

Urban Transport: A Proposal of Light Rail Transit (LRT) System in Lahore

Ayesha Khan (Corresponding Author)

University of Engineering and Technology, Lahore Pakistan, Lahore College for Women University, University of Engineering and Technology, Lahore Pakistan, University of Management and Technology, Lahore Pakistan
Email: ayshakhan036@gmail.com

Haroon Gulzar

University of Engineering and Technology, Lahore Pakistan, Lahore College for Women University, University of Engineering and Technology, Lahore Pakistan, University of Management and Technology, Lahore Pakistan

Hafsa Shoab

University of Engineering and Technology, Lahore Pakistan, Lahore College for Women University, University of Engineering and Technology, Lahore Pakistan, University of Management and Technology, Lahore Pakistan

Hamza Saleem

University of Engineering and Technology, Lahore Pakistan, Lahore College for Women University, University of Engineering and Technology, Lahore Pakistan, University of Management and Technology, Lahore Pakistan

Asra Hafeez

University of Engineering and Technology, Lahore Pakistan, Lahore College for Women University, University of Engineering and Technology, Lahore Pakistan, University of Management and Technology, Lahore Pakistan

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Abstract

Given the broadening experience with the little thought of subordinate petrol stores and the regular aftereffects of eating up it, the extending years for better available transportation structure proceeds throughout the planet. An enormous proportion of adventures and resources is being mixed into the progression of transportation structures, including light rail, as the necessity for better and faster transportation is compared with the monetary improvement. Regardless, there is a certified shortfall of appreciation concerning the basic weaknesses, similarly to their impact on introducing these establishment projects. As a result, execution results that are lower than the measures are customary in rail transportation, and money-related or social benefit of light rail ventures get sidetracked enormously dependent on what is, for the most part, expected. In an enormous number of these cases, either the overall cost of the endeavor winds up being much higher, or the help winds up being unquestionably not actually at first decided. This research targets decreasing such an opening in the composition by contemplating the problematic thought of the interest. Even more expressly, this examination proposes a real options-based framework for the attainability assessment of the potential spaces of light rail stations. In any case, it measures the interest for each proposed station region, considering the endogenous weaknesses related to the assessment of interest. Second, the chance of different station improvement circumstances is researched using the net analysis method. Third, a real choices examination is done on various improvement circumstances by pondering the expected advantages of joining flexibility in the new development. Fourth, considering the level and nature of the weakness in the station interest for each space, the financial benefits of joining flexibility for the station improvement are assessed. Using a relevant examination approach, the proposed model is applied for a station region on the Lahore light rail system. The results suggest that seeing the huge weaknesses at a starting stage and combining versatility into the structure design pays off in exact circumstances. Lahore's nascent light rail transit (LRT) system will model many other Pakistan urban transportation projects. As the region's transportation systems' capacity to convey people outstrips the increase of metropolitan populations, the demand for light rail shows no signs of waning.

Keywords: Light rail; Mobility transit; Lahore; Sustainable; Transportation; Congestion.

1. Introduction

Cities serve as economic and social centers. How a city works and connects (locally, regionally, and globally) is critical to its long-term productivity, resilience, and success. According to urban and transportation studies, the use of alternative means of mobility must be introduced to meet the needs of the world's rising population in major cities. For the majority of these city dwellers, private automobiles remain the primary mode of transportation. Thus alternative modes of transportation, such as mass public transportation, are seen as a solution to deal with the negative consequences of increased use of auto, which results in congestion, emissions and individual mental and physical health. Communities are being planned or modified to allow residents to use these alternate modes of transportation for their everyday excursions, reducing their reliance on automobiles to get to their destinations. Similarly, Lahore, as a developing global metropolis, aspires to provide all kinds of mobility to its citizens, including efficient public transportation (Tateishi *et al.*, 2021).

As a result, the study's goal is to plan an efficient, effective, and environmentally sustainable integrated transportation system to meet the needs of the Lahore Capital City Region's current and future population, stimulate

the economy, and boost global competitiveness while preserving the region's values, heritage, and vibrant culture, and improving residents' quality of life. The aviation, maritime, public transportation, and highways sectors are part of a integrated transportation system that serves the interest of public by improving mobility and offering safe, secure, and ecologically liable services.

1.1. Research Objectives

The major purpose is to identify and implement more sustainable transport by the vision of the Transport Master Plan 2030, which provides an idea of efficient, safe, and sustainable means of moving people throughout Lahore while also achieving associated benefits and meeting environmental, social, and economic efficiency goals.

- In Lahore, creating a framework for site-specific transportation strategies.
- To strengthen sustainable modes of transportation conditions to improve access to public transportation for all people and organizations.
- To meet the mobility needs by making better use of planned land-use Infrastructure and transportation.

1.2. Scope of Research

The study focuses on the disparity between policy and planning rationales for executing LRT projects and the rationales that support transportation modeling and socioeconomic evaluations in Lahore. The study examines how LRT systems have been implemented by looking at how actors have been enrolled into a bigger LRT network and how, as a result of these procedures, LRT systems have been implemented. LRT projects have shifted from being seen as transportation infrastructure projects focused on trip time to being seen as urban development projects supporting strategic spatial objectives (Dimitriou and Sartzetaki, 2020).

To establish more democratic and transparent decision-making processes, there is a need to close the gap between the anticipated strategic benefits of LRT systems and the benefits contained in the decision support. Furthermore, political visions and rationales for implementing LRT, as well as the findings of socio-economic evaluations, raise important questions about the basis on which political decisions to implement LRT systems (or not) are made, and whether existing decision support tools are adequate for dealing with the complexities that many larger infrastructure projects entail (Olesen, 2020).

