projects require detailed Environmental Impact Assessments and Social Impact Assessments before construction work commences. For instance, these assessments identify potential risks and recommend ways to mitigate the impacts of construction work on the surrounding communities (Ahmed et al., 2023). In the case of the Orange Line Metro Train, in Lahore it is important to see how the project has affected the people living there in terms of getting and using the infrastructure and the environmental conditions. Understanding the impacts of the Orange Line Metro Train helps the people who make policies and the planners make better transportation projects in the future. This way the infrastructure development can help the cities grow in a way(Ragmoun, 2024a, 2024b; Ragmoun & Alfalih, 2024).

Figure 2: Percentage of TRPUA



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2.3. The benefits of public transportation

Public transportation systems are important for making cities easier to get and for reducing the number of private vehicles on the road. In a lot of cities that are growing fast more and more people are buying cars, which is causing traffic jams polluting the air and wasting land. If we have public transportation systems, like metro trains we can solve some of these problems (Litman, 2015). One of the things about public transportation is that it helps people get around without having to spend a lot of money. For people older people and people with disabilities it can be hard to afford a car. Public transportation gives these people a way to get where they need to go that is reliable. Does not cost too much. This means that public transportation helps people get to work go to school see a doctor and do fun things with their friends. Public transportation systems play a role, in this.

Public transportation is good at using resources because it lets a lot of people travel at the same time on one system. Metro rail systems are especially good at carrying a lot of passengers compared to cars. One metro train can take hundreds of people at once which means we need cars on the road. This helps reduce traffic jams, the amount of energy we use and the bad things we release into the air in cities. Furthermore, public transportation systems that are well planned help make cities better places to live in a way that's good for the environment. They do this by making sure people live close together and by supporting development that is focused on transportation. When cities plan their transportation systems and urban planning together they can make neighborhoods that're nice to walk in and make it easier for people to get around the city. Public transportation systems like these are very important for cities. They help with sustainable urban development and public transportation is a key part of this as researchers, like Nawaz and others have found out (Nawaz et al., 2019).

Figure 3: Different views of OLMT

2.4. Background

With more than 11 million inhabitants, Lahore, the provincial capital of Punjab, is the second most populated city in Pakistan (Javed & Riaz, 2019). Rapid urbanization and population growth have greatly increased limited space and transportation needs and consequently turn Lahore into a city of traffic jams, pollution, and mobility issues (Pucher et al., 2007). To solve this issue and to make urban mobility sustainable, the Punjab government has taken many initiatives such as LAD-I "Lahore Access Development Project," (Khan, Jamil, & Malik). Which aims at preventing the inclusion of 278.7 km of the road network from interruption at all railroad crossings and CAA "Construction of Alternate Accommodations" which aims to ease the construction process through identifying and relocating all

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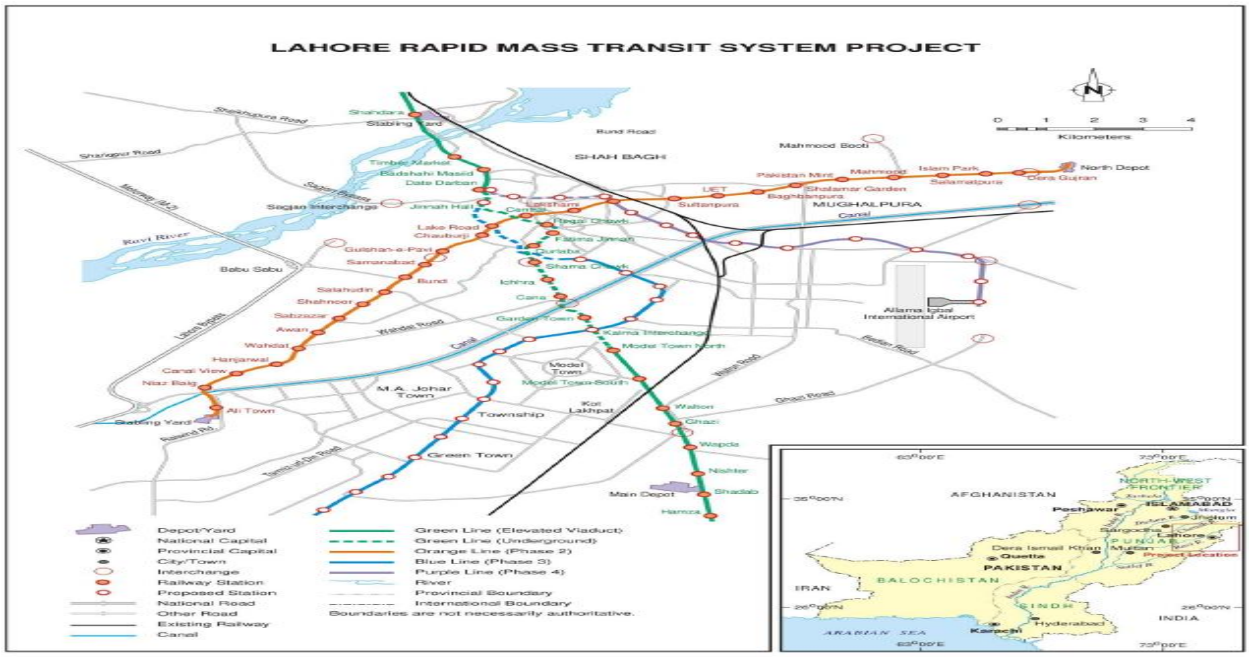
transportation, people, and utilities. The Punjab government has recently launched several major projects for the development of transport infrastructure. They have included the construction of an elevated light rail line called the Orange Line Metro Train (OLMT), part of the Lahore Rapid Mass Transit System, under the China–Pakistan Economic Corridor (CPEC) (Khan, Jamil, & Malik). The project is regarded as one of the largest investments in Pakistan, and the Ministry of Planning, Development and Reform is keen to include the concern of urban amenity, transport affordability, and safety and security for passengers. The Orange Line is a 27.1 km-long corridor from Ali Town in the east to Dera Gujran in the west, passing through many densely populated areas of Lahore. Authorities intend to provide the train with a daily capacity of 250,000 passengers (Khan, Jamil, & Malik). Construction on the rail officially began in 2015 after the Punjab government and Chinese partners signed the project agreement in May of 2014. This article will describe the project by considering its history, purpose, social and environmental considerations, funding, and concerns about whether the project will fulfill the plan.