1.3. Justification of Research

Many communities have begun planning and implementing light rail transit (LRT) because of its affordability, technological feasibility, and environmental benefits. Despite these ostensible benefits, LRT development has run into the same roadblocks as other large transportation infrastructure projects. As part of the development application process in Lahore, a new requirement will be implemented. In an iterative process, developers or consultants must design the proper form of transportation management strategy. Sustainable transportation infrastructure development is inextricably linked to economic development. Schemes like car sharing or demand-responsive transportation provide rapid wins by improving access and providing more sustainable alternatives to the single-occupancy car. Transportation management has the opportunity to achieve broader benefits, like lower CO₂ emissions, cost savings, and enhanced health, in addition to reducing congestion (Fan *et al.*, 2020).

This research was carried out to address the shortage of LRT system deployment strategies in Lahore. Current transit users' impressions can aid in service suggestions and the identification of characteristics of trips, travel behavior, and people perceptions that can improve the existing transit system and provide recommendations for the introduction of an effective light rail transit network. The finding of this research would be beneficial for both planning and development agencies and will also helpful for the private sector, thus, helping them to adopt more viable approaches and standards (Almardood and Maghelal, 2020).

1.4. Literature Review

A growing consensus has emerged that the private automobile, when favored over other modes and used indiscriminately for decades, is incompatible with an appealing urban environment. Some means of regulating and limiting its use are necessary if we want livable and healthy cities. The link between LRT and modes adjacent to it in the transit spectrum has been explained to some extent, but it continues to be a source of much debate for individual applications. The debate about the merits of LRT versus RRT has been intense, and two extreme points of view have often unnecessarily muddled the issue. On the one hand, others argue that its grade crossings and surface operations so severely hamper LRT that it will never perform satisfactorily. As a result, RRT is the preferred mode.

On the other hand, some argue that LRT has more alignment flexibility. With correct design and control of crossings and street running, this mode may almost match RRT performance; thus, LRT is preferable to RRT in practically all applications. It is rather simple to demonstrate that both of these extreme viewpoints are overgeneralizations. Individual patterns of transport use in the City of Lahore, on the other hand, are poorly documented. This study is necessary and urgent because of Lahore's rapid urbanization and a shortage of research on the subject. Understanding transit user behavior will benefit urban, and transportation planners and have important consequences for the transit development future in Lahore.

2. Issues in the Implementation of Light-Rail Transit

A relative lack of understanding of modern LRT technology is found among key decision-makers. As a result, the image of streetcars, overhead trolley lines, and safety issues has a negative connotation. Numerous people are

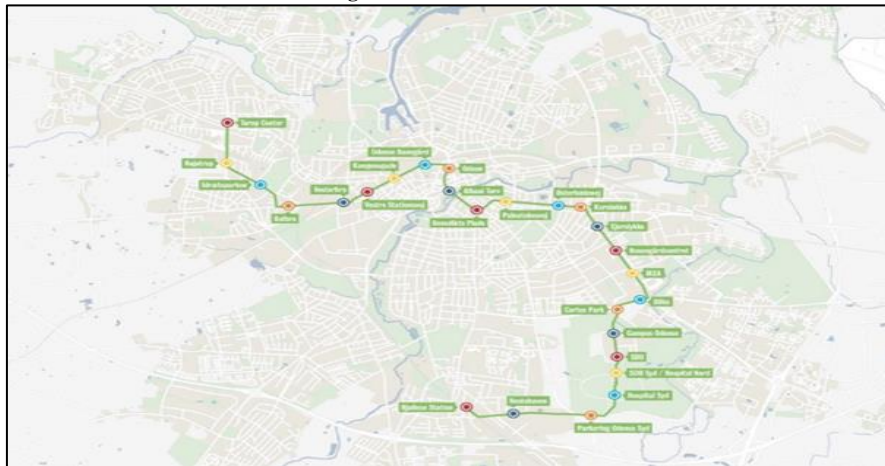
opposed to its use in many places. Because of our firm belief in the potential of this mode of transportation, we may suffer from some myopia when developing LRT systems. We need to expand our coalition of champions to include elected leaders at all levels of government while also involving the general public in programs that can open their eyes. Both of these groups must know that petroleum reserves have a limit for us to succeed. To influence the public's perception of the automobile's utility, we must act as a catalyst. Then, after this foundation has been laid, we may resume our role as LRT planners (Almardood and Maghelal, 2020).

2.1. Case Studies

2.1.1. Denmark

In a few simple phrases, researchers investigated the decision-making processes for establishing LRT systems in the three largest Danish cities, Aarhus, Odense, and Copenhagen (Ring 3). First, key actors and events are mapped, focusing on actors in decision-making processes at various scales (national, local, and global) and actors representing various practices (the bureaucrats, the planners, the consultants, and the politicians). Second, semi-structured qualitative interviews with key human actors were conducted to obtain central perspectives on decision-making processes.

Figure-1. The LRT network



LRT is viewed as more than a technology in this context. Electric trams and other LRT-like technologies have been around for over a century, and they've had a significant impact on urbanization processes and city shape. The strong relationship with particular values and rationalities, such as sustainable mobility, transit-oriented urban development, livability, and economic growth, is 'new' about current LRT projects. When cities develop LRT projects, they subscribe to these values and the network of cities that have adopted these values. We think of LRT as a "travelling idea" because of this understanding.

2.2.2. Shenzhen

By the end of 2017, Shenzhen's entire urban bus fleet, totaling roughly 17,000 buses, will be electrified. SZBG's electric bus fleet consists of 4,964 heavy-duty and 1,089 medium-duty (less than 10 meters) buses. Heavy-duty buses have an average lifespan of eight years, whereas medium-duty buses have an average lifespan of five years and a yearly traveling distance of 66,000 kilometers. From 2009 to 2017, SZBG electrified its entire bus fleet, beginning with a demonstration phase in 2009-2011, followed by minor pilots in 2012-2015, and then full-scale electrification in 2016-2017. The buses were purchased from three different manufacturers: BYD (79.1%), Nanjing Golden Dragon (17.0%), and Wuzhoulong (7.0%) (3.9 percent).

Figure-2. Shenzhen dominant bus model



SZBG chose a concept that required minimal adjustments to current bus routes and schedules to achieve large-scale adoption quickly. Unlike other cities that experimented with several e-bus technologies, Shenzhen relied on a single, tried-and-true vehicle technology – electric buses with a huge battery – to meet its daily mileage requirements.

As a result, the necessity of fostering a collaborative environment when moving to a new system cannot be overstated. The collaboration between bus operators, bus manufacturers, financial institutions, and charging firms greatly reduced technological uncertainties and distributed the cost burden. We can stay on top of policy developments and fight for good support by working directly with government bodies (Berlin, 2017).

2.2.3. Mexico City

Having a population of over 20 million people, the city is one of the world's megacities. Every day, the city sees about 30 million vehicle trips and 3.5 million cars. Public transportation accounts for 70 to 80 percent of travels, including 4.5 million rides on Mexico City's 125-mile metro system. Two additional cable car lines will connect to the metro system, making it the city's most efficient connectivity system. It will assist people in overcoming urban constraints that might result in long and dangerous commutes.

Figure-3. Transport Collective – Metros MEXICO



UNOPS is also introducing worldwide best practices to acquire 118 new buses, which will assist approximately 72,000 passengers daily. Once the upgrading projects are completed, it is estimated that by 2024, Mexico City's combined transportation system will be able to efficiently convey an additional one million passengers than it can now. Simantane will assist in making the city greener and more sustainable and increase access to schools and health centers by reducing traffic congestion.

As a result, BRTs are a popular way to modernize public transit in many developing cities. Its long-term viability is based on its ability to provide a cost-effective form of transportation compared to automobiles and its potential to reduce traffic congestion and polluting emissions (BRT of Mexico City, 2012).

2.2.4. Hong Kong

The metro system in Hong Kong SAR, China, was designed to accommodate future population development. The initial system's designers learned from other systems worldwide that they regretted establishing a small metro with insufficient space in the trains or stations. Given the city's density and population size, the high-capacity design provides a stable financial foundation. For example, its 'metro' type lines run 183m 8-car trains, while the former KCR suburban lines have 4-car to 12-car trains. The MTR's ability to meet its goals (mass transportation) is aided by the high-capacity trains, which also help with financial efficiency: MTR's 8-car 183m trains have a capacity of 1800 passengers, but China's 6-car type B train has a capacity of 1100 passengers and the London Underground Northern Line 'tube' trains, which are confined by tunnel width, have a capacity of 700 passengers.

Figure-4. Hong Kong's Mass Transit Railway



Strategies for the Successful implementation of Mass transit system:

- The MTR business model establishes MTR's independence and significant autonomy. MTR has always been commercially prudent, developing a long-term business model and finance. Its investments generate a profit, please shareholders, and keep passenger rates affordable.
- Stakeholder management is transparent, proactive, and outward-looking. The government (as a shareholder and regulatory), passengers, and shareholders are the key stakeholders. MTR is always looking for new ways to build and strengthen partnerships (Hong Kong Case Study, 2017).

2.2.5. New York

The most significant adjustments to bus system of New York is related to bus speed. Due to increased traffic, the city's average bus speed has worsened. The average scheduled speed of bus in Brooklyn is 11 km/h, which includes few-stop buses and Select Bus Service but not express buses; the average speed in the city of Paris and its inner suburbs is 13.6 km, which is to some extent less dense than Brooklyn but has more job density and through-traffic from the outer part of suburbs.

Various treatments to boost bus speed have been proposed by reform-minded organizations. The following are some of them:

- Fare collecting off-board, allowing for all-door boarding.
- Increase the interval between stops by stopping consolidation.
- Dedicated bus lanes that are ideally separated from automobile traffic by modestly elevated curbs.
- At intersections, traffic signals take precedence.

Routes that are too short or too long are avoided to improve bus operator satisfaction. More broadly, we advocate a process rather than an unchanging finished result. According to transport policy, more bus routes duplicating subway stops to be abolished and their service hours needed to be redistributed as more metro stops are made accessible (Metropolitan Transportation Authority, 2019).

2.2.6. Beijing

Beijing, China's capital, is the country's first city to adopt BRT. BRT development is currently the dominant trend in Beijing's urban public transportation development. The following are the reasons: To begin with, while Beijing's rail system is well-developed, traditional urban public transportation has significant flaws, such as difficult transfers. Second, peak hours are notorious for causing traffic congestion and other concerns. Third, Beijing urgently needs large-capacity urban public transportation. BRT can greatly assist in fulfilling passenger demand, maximizing land resources, and creating a seamless network between metro and conventional buses. Beijing's first BRT lane was formally opened in December 2005. This lane had a total length of 16 kilometers in 2008, with 17 stations. Beijing BRT achieved 200 kilometers in length in 2011, with three main routes.

Figure-5. Beijing Subway



By 2015, Beijing Subway expects to have 19 lines in operation, totaling 708 kilometers (440 miles) of the track, and 1,050 kilometers (650 miles) of the track by 2020, with nine million passenger journeys every day.

BRT can provide high-quality transit services while being constructed rapidly and at a low to moderate cost. More importantly, municipal decision-makers have generally supported project implementation and have supplied considerable political power and resources to handle the challenges of building BRT initiatives. As a result, BRT schemes have been widely adopted in a short amount of time.

2.2.7. Guangzhou

In 2010 Guangzhou Bus Rapid Transit (BRT) system was completed that was awarded by the 2011 International Sustainable Transport Award. After Bogota and Curitiba this is the second in capacity BRT System, having the capacity to move more than 27,000 people per hour in a single direction and with more than 800,000 boarding's per day. Guangzhou is one of the Chinese cities that is financing in public transportation to reduce traffic congestion.

Furthermore, Guangzhou's BRT system boasts the biggest passenger capacity per bus, the highest bus frequency, and the longest platforms in the world. It is also one of the advanced BRT systems, assessed on several qualitative criteria (which not only increases the flow but also improves the traffic system and environment). Guangzhou officials are working with the city's residents and ITDP to develop it even more.