Figure 4: Lahore rapid mass transit system master plan



2.5. Mass transit project System Lahore

The government of Punjab launched numerous mass transit initiatives to improve urban mobility in Lahore after the successful implementation of the Lahore Metro Bus system (Anwar, Leng, & Ahmad, 2024). The Orange Line Metro Train, which has a maximum speed of 60 km/h (37 mph), is one of these projects and is a component of the much larger Lahore Rapid Mass Transit System. To improve transportation in the city, the trains run on structure outdoor rails along 25.4 kilometers of the track (Idrees & Sarwar, 2022), and are designed to replace the outdated public transportation system. This project's primary goal is to lessen traffic congestion and dependence on private vehicles by providing cheap, safe, and effective public transportation. Under the framework of the China Pakistan Economic Corridor (CPEC), the Punjab government and Chinese partners jointly financed and built the project. The main goal of the project is to extent urban and economic development in Lahore, Pakistan. The route also passes through some of Lahore's most important urban corridors through Multan Road, Mc Leod Road, and Allama Iqbal Road. The new system is made up of 26 stations along this corridor with 2 underground stations at Anarkali and Central Stations and 24 elevated stations. The Lahore Rapid Mass Transit System will benefit thousands of people each day

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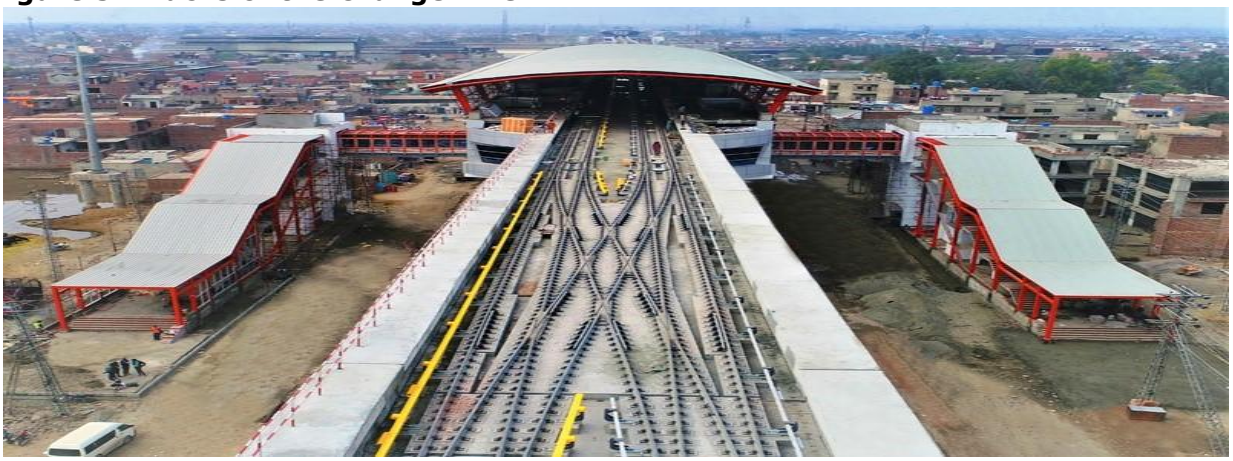
with safe, comfortable, and effective transit services which promote sustainable urban development.

2.5.1. Tracks of OLMT

The track system of the OLMT is made up of a pair of railway lines running parallel to each other, thereby enabling train travel in both directions. The length of this corridor, which includes the width of the rail tracks, is roughly 51.16 kilometers, since one kilometer of track each is dedicated to the two directions of travel. The construction of this modern railway infrastructure included the choice of suitable materials. Along with the assistance of China, the track engineering was completed utilizing railways engineering techniques following the international rail standards. Owing to the use of jointless track circuits and continuous welded rails, the OLMT system ensures optimal ride quality, decreased noise and vibration, and greater efficiency and operational safety in the operation of rolling stock. Also, for the main running tracks, the Rails (60 kg/m) will be used with concrete sleepers to guarantee higher rail life, higher load capacity, and a performance bearing. On the other hand, the interconnection tracks of the depots remain to be regarded as a means of parking and carrying out maintenance on the trains (François et al., 2024).

Figure 5: Tracks of the Orange Line



2.5.2. Architectural design station

The architectural design of the stations of the Orange Line Metro Train (OLMT) was created in accordance with global standards and guidelines for infrastructure related to public transportation. The design was centered on the functional efficiency of the stations as well as the safety of passengers. In addition, the stations were designed for easy integration into the surrounding urban environment. M/s CR-NORINCO Joint Venture provided technical assistance and construction support for the project. The OLMT system comprises 24 elevated stations at various heights at each end and a two-station underground section. The railways are separated at grade from the surrounding roads to safely accommodate a high volume of both pedestrian and vehicular traffic. The railway lines were separated at grade from the surrounding roads and designed to accommodate high volumes of pedestrian and vehicular traffic. The stations were designed with the expectation of high passenger flow and the infrastructure was carefully organized to facilitate ease of movement. The 22 buildings designed for the stations were also concerned with functional, structural, aesthetic, and other considerations such as the flow of passengers and arrangements for ticketing and other station amenities (Agustiyara et al., 2025).

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Figure 6: View of Anarkali Station

2.5.3. Raised stations

The stations of the OLMT line are each comprised of two-story buildings typically located either adjacent to important roadways or over them. The primary design goal in selecting a station location was providing easy access for passenger entry or exit while simultaneously limiting the disruption the stations would cause to the current urban infrastructure. For the station layout, China Railway Engineering Corporation, who had been tasked with providing the general engineering expertise to execute the construction, served as the technical help in predicting the future technical functions of the station buildings. One of the most important considerations during the design of the station buildings was the placement of the presiding technical and operational rooms within the structures such as the area near the station entrances. This compact structural layout limited the land needed to build and avoid the large-scale displacements that otherwise would have been required. This allows for maximum land use while minimizing the impact to neighboring towns (Ahmad, 2024).

2.5.4. Entry level

The entry level of the stations of OLMT is designed to facilitate the ease and security of people coming from each side of the road by allowing them to cross the road and enter the stations without getting involved in traffic. Station entrances are located on both sides of the road and connected with footbridges. Each station's entrance counter, which makes the transition from the station to the road, is 4.5 meters above the pedestrian level of the platform and allows pedestrians to walk directly from one side to the other. You can reach the station from each entrance by entering the station through the station lobby. The station lobby is a space that is about 4 meters wide and has an opening toward the pedestrian level. It has five entrances that lead to the road and a stairway that leads to the concourse one. Each of these five entrances has two stairways. They have coverings above them, which cover the stairways and provide cover for the users. The maximum width of each of these stairways is about 2 meters.