Figure-6. Guangzhou BRT



Some points for the sustainable implementation of the BRT systems include:

- Travel times for vehicles and bus users in the corridor have decreased by 20% and 29%, respectively.
- Real-time bus information deployment and introduction of new stations, the quality of bus service has improved substantially.
- A 30% increase in the speed of buses, resulting in saving average time of 6.63 minutes per bus rapid transit journey, or about 88,000 passenger-hours per day, or over 30 million passenger-hours per year.
- A reduction of 15% in the wait time of bus along the BRT network.
- Increase in cycling about 50% along the BRT path in the congested areas.
- Improvements in sustainable transportation boost the city's overall economic outcomes by cutting travel costs, improving employment access, and reducing congestion for economic activity.

2.2.8. Moscow

The Moscow Metro's 70-kilometer-long Big Circle Line (BCL) is one of the most ambitious metro construction projects globally. Thirty-one stations and three train maintenance facilities will serve the railway line. It will be the world's longest circle line, surpassing the 57-kilometer-long Second Circle Line of the Beijing Metro. The Petrovsky Park, Delovoi Tsent, CSKA, Khoroshevskaya, Shelepikha stations, and the Savyolovskaya railway station opened in February 2018, and the Savyolovskaya railway station opened in December 2018.

With the inauguration of the western portion of the BCL, the peak hour headway at the Savyolovskaya-Khoroshevskaya section was cut by 15 minutes, from two hours 45 minutes to two hours 30 minutes, resulting in a 2,600-seat increase. The Narodnoe Opolchenie and Mnyovniki stations, which will open in April 2021, will accommodate 42,400 passengers per day. The stations' overall ridership is predicted to increase to 95,400 passengers per day in the future. Due to convenient connections to Lines 2, 7, and 9, travel times on some routes are expected to be reduced by 40 minutes. Up to 5,500 extra passengers are expected to convert to trains as a form of transportation due to the new stations.

Figure-7. Moscow Metro BCL



It should include a smart ticketing system, a single navigation app, and an intermodal help service for travelers with limited mobility. Tram speeds will be increased, track maintenance will be improved, the number of repairs will be cut in half, and maintenance costs will be reduced due to network modernization. a concerted attempt better integrates its transportation system (de Moraes *et al.*, 2020).

2.2.9. Tokyo

However, according to a recent study from Chuo University, Tokyo's massively overburdened railway infrastructure may fail to deal with the influx of new passengers in 2020. It's yet another source of concern for the Tokyo Organizing Committee of the Olympic and Paralympic Games (TOCOG), which is already under fire following construction delays at several sites. Takahiro Yamaguchi is a spokesperson for Tokyo Metro, which runs several subway lines throughout the city and is a TOCOG official partner. Tokyo Metro stated in a news release that it will provide smooth transit services by acting as a "navigator of Tokyo." "To determine the sources of obstruction, we are inspecting passenger flow at stations and simulating passenger flow," Yamaguchi adds. "To handle overloaded passenger operations, a larger number of station workers, security patrol staff, and other measures will be on duty." East Japan Railway Company (JR East) has pledged to enlarge platforms and improve the range of barrier-free amenities at stations likely to be busy during the Games as part of its 2020 initiative. It has also agreed to collaborate with other transport operators to improve capacity as demand grows.

Figure-8. Tokyo Metro



However, each operator is responsible for only their network, and the system is run as a collection of rail networks rather than as a unified entity. Walking and cycling should be encouraged. Private automobiles and motorcycles play a supporting role.

2.2.10. Shanghai

Shanghai has one of the worlds newest and fastest-growing public transportation networks known as Shanghai Metro, with 162 stations and over 225 kilometers of elevated and underground track. The system serves well over two million people daily, with future growth plans bringing that figure to over three million. TDSi's EXpert controllers, EXgarde Enterprise software platform, and MIFARE smart card readers comprise the project's access control solution. A fully-featured and networkable system that has been delivered by the expert which is specified for its proven performance in high-volume applications. 48,000 cards can be hold by each controller and enables quick and effective access management for projects like this Metro, which sees enormous numbers of customers transiting through various sites regularly.

Figure-9. Shanghai Metro



Thus, the following principles should be implemented for the integrated development of metro stations areas:

- Distribute facilities based on traffic accessibility.
- Include a mixed-use function in the design to prevent peak-hour traffic patterns.
- Maintain a healthy balance between spatial volume and traffic accessibility.
- Based on metro accessibility, arrange function distribution and improve spatial performance (Zhang *et al.*, 2018).

2.2.11. Seoul

Seoul Metropolitan Rapid Transit (SMRT) is a world pioneer in urban rail technology. Through high-tech IT solutions, Seoul Metropolitan Rapid Transit provides a convenient and comfortable traffic environment. If traveling a distance of 10 kilometers, travelers are only charged a basic ticket on their transit card under the all-in-one scheme (transfer between different means of transportation is free of charge). If they travel more than 10 kilometers, they will be charged an extra 100 won for every 5 kilometers on their transportation card. Passengers can get real-time subway information from the Bus Information Terminal (BIT) situated within the stations. Open API also enables citizens to access this information via the Internet and mobile applications. A smartphone app called "Seoul Public Transport" was created especially to provide real-time train information.

Figure-10. Seoul Metro



We should promote the Oriented, Convenient Transportation system in Lahore.

- Economical and environmentally sustainable urban train construction
- Fast and safe urban railway
- Convenient and attractive urban railway
- Cutting-edge technology enables smart functioning.

2.2.12. London

Infrastructure Plan 2050

The London Infrastructure Plan (LIP) 2050 is a big project in the final stages of development. The project's scope includes many high-level spatial planning features such as transportation modes, green Infrastructure, digital connectivity, energy, water, and waste management. The goal of this Plan, which is based on the mayor's 2020 Plan and the London Finance Commission Report, is to address strategic planning and integration across multiple infrastructures and outline the funding and delivery method needed to achieve short- and long-term ambitions and

expectations. Active transportation corridors (walking and cycling) and public transportation systems are important components of transportation infrastructure (bus, metro, and rail).

The mayor's 2020 Vision was used to frame the Plan, which included the following important objectives:

- Greener: Promote active, healthy lives, a better living environment, and better transportation and drainage systems.
- Reduced Pollution: Low-emission vehicles, low-emission fuels, low-emission zones, and a goal of halving air pollution emissions by 2020.
- Financially sustainable: Enabling fiscal policies and regulations, such as multiple tax alternatives and fiscal devolution, allow optimal infrastructure investment.

The LIP 2050 will be implemented and measured in stages due to its long-term strategic nature. More crucially, the LIP 2050 recognizes the scale and scope of infrastructure investment and projects that will be necessary for the coming decades. As a result, precise strategies for prioritizing and optimizing the delivery of these infrastructure projects have been established according to Master plans Reports.

2.2.13. City of Vancouver (Canada)

Transportation 2040 Plan

The Plan's vision and goals were built around the three pillars of sustainability while also addressing the city's growing challenges, such as population growth with limited road space, high demand for transit, obesity, high living costs, aging populations, rising fuel prices, climate change, and growing downtown. The Plan's main goals are:- Economic: A smart and efficient transportation infrastructure that promotes economic growth while lowering costs. - People: Mobile, healthy citizens in a safe, accessible, and lively city. - Environment: A better natural environment that ensures humans and the planet's health in the future.

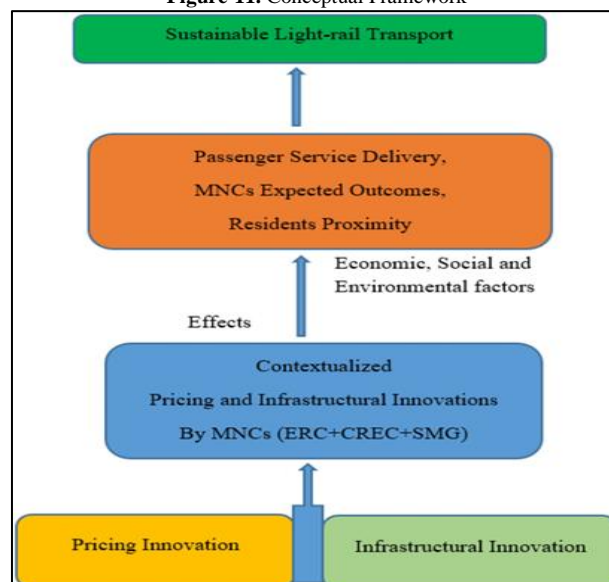
Many of the Transportation 2040 Plan measures require more comprehensive investigations and consultation due to the strategic nature of the Plan. The activities were prioritized and implemented based on which ones provided the most advantages, met long-term demands and aligned with other city-wide projects and goals. The implementation plan also included the creation of low-cost pilot initiatives to test new concepts. Ongoing monitoring was also included in the implementation strategy, with a defined remit to collect learnings and encourage adaptation to ensure transportation plan 2040. Lessons should be learned from this project. Collaboration among partners and participation and empowerment of citizens and companies were all factors considered during implementation. The city was able to identify the resources (both internal and external) and activities required to deliver, monitor, and manage the Transportation 2040 Plan thanks to this thorough and multi-faceted implementation plan.

3. Conceptual Framework

The method is the most crucial part of the research. Since it decides the design of research. It adopts what route map the investigation will follow and the instruments adopted for the study. The methodology chooses the research design and evaluates the research map. It is essential to select the research methodology that is most suitable to research.

In this part, as displayed in Figure, the applied model depicts the estimating and infrastructural advancement, and how they are both contextualized. Likewise, the impacts of monetary, social, and natural components from the contextualized evaluating and infrastructural developments have been depicted. These impacts are worried about the light rail travel framework, traveler administration conveyance and what impact the occupant's closeness had while living and working together along the LRT course. Moreover, re-transformations have been proposed, with thoughts to give a more manageable light-rail transport that thinks about the social, financial, and natural elements (Lopes and Lindström, 2012).

Figure-11. Conceptual Framework



Under this framework, the main objectives of the research are as follows:

- To provide a better understanding of the factors that make light rail transit system sustainable.
- To explore alternative ways of providing and sustaining co-ordination between transport and urban planning.
- To establish mechanisms for influencing the factors that affect the success of light rail systems with the underlying purpose of making them more successful.
- To design a planning framework which incorporates the findings of the analysis and can help urban rail system planners and operators to maximize the success of their systems, and enhance the co-ordination between transport and urban planning.
- To demonstrate the validity of the planning framework. To apply the framework to new British and Turkish urban rail systems, and identify ways in which the urban rail planning process in these countries can be improved.

In the hypothetical structure of Figure, manageable Light-Rail Transport is the reliant variable, as it relies upon the financial, social, and natural. Framework is required at LRT stations, which should be contextualized to suit the land space that is accessible, passerby needs, availability to other public methods of transport, spatial closeness to the stations by travelers, and so on. Moreover, the vicinity of the inhabitants along the LRT courses begins from the presence or nonattendance of some LRT support framework, for example, the division structures between the streets and the LRT courses. In financial hypothesis, there are three techniques for computing costs, which might be applied to move administrations.

1. Costs strategy: The cost incorporates the unit costs caused by the organization to offer types of assistance, as a value edge. This technique is normally utilized.
2. Demand technique: This depends on deciding the cost as a current or expected interest.
3. Method dependent on rivalry: This is the methodology where the cost is resolved dependent on value examination of fighting administrations, for example, contenders like public transport administrators, Bus Rapid Transit (BRT), taxi, and private transport administrators. The LRT in Addis-Ababa utilized this technique.

Foundation advancement is involved help for framework, gives structures vital for help a traveler's utilization of public vehicle, like person on foot openness framework, park and ride, data arrangement for travelers, and public vehicle measures (need and expanded recurrence), accordingly propelling the degree of use of the LRT public vehicle framework. Foundation development is acquainted with advantage the protected development of travelers, give a high travel interest, ongoing outing data to travelers, better availability and vicinity to LRT stages, diminish blockage and energize modular change from private to public vehicle, like the utilization of park-and-ride offices.