2.5.5. Concourse level

The elevated station's levels are designed to support various operational needs. The concourse level, which generally forms the first level above the ground, is located approximately +8.0 meters above the ground level. This high level provides ample oversight of station operations and passenger movement. This level encompasses the Public Unpaid Area, the Public Paid Area, and the Technical and Operational Zone. The Public Unpaid Area is that part of the station where all visitors can freely access upon escalators, elevators, and stairs, and it can also be known as the "free area" and has ticketing facilities, waiting spaces, lobby, and other facilities. Visitors who intend to travel to other stations or travel inside the

station will need to purchase tickets or validate their travel cards at the ticket counters or automated machines and then enter the Public Paid Area. The Public Paid Area is that part of the station that is located after the fare gates, where travelers are expected to have successfully purchased tickets or validated their travel cards at the fare gates and is only accessible to select travelers. Only travelers who have purchased tickets or validated their travel cards can access the platform level. It is a designated commercial zone that yields a profit for BART through retail sales and rent. The Technical and Operations Zone, the third part of the concourse, comprises control rooms, equipment spaces, and operational support sections. To optimize circulation within the station, the concourse was designed with efficient circulation in mind. The concourse layout provides a smooth flow of commuter traffic similar to the design principles discussed by (Oh et al., 2025).

2.5.6. Platform level

A second level, known as platform level, is utilized for the entry and exit of passengers who are boarding and disembarking from a train. This level is approximately 14.2 meters above the surface, level of the road. This level, hereafter the platform level, contains Automated Platform Gates (APG) that prevent the falling of passengers onto the tracks when not in use. The gates open when a train is correctly aligned with the platform and passengers can use the gates to approach or leave the train. Vertical movement is achieved using elevators, stairwells, and escalators. The stairwells and escalators connect the platform and concourses; the escalators that connect the two levels are mainly used to move passengers upward, allowing them to switch to the other level while the stairwells move passengers downward to allow them to leave the system. The elevator shafts, which are centrally located, are used to move disabled passengers and those who are unable to use escalators or stairs.
The underground stations are in the central district of the main urban area of Lahore. In total two underground stations are considered, which are Anarkali Station and Central Station. The underground stations are constructed below ground level to minimize visual impacts on the surrounding environment. The underground stations are appropriate for densely built up, historical and commercial areas, as this will have minimal impact on the urban fabric of the city and be less obtrusive. The design and construction of the underground stations are aimed at integrating with the surrounding architecture, high quality standards of modern functional specifications should be achieved. Design of entrances and cooling towers should be carried out with careful consideration of the urban landscape. All surface structures such as ventilation shafts, cooling towers, maintenance facilities and other operations facilities should be designed to blend with the pedestrian walkways, landscaped areas and the surrounding public amenities.

2.5.7. Under-ground stations

The OLMT system has two underground stations in the central urban area of Lahore. These are:

i. Anarkali Station
ii. Central Station

The underground stations were chosen to reduce their effect on the visual and physical environment of the surrounding urban area. In comparison with elevated stations, underground stations do not significantly impact the viewshed of the station, since these stations remain below the ground. The main reason for this is that the structures of underground stations consist of suspended platforms, which are also supported by columns that extend below the paved surface to prevent pedestrians from inconvenience. Under-ground stations are more suitable for densely built areas because they can add visual value to the established design by providing modern, state-of-the-art facilities in their surroundings. Underground stations tend to draw more attention because of the design focus provided in

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creating visual value and integrating the scenic design, while still functioning for the convenience of the waiting and commuting population.

i. Anarkali-station

Anarkali Station is one of the underground stations of the OLMT having two main underground levels supported by a centralized air conditioning system. The ground level contains the entrance and the concourse level for advertisements and ticketing purposes, while the basement contains the platform. The station consists of two main entrance structures. One main entrance toward Lower Mall Road, and another structure face the public square. The public paid area is used to access services which include escalators, elevators, passes, and cut-through access to other stations and commercial activities. The remaining paid area is used for ticketing establishment and is equipped with push-button automatic ticketing machines for easy ticket purchase. The ticketing machines will be provided by the Lahore Development Authority to the OLMT project. This is also the point where ticket checks are conducted. The non-paid area is used for access to the platforms. The platform has bay-type platform area with 2 tracks for trains. There are two tracks for eastbound and westbound trains. The platform is equipped with escalators and elevators for comfortable access. Rotary ticketing booths will be utilized in the station for efficient handling of passenger flow.

Figure 7: Main Entrance of Anarkali Station

ii. Central-station

The second underground station of the Orange Line Metro Train (OLMT) system is the Central Station. The station is well designed for passenger circulation and access through multiple entry points. Four public entrances are provided, with staircases and escalators. Another two elevators are providing easily accessible routes through the station, providing for not only the visually impaired, but also the elderly and persons with a mobility limitation, and one exit from the station. The platform level was placed in the basement and includes the boarding platform where these trains stop, and these platform levels include well-marked, smooth platforms to ensure safety and efficiency of passenger movement. Besides the passenger areas, the other station rooms, including technical rooms, operations rooms, maintenance rooms, ventilation, pipes, and electrical systems, are in the platform levels. There are separate public paid areas and public unpaid areas in the stations, and access to the metro stations is carefully controlled through ticketing systems. In general, however, the stations focus on the efficient movement of passengers both within the stations and between the stations and the city streets. The design emphasizes effective flow, but also maintains the role of the underground space in the stations (Shakeel & Liu, 2019).

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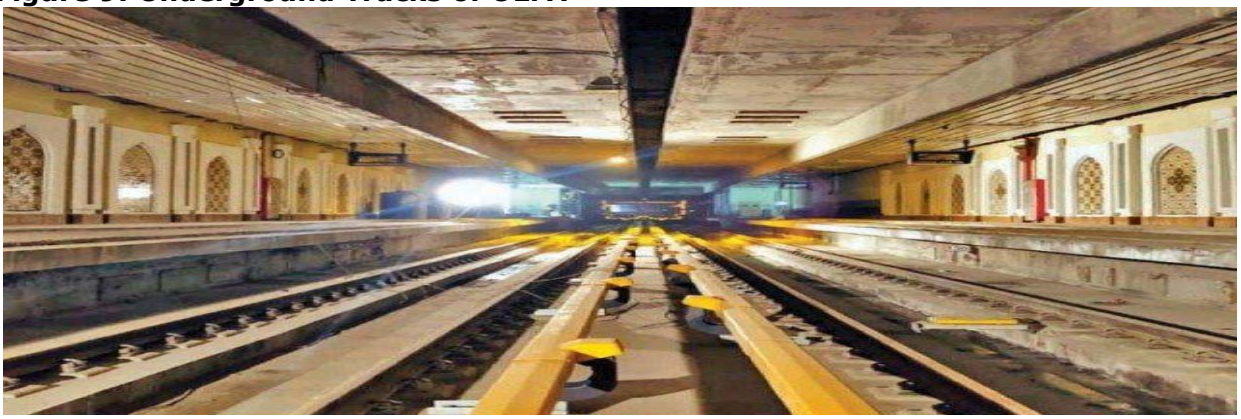
Figure 8: Underground Central Station

The underground link between the two stages at this station is an amazing feature. There are stairs that connect each tier to the next through a tunnel in the basement. This is the primary station with air conditioning. In this station, the only architectural features visible on the grade are stairs and escalators. Due to its proximity to the G.P.O., this station will share many of the same architectural details and construction methods.

Figure 9: Underground Tracks of OLMT



2.6. Way of Lahore orange line metro train project (OLMT)

The South North Corridor, a 27.1 kilometre route that begins at Ali Town Raiwind Road and ends at Dera Gujran, will continue to be the OR line of the LRMTS. The line has 26 stations, 24 of which are high stations, while two are basement stations. Focusing on your study or potentially having an influence on it is (Shahid et al., 2020).

2.7. Engagement and Types of impact

The first stage in impact preparation. The effects of study can take many different forms and apply to a variety of areas:

OLMT impacts, Travel time impacts, Environmental impacts, Public health impacts, Road safety impacts, Air quality impacts, Other OLMT impacts, Effects of public policy, Cultural impact, Political impact, Economic impact, Architectural impact

2.7.1. OLMT Impacts

The OLMT high-speed transport system will have an impact on general performance metrics as well as the quality of lifespan, strength, and security of city dwellers. Travel time,

environmental implications, and public health & safety advantages are all covered in recent study on these effects in various ways. Passenger travel times will be decreased by converting the OLMT to mixed traffic and special, distinct lanes.

2.7.2. Travel Time Impacts

Traveler embarkation and landing times will be sped up because to several high-quality OLMT systems' design components, reducing total trip times: pre-paid embarkment: tickets purchased from the OLMT off-board, often at the station's entry;

i) Many boarding doors on an OLMT with high capacity.
ii) The split way for OLMT facilities sets OLMT apart from other types of transportation.

2.7.3. Environmental Impacts

The OLMT's quick transport systems can benefit the environment by reducing the amount of local air pollutants that produce smoke and air pollution throughout the city as well as the amount of greenhouse gases (GHG) that contribute to global climate change. The number of vehicle kilometers travelled (VKT), fuel economy, and OLMT technology may all be improved to reduce vehicle emissions.

2.7.4. Public Health Impacts

Significant societal benefits of OLMT rapid transport systems include reduced personal exposure, minor traffic fatalities, and accidents. Transit service has a positive impact on safety with OLMT for each year, corridor, and length.

2.7.5. Impacts of Road Security

According to recent research, the implementation of OLMT can significantly improve traffic safety by reducing the frequency of accidents, their associated costs, and fatalities, while accidents can also lower stress levels in cities. The study of how OLMT systems affect traffic safety, however, is still in its early stages. in other impacted regions.

2.7.6. Air quality Impacts

The impact of exposure to harmful air pollutants is a combination of the contaminant's environmental attention and the duration of the exposure. OLMT systems can therefore assist travelers who switch to OLMT from other methods in two ways to reduce their personal exposure to air pollution:

OLMT automobiles awareness of background air pollution is being decreased citywide or among individual vehicles.

Lowering journey times at stations or within the OLMT to decrease the amount of exposure OLMT users have to air pollution.

2.7.7. Effects of Civil Policy

Utilizing these services results in advantages for public transit; increased usage results in more benefits. With air pollution, traffic congestion, injuries, and unsustainable land usage, crowded trains and OLMT service a smaller market share of automobiles. Increased traveler rates might make mass transit more profitable, lowering the need for subventions or simply paying all of the expenses of operating the system in some areas with extremely high densities.

2.7.8. Cultural Impact

According to a statistic from 2016, Lahore, the capital city, is home to 10,355,000 people. In addition to its illustrious past and affluent neighborhood, it has experienced a number of changes lately, like the Lahore (Ring Road), the Metro OLMT Facility, raised turns

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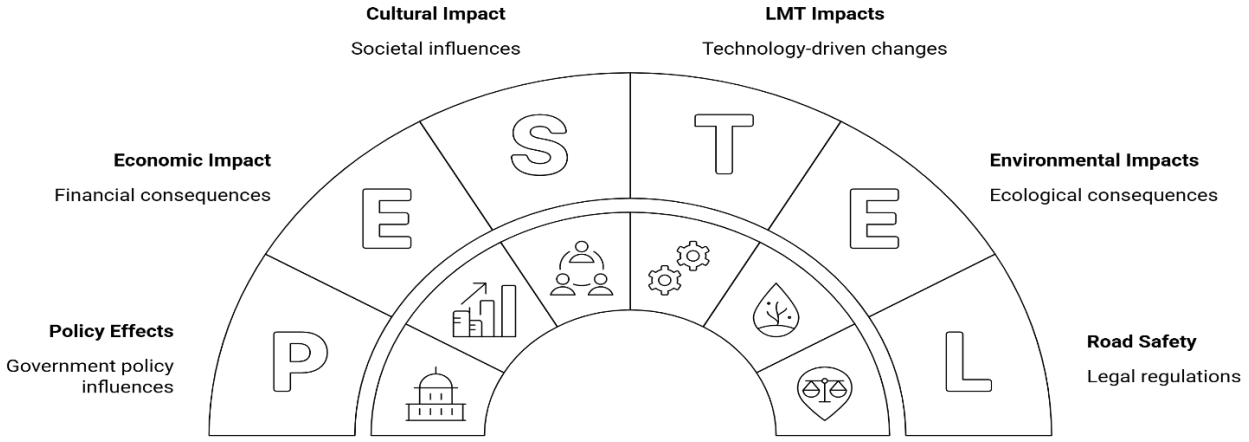
on various roads, etc. The Punjab Government has once more initiated the OLMT Project in collaboration with China in order to serve the city of Lahore's ever-growing population. By traversing Multan Road, McLeod Road, and G.T. Road across the city of Lahore, the project will encourage public transportation.

Figure 10: OLMT-structured analytical framework



2.7.9. Political Impact

In Pakistan, cultural rights are protected by many local laws. The Antiquities Act of 1997 states in Section 22 that "the Director General" or, in the case of Section 11 of The Punjab City Special Premises, "no development plan or scheme of any other new building shall be undertaken or implemented within 200 feet of the protected immovable antiquity, unless with the agreement of the General Director" or with the support of the Government or of the Group."