4. Research Proposal Regarding Lahore Rail Transit

Studies have shown that rail transit is standard in many cities. People now adopt the rail transportation method, since it is cheap, continent and it covers the distance through the dynamic process. Rail transportation is a continent since it takes several ways of traveling. Rail is transmitted through coal, oil, gas, and electricity. So, it is the most convenient method as adopted by modern-day transportation (He *et al.*, 2016). Rail transportation is becoming common and convenient.

Lahore light train project is spread over 50 KM, and there are 77 stations around the city. The circulation speed of the project is designed as 80 km/hour (Adnan *et al.*, 2020).

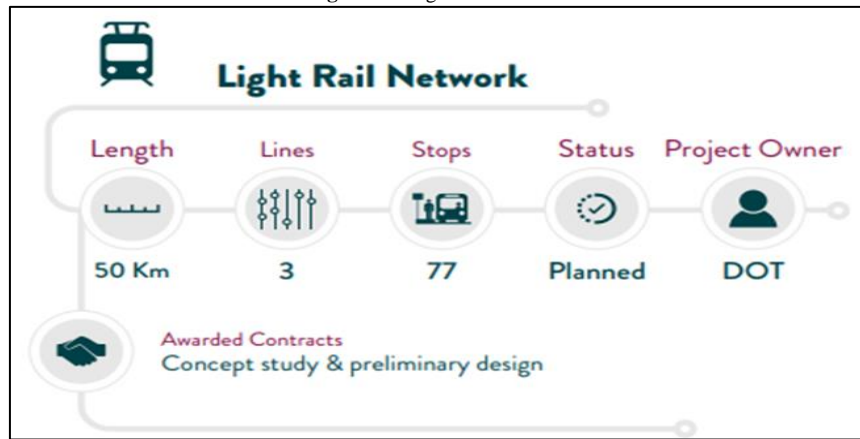
Lahore light train project is an electrically powered transportation project, which is a renewable source of energy and produces low emissions as compared to other sources of energy. The transport department and Energy department are both actively participating in this project and overcome issues together. There is a code developed which should be followed by every designer in this project to make it sustainable, and the Department also encouraging the investors to invest in this green technology.

This rail system will connect with other transportation networks such as metro and busses network to provide smooth and continuous access to different regions of the city. The total length of the combined systems is about 131 KM of length.

The infrastructure is designed considering the local traditional cultural design and heritage, which will also help boost the tourism industry. The interior of these trains will provide a healthy and appeasing environment to the commuters. There will be seat classes and separate family spaces.

In this study, the transport user used a special study to evaluate the characteristics of the movement. Travel Behavior The concept of service quality, communication, and personal characteristics of transport users. User transport facilities reflect the need for public exclusion and the need to build more houses in the station area. In Lahore city, proposals were made to improve the built environment and travel services in order to enhance the accessibility and better experience for transport users (Rizzo, 2013).

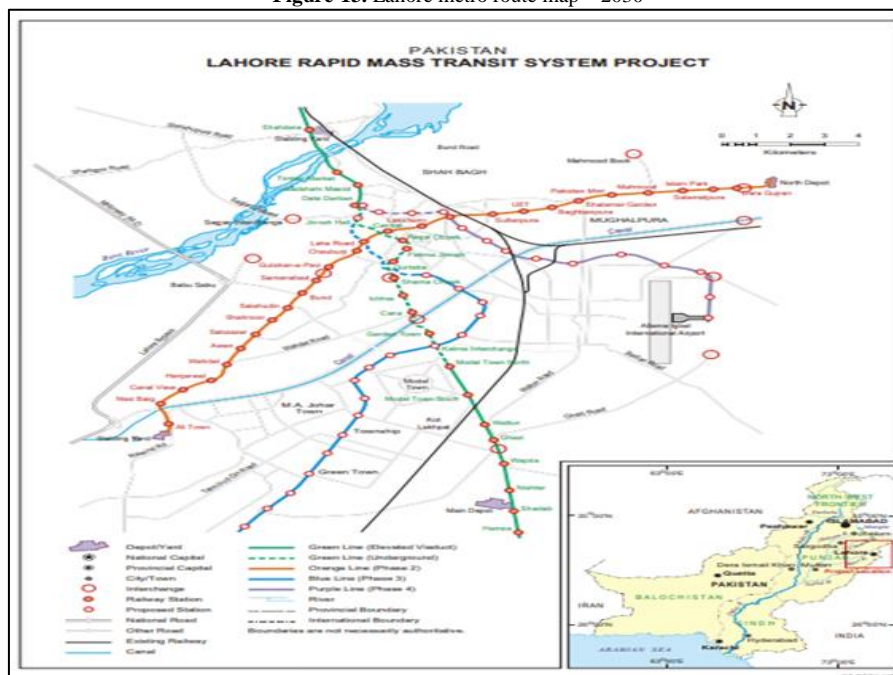
Figure-12. Light Rail Network



The strategy is designed to protect the land for the development of transportation infrastructure to increase the Lahore's high population. Immediate and short-term detailed planning for passenger accommodation is proposed. This strategy was designed to complement future land use plans for the city and has strengthened the development of the city center as a primary public transit hub while surrounding the city with multi-modal transit hubs. It also supports the development of sustainable district centers. It will exchange with city transit and taxi networks and support car-to-public transit modes. Also control the availability of parking. Promoting walking and cycling (Sekasi and Martens, 2021).

The Lahore Level Transport Master Plan (STMP) identified the need for Rail travel along the main travel corridor in Lahore, such rail public transport must provide additional transport Network capacity to alleviate increasing traffic congestion in high demand corridors. This is a world-class technology system consisting of two tracks of more than 200 miles of High-density support. Metro consists of 75 billion meters of built metro lines the current structure consists of 47 stations and three depots. The primary goal was to connect heavily inhabited areas with new financial and business districts, resulting in increased trade and corporate integration (Qiu and Tong, 2021).