The project will harm 21 Colonial and Lahore Mughal heritage treasures, including Fort and Shalimar, according to the Acting Director General, who rejected the Orange Line Metro Project's No Objection Certification (NOC).

2.7.10. Economic Impact

Shahbaz Sharif previously referred to the Orange Line as a "gift" from China to the Punjab. China did provide 150 billion rupees of the initial 165-billion-rupee expenditure. But since it was a loan rather than a contribution, extra finance was ultimately required because the project's estimated cost would rise to Rs. 271 billion. In this regard, the entire health budget for the federal and provincial governments in 2015–2016 was Rs. 225 billion.

2.7.11. Architectural Impact

The architectural impact of the project was reviewed by the Punjab government in June 2015. Apart from the acquisition of land and its effect on the city's architectural tradition, there was no discussion about the lives and lifestyles of its people. Based on this assessment, the Lahore Development Authority in August 2015 identified roads, buildings and other structures for demolition. He was accompanied through officers. Gas and energy services were cut off in many countries to evict people from their homes. These tactics resulted in intermittent, small demonstrations. Between August 2015 and January 2016, there will be more than 100 protests in the area around the Wave River alone. The September 2015 protests were also attended by a coalition of civil society activists (Asia Jabeen, Anbrine, & Khalid).

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3. Methodology

In this section, the research methods used to explore the socio-environmental impacts of the Orange Line Metro Train (OLMT) project in Lahore are described. The methodology outlines the data collection, analysis, and interpretation procedures. The study is a combination of field observation and survey data to evaluate the impact of the OLMT project on the communities and urban infrastructure. Primary data were gathered from residents living along the Orange Line corridor and a review of the Environmental Impact Assessment (EIA) report of the Orange Line project was carried out. This method allowed a comparison to be made between official project reports and actual local experiences (Nawaz et al., 2019).

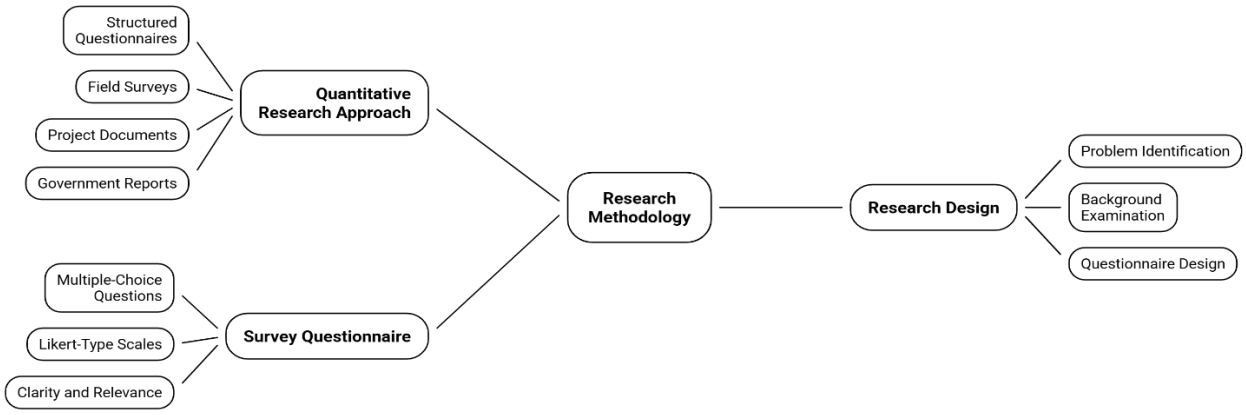
3.1. Research Methods

The research design for the study is the quantitative research, which is one of the research strategies used for assessing social impacts of the project of the Orange Line Metro Train. It has been decided to use quantitative methods due to their ability to gather data from many respondents and facilitate statistical analysis of the results. The primary data was collected with the help of structured questionnaires and field survey and the secondary data was collected from various project documents, government reports and Environmental impact Assessment (EIA) Reports on the OLMT project.

3.2. Research Design

The research was designed in multiple phases to allow data collection and analysis to be done in a systematic manner. The research problem was identified to address the impact of Orange Line Train on Socio-Environmental aspects as a topic. This step included a literature review on literature pertaining to metro systems, transit-oriented development (TOD), and transportation impacts. Secondly, background information was explored on the Orange Line Metro Train project, its planning process, construction procedures and Environmental Impact assessment (EIA) documentation. Third, a survey questionnaire was prepared for residents in the areas influenced by the construction corridor of the OLMT (Aoki et al., 2024). Multiple choice questions were asked of the survey participants concerning travel behavior, public utilities, environmental conditions, and social impacts. The questionnaire was designed with simple response options and a Likert-type scale, asking about the respondents' perceptions of the impacts of the metro project. The questionnaire was pretested to make sure the questions were clear and relevant before conducting the full survey (Eyles-Ferris et al., 2025).

Figure 11: Research Design and Methodology



3.3. Survey Question Example

These are the questionnaires used for the OLT Construction and Community Impact Survey:

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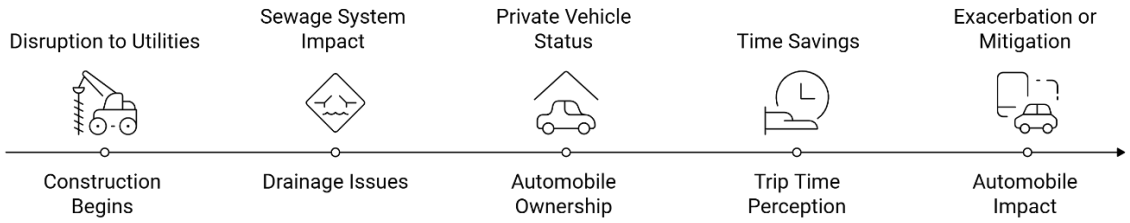
1) Do you think Orange Train construction has impacted or interfered with access to public utilities? (such as: Electricity, Gas, Phone Line etc.)
2) Did the building of the orange line train have an impact on the drainage and sewage systems in your neighborhood?
3) Do you have their own car?
4) Do you think riding the orange reduces your travel time?
5) If so, do you believe owning a personal automobile has made the issues caused by metro trains worse or less so?

Figure 12: OLT construction and community impact survey



3.4. Data collection

Collecting data is one of the primary stages of any research project. Both secondary und primary data is collected for the topic under research. To check that the things mentioned in EIA are, on ground or not, secondary and primary research is conducted. With the data collection, researcher has a clear idea on what is occurring on ground.

3.4.1. Primary data

Primary data collection step is the step that helps in achieving the research objectives. In this instance, primary data will be gathered to cross-check whether the mitigation measures mentioned in the EIA are present on the ground or not, and to compare what is mentioned in the EIA and what is present. For that, an observatory survey was done initially, in which a reconnaissance study was conducted, and pictures of the ETA violation were collected. The detailed questionnaire analysis is then carried out to get on ground information from the inhabitants of the project area. Interviews are held with the project proponent (LDA officials) and the implementation team (supposed to implement the application of EIA) (Robert Cervero, 2013).

3.4.2. Secondary data

The secondary data is obtained in the form of literature that is similar construction situation in other countries. For that the case studies of Thessaloniki Greece, Chinese cities, Hong Kong express railway, Delhi Metro Train India, are examined in detailed. All the projects EIAs are discussed, with the emphasis on social and environmental aspects. The Environmental Impact Assessment (EIA) of the Orange Line Metro Train Project is also conducted. The socio environmental impacts mentioned in EIA are discussed in detail and are further substantiated through primary data collection method. The approval conditions by EPA have also been included and further certified in the interviews conducted by officials of Lahore Development Authority (LDA).

3.5. Documentation

The write up is carried out side by side as documentation is a key component of research work. Once the research is documented, it can be saved and used for future consultations. Each research is provided chapter-wise in the models of introduction, objectives, literature review, data collection, data analysis and conclusion and recommendations (Ng et al., 2025).

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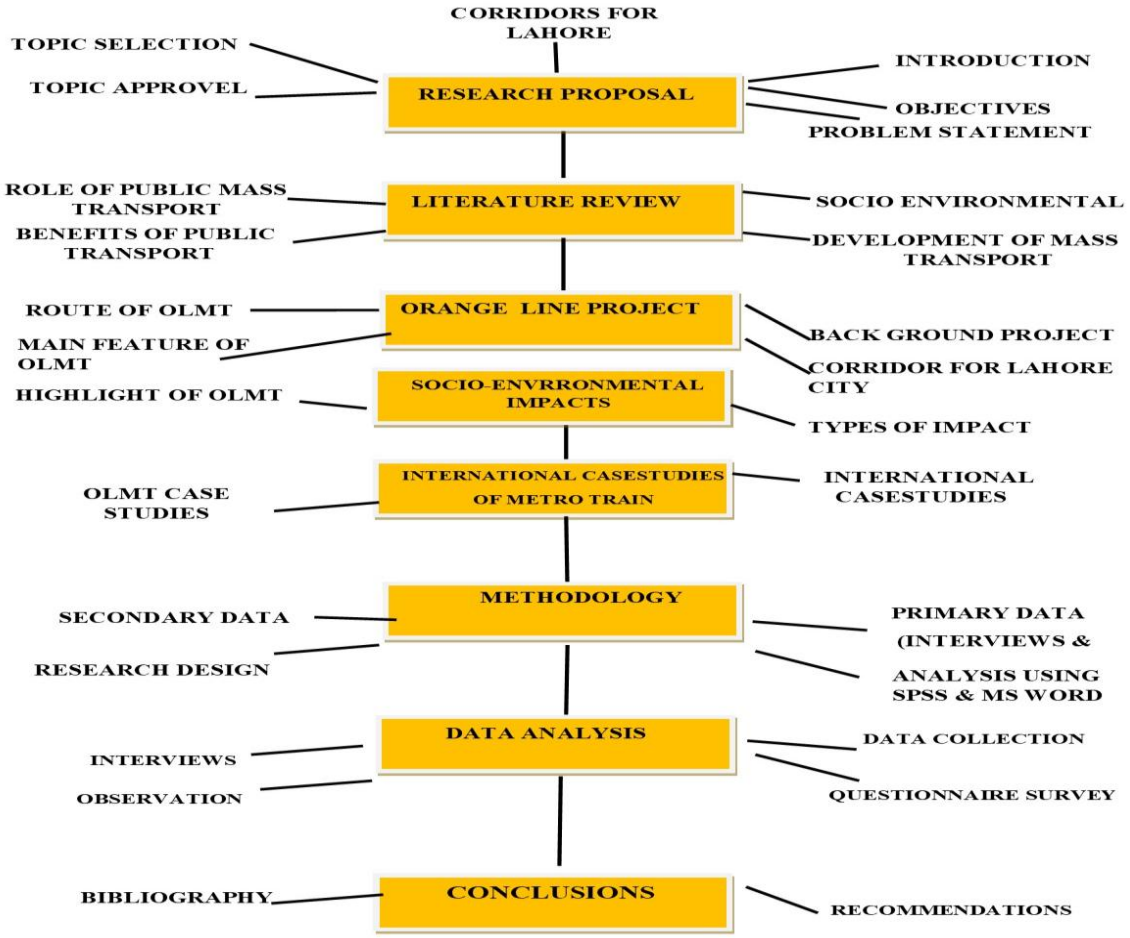
Figure 13: Impact assessment model



4. Research Questioners and Discussions

4.1. Data Collection

The data has been gathered by field survey through questionnaire. The road users, shop owners and residents of that area are the respondents. The patch on which the survey is conducted is from Ali Town Station to Thokar Niaz Baig Station. The following social and environmental related questions were asked from the people are below:

i. What are the impacts on public utilities?
ii. Was the sewerage, drainage and solid waste collection impacted by the construction?
iii. What are the current environmental effects?
iv. Are there any trees being cut in your neighborhood?
v. Did the construction increase mental fatigue?

4.2. Has Orange Train construction affected or disrupted your access to public utilities? (like; electricity, gas, phone line etc.)

Public utilities as sui gas, electricity, phone lines, etc. suffer significant harm wherever such initiatives are to be carried out. If some of the utility services are to be terminated, then an alternate must be made available as stated in the EIA. This is an enquiry about the possibility of providing an alternative to public utilities in the area in which the orange train is being constructed. Almost 70% reported public utilities affected, and that there is no alternative (Azhar et al., 2024)

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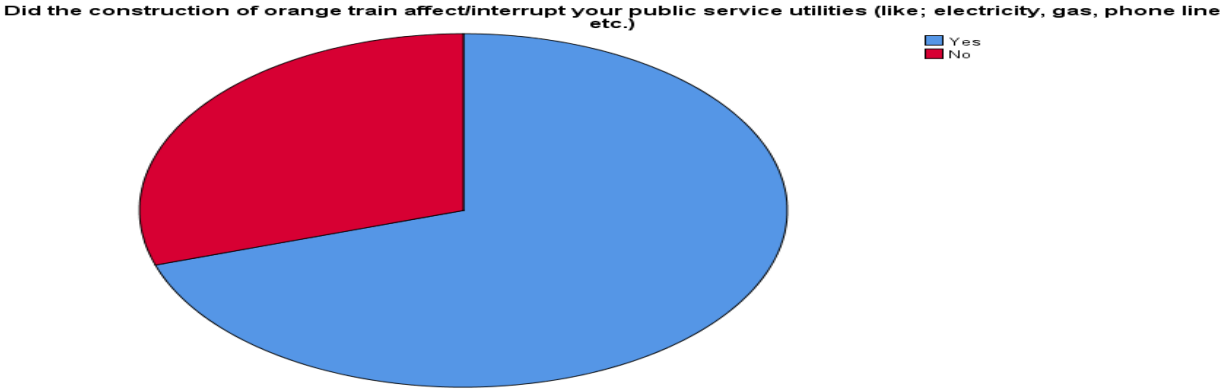
Figure 14: Effect on public utilities