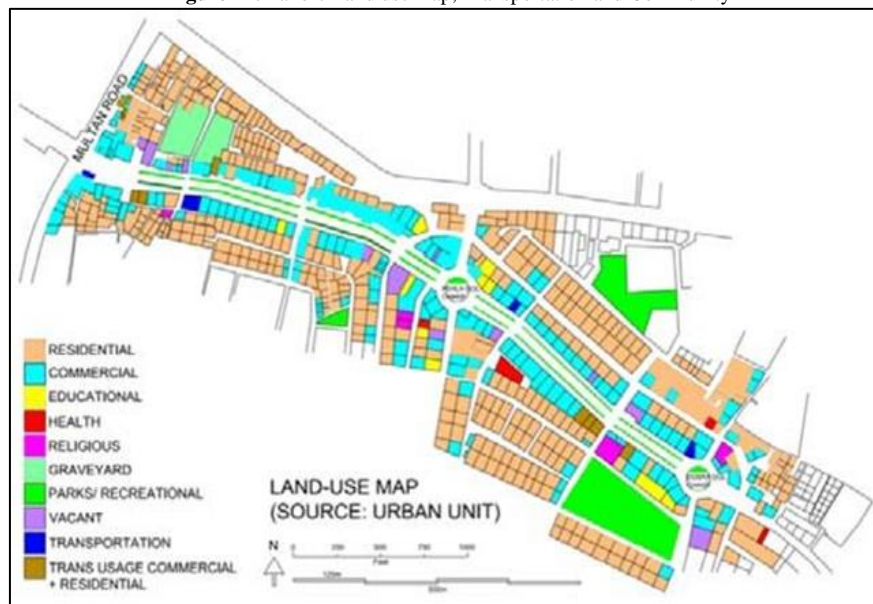
Figure-13. Lahore metro route map – 2030



5. Urban Planning of Light Train Transportation System

This Urban Framework Plan Structure gives applied arrangements to form the development of Lahore throughout following sector of a century. These arrangements first location the significant problems that shape metropolitan structure

- Land use
- Transportation
- Environment
- Capital city image and open space and then provide more comprehensive analyses (Gulcimen *et al.*, 2021).

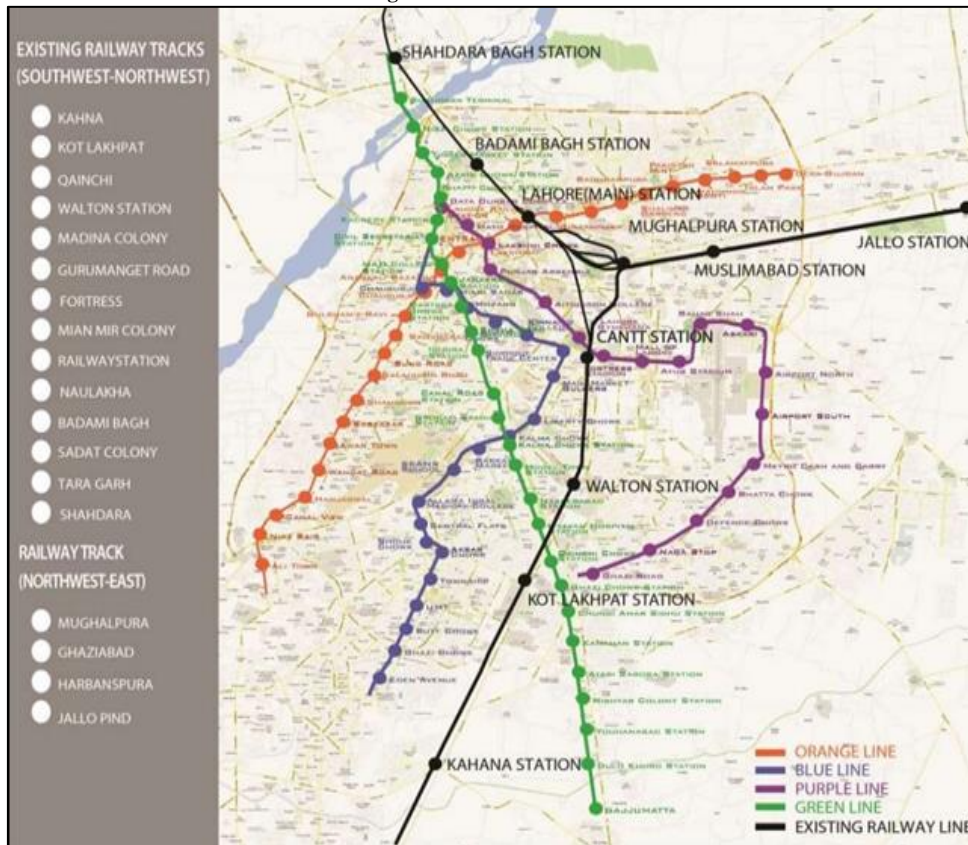
Figure-14. Lahore Land use map, Transportation and Community

Metropolitan structure alludes to the actual elements, like populace thickness, the example of metropolitan advancement, and the area of work and shopping complexes. Metropolitan structure might affect the fulfillment of most targets and is probably going to influence the metropolitan frameworks support of rail, just like the support of complete open vehicle frameworks. Metropolitan structure may decide if working a metropolitan rail framework in specific metropolitan region can be cost effective. What's more, metropolitan structure may have impacts on the accomplishment of land-use goals. On the off chance that the metropolitan structure is truly inadmissible for public vehicle use, it very well might be hard to change the example of metropolitan development just with a metropolitan rail venture. The socio-economic states of the residents as well, may affect in achieving few destinations. Such as, pay and vehicle proprietorship levels may impact the support. This may lead to individual decision on surrendering their vehicles and utilize the new framework. Henceforth, these elements can contribute in influencing the achievement of goals with respect to vehicle traffic and public transport. The construction of nearby governments in a city may likewise influence the accomplishment of metropolitan rail frameworks. It might influence the degree of co-appointment among metropolitan and transport arranging, which was examined as one of the fundamental factors that impacts the achievement of metropolitan rail frameworks. Financing instruments are one more factor that is viewed here as external to the arranging of the frameworks. This is on the grounds that they are resolved fundamentally by public and nearby government financial designs as monetary arrangements with regard to move ventures (Baker and Lee, 2019).