4.3. Did the building of the orange line train have an impact on the drainage and sewage systems in your neighborhood?

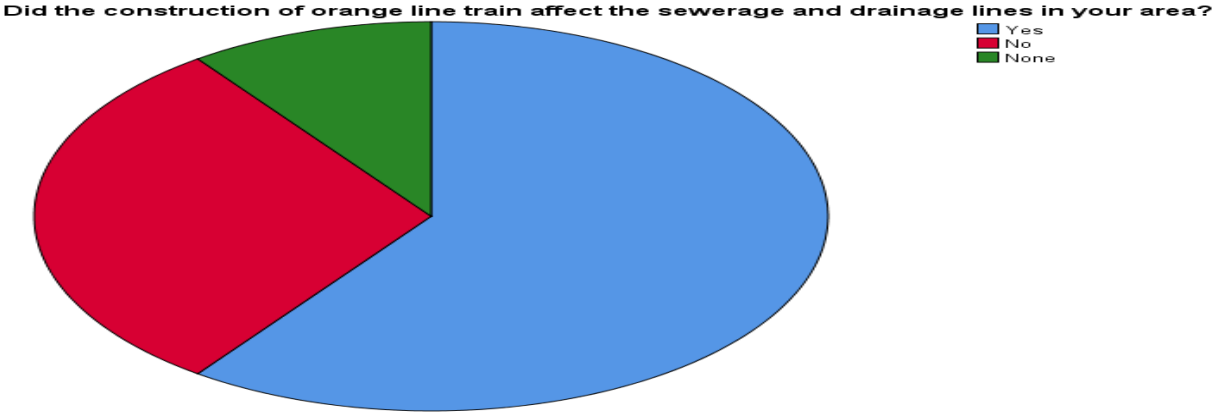
Large-scale infrastructure works, of which metro rail systems are a familiar example, typically require sustained construction activity along major road corridors. Such activity has the capacity to disturb the underground networks that run beneath these corridors, particularly drainage pipelines and sewage lines. Excavation undertaken for the Orange Line Metro Train extended beyond the rail alignment to include road reconstruction and the installation of supporting infrastructure, and in several locations this work affected the existing drainage and sewage networks. The survey responses indicate that an estimated 60% of respondents observed disruption to the drainage and sewerage systems in their immediate neighborhoods during the construction phase of the project (Ahmad et al., 2023).

Public transportation systems, when efficiently designed, are intended to shorten travel time and improve mobility for urban residents.

According to the Environmental Impact Assessment (EIA) and the associated project management plans, a few diversion routes and traffic management strategies were introduced during the construction phase of the Orange Line Metro Train, with the stated aim of minimizing disruption and maintaining the flow of traffic.

The survey results suggest that approximately 80% of respondents experienced a reduction in their overall travel time after the introduction of the Orange Line Metro Train. A considerable number of participants indicated that the metro offers a faster and more reliable mode of travel than the conventional road-based alternatives available to them.

Figure 15: Damage to sewerage and drainage lines



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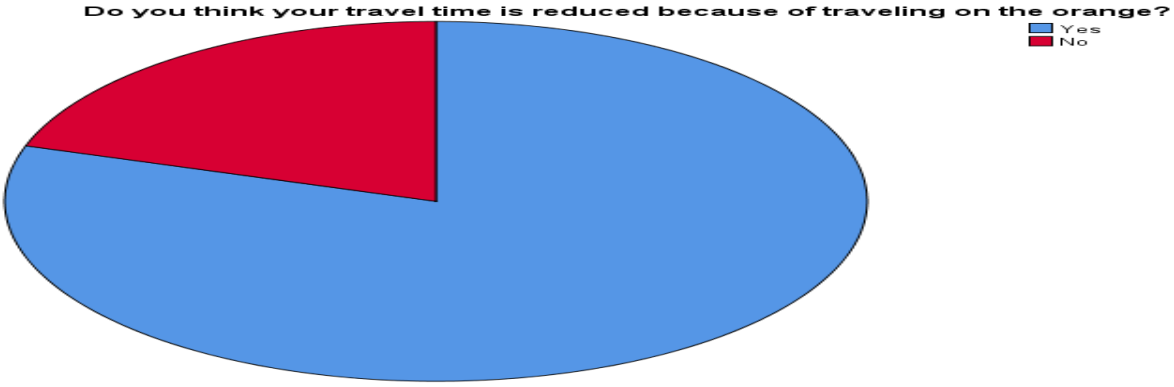
4.4. Do you think your travel time is reduced because of traveling on the orange?

In an official EIA report submitted to the authorities, the project-affected residents, features of the project, and municipal authorities all believed that alternative routes and diversion arrangements had been developed to ensure the public would travel comfortably. However, when exploring this matter further, I find that this is not the case in practice. During a survey of the pilot study residents, I found that as the roads became more disorderly, the less they travelled. In general, 80% of the respondents reported a reduction in the number of trips undertaken, and many of them traveled only when necessary. Further, the diversion plans were not of much help in practice, in the sense that the relevant information boards were not present at the important turning points along the affected routes(Mustafa & Jbara, 2018).

4.5. Does the orange line really make your trip time shorter?

However, it is important to remember that the purpose of public transport systems, when designed successfully, is to decrease travelled time and increase the mobility of the urban residents. According to the Environmental Impact Assessment (EIA) and the project management plans, a set of diversion routes and suggested traffic management strategies were introduced during the construction phase of the Orange Line Metro Train to reduce the adverse effects of construction on residents. According to the survey, about 80% of respondents stated that their overall trip time was less than before using the Orange Line Metro Train. A significant number of participants also stated that the Metro trains offered faster and more reliable travel than conventional travel along a road (RB Cervero, 2013).

Figure 16: Effect on travel behavior/trip



4.6. Do you own a private automobile?

315 respondents were asked the significance of personal transport to their lives. Their responses resulted in a further division into entire sample. The general term "private vehicle" was used to refer to "any personal mode of transport" (e.g. two-wheeler, car, etc.). Out of the entire sample, 273 respondents (86.7%) stated that they own a personal mode of transport. In the sample, 854 respondents were on the path of completing their work. Out of which, 206 respondents (24.1%) stated that they own a personal mode of transport. Out of the entire sample, 243 respondents (27%) said that they do not own a personal mode of transport. And out of the entire sample remaining, 89 respondents (9.4%) replied that they do not own a personal mode of transport but do own a bicycle. Thus, the conclusion of (Cervero & Murakami, 2009) that the introduction of the Orange Line Metro Train may influence the transportation choices made by residents of Lahore (Cervero & Murakami, 2009). (who have borne witness to the adoption of a Metro Train) may be proved true.

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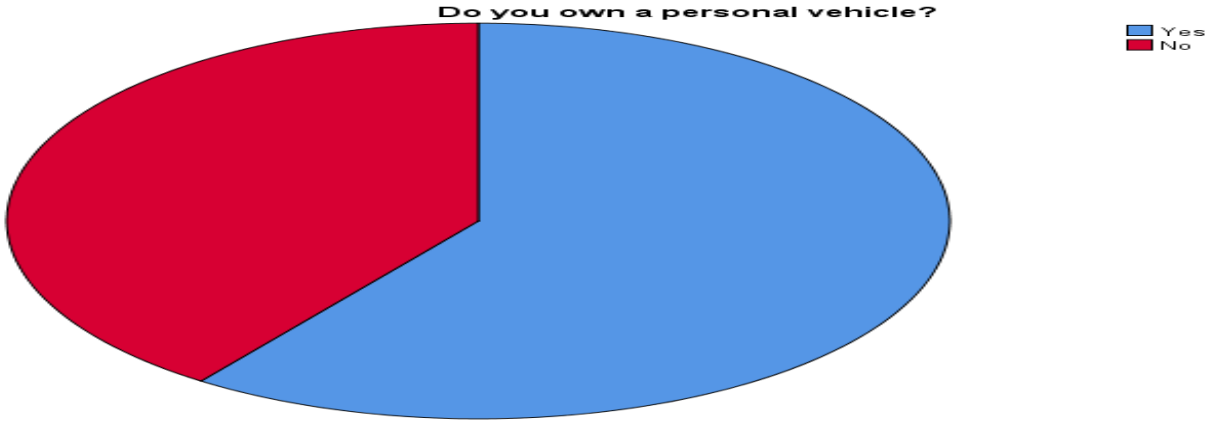
Figure 17: Personal Vehicle ownership

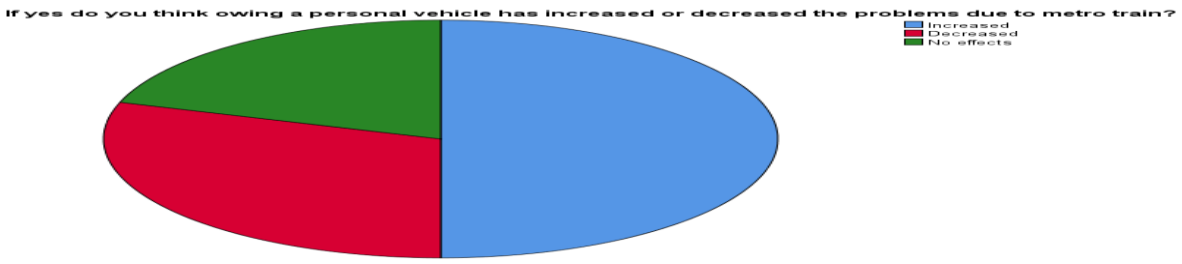


4.7. If so, do you believe that owning a personal automobile has helped to make the problems worse or less so?

If you own a private automobile, do you believe that it has increased or reduced the transportation problems caused by the metro train project? Ownership of a private vehicle is likely to shape, in significant ways, how an individual experience a large infrastructure project of this kind. Within the areas affected by construction of the Orange Line Metro Train, both private motorists and public transport users encountered temporary difficulties brought on by traffic congestion and successive road diversions. According to the survey results, approximately 50% of respondents reported a worsening of traffic-related problems in the project area, with the construction phase emerging as the period of greatest difficulty. Those who provided complaints, 70% centered on the higher frequency of road diversions, congestion, and reduction of carriageway space with the construction occurring. The remainder of complaints (30%) were issued from those who prominently depend, of course, on public transportation services such as trains and taxis to move around in the city. They complained that their service was maintained with only 50% of the original frequency complained about delays, lack of availability, foul schedules, and unsafe procedures (Ahmad et al., 2023). 20% claimed there was no negative impact to their daily travels.

A number of these participants observed that the operational phase of the Orange Line Metro Train has, in their view, improved overall travel efficiency and provided a reliable alternative to road-based modes. Taken together, the findings suggest that although the construction phase introduced temporary transportation challenges, the longer-term benefits associated with the metro may contribute to improved mobility and a reduction in traffic congestion across Lahore. Road diversion is difficult to avoid when road improvements are undertaken, but it is more detrimental when the created havoc is expected to last for a prolonged period. Several measures ought to be in place before any route is closed; traffic diversion plans should be communicated to the public well in advance, and round-the-clock coverage by traffic wardens should be assured at the affected locations (Duong et al., 2025).

Figure 18: Problem due to ownership



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5. Conclusions and Recommendations

Environmental Impact Assessment (EIA) testing, and the mitigation it prescribes, are a widely recognized requirement globally, to address the negative consequences of large-scale development projects. Although EIAs are carried out in Pakistan, the fate of the reports, and the way they perform on the ground, are significantly different from the common practice in developed countries. In the latter world, the measures recommended through the EIA process are generally valued and followed in earnest; the same cannot be said of Pakistan. The document invariably remains under-implemented, with little monitoring or enforcement to support the process. Given the inherently fragile nature of environmental systems, such circumstances affect surrounding ecology in an unpredictable manner.

The present project has already disturbed the local public utilities. It has also affected the adjacent infrastructure of sewerage, drainage, and solid waste management arrangements in the nearby premises. Travel through the area has also become increasingly difficult due to recurring traffic congestion in the affected roads. People in the vicinity have become much more vulnerable to health hazards, including skin allergies, breathing disorders, and various forms of infectious diseases. In Pakistan, EIA reports tend to be prepared and then left to gather dust on the bookshelf; their commitments are seldom verified in practice. The present research examines each of those commitments one by one and measures the progress of the project against the parameters set in the final EIA report. The eventual conclusions of the research are summarized through the following recommendations.

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