6. Development of the Transport Master Plan

The transport master plan was planned as a comprehensive plan for the execution of facial transport in Lahore, based on the vision of the rulers laid down in the Lahore Strategic Plan. One of STMP's recommendations was to implement high quality, high-speed rail system that could help other face-off routes used in Lahore. The implementation of the application has changed in last four years and the latest DOT declaration is reflecting changing economic conditions and priorities.

Figure-15. Master Plan 2030



The announcement attracted significant interest from industry participants with reports that hundreds of companies have registered their interest in participating to know what is expected to be one of Lahore’s largest acquisition projects (Schuler, 2009).

The DOT has established that the first segment of the tender will include the following:

- Light Rail Transit

According to recently publicized plans comprise two simple trains that will function at distance level: Currently, the DOT aims to build from two simple train operations for the construction, erection, operation, and maintenance of the foundation, and possibly based on FIDIC. We expect tenderers to apply for L.O.T. Both lines are willing to discuss with the DOT whether they are open to nominating one person to provide.

Figure-16. Present Transit Routes



We understand that LRT lines will run between affected roads, so a lot of work needs to be done on the affected roads to make this happen (e.g., diversion, redesign, repair, alteration of road signs, etc.). When the tender documents are issued, whether the DOT itself will approve the project, it will be of special interest to exclude this part of the project from third-party contractors or to include it at the level of responsibility for successful bidding (Sandoval and Hidalgo, 2004).

- Bus Rapid Transit

The concluding component to the project will be the outline of a bus rapid transit, which will comprise a passageway to and from the landmark. This Orange Line will be a shut loop of approx. 4 km with about 25 stops.

We presume this structure will likewise be acquired on a design, build, operate and maintain foundation but expect more comprehensive statistics from the DOT (Karaca *et al.*, 2020).

Figure-17. Prior transit plans



- Line L2 15 kilometers (9.3 mi) light rail with 24 stops
- Line L3 13 kilometers (8.1 mi) light rail with 21 stops

At present, the DOT means the extent of works for the two light rail lines will behave been secured independently on a configuration, assemble, work and look after premise, again presumably FIDIC based. DOT anticipate that bidders should be especially keen on talking about with the DOT whether the DOT is available to the likelihood that one bidder could be designated to give both LRT lines. DOT comprehend that the LRT lines will run down the center of the influenced streets, consequently requiring generous work to the influenced streets to make this conceivable (e.g., redirections, re-plan, alterations, traffic flagging changes and so on) At the point when the delicate archives are delivered, regardless of whether the DOT will acquire this work itself, pass this bit of the undertaking to isolate outsider project workers or remember this for the extent of the effective bidders' commitments will be exceptionally compelling (Karaca *et al.*, 2020).

6.1. Challenges of Light Rail Network Operations

In any framework project, there will undoubtedly be traps and issues en route. This is reliable with LRT projects. Press features on ongoing LRT's are tragically turning into generally very natural.

Similarly in Lahore light rail transit projects, there are number of challenges faced by authorities.

- Increasing Public Travel Demand Leads to Great Challenges to Operations and Management
- Inaccurate Travel-Demand Forecasting Causes Insufficient Supply
- Old Management Systems could not Satisfy Increased Network-Level Operations (Yang *et al.*, 2019).

7. LRT Planning and Procurement

Table-1. Planning and procurement of LRT

Challenge	Risk Mitigation
Lack of procuring organization capability (especially if it is the first LRT the client has procured)	Hire in proven advisers who are specialists in LRT, with experience in the local area
Problems with forecast patronage, journey reliability and train speed	Focus on getting the frequency of stops right, and make sure trams have priority at intersections
Split contract responsibility for procurement and delivery of tram fleet, versus infrastructure build and onward maintenance of tram fleet	Keep interfaces to a minimum and where they can't be eradicated, make sure there are robust and workable interface agreements in place
Beware local politics and the power of special interest groups	Keep the public engaged. Avoid signing the contract until any judicial review or statute of limitations period has expired

8. LRT Construction

Table-2. Construction of LRT

Challenge	Risk Mitigation
Utilities: The outturn construction cost of new tram routes is dominated by the costs and associated time periods for utility relocations	Do extensive and detailed mapping of existing utilities (live and dead) and where possible minimize relocations. Do any that are key in advance of construction.
Method driven specifications leading to inefficient and out-of-date technology solutions	Utilize performance and capacity specs, capable of being adapted to new technologies
Complex signaling specifications needing to integrate with an existing network system	Keep it simple, and build in extra time for the commissioning phase (and then more)
Maintaining the goodwill of the travelling public and impacted businesses during construction	Extensive prior consultation to keep public on-side, and hit areas hard and fast

9. LRT Operations

Table-3. Operation of LRT

Challenge	Risk Mitigation
Aggressive performance criteria with an unbalanced penalty to reward system	Keep performance criteria reasonable and objective. Design the regime to incentivize improved performance over a base level of operation
Trams being used in more severe climates than they are designed for, leading to unreliable running and user frustration	Extensive live trial running of adapted tram fleet before the go-live date
Driver behavior increasing wheel and track wear (can be a challenge where drivers are provided by a separate organization)	Extensive driver training and contractual right to re-train with ultimate redeployment if their behavior doesn't respond
The ability of any long-term contract and technology to adapt to change	Patronage and technology will inevitably change over time, and the contract provisions should recognize that

10. Analysis and Results

- Trackless tram
- Infrastructure costs

Trackless trams are regularly sold on the possibility that the infrastructure costs needed to execute them are low - the thought being that they can utilize the current street network with only a tad of paint for the direction framework, and all you truly need to fabricate are the "stations", which can be something like an available trams stage stop (or something more intricate on the off chance that you so want). This is diverged from traditional trams, which require similar cost for stops, yet in addition expect you to tear up the street surface and lay steel rails.\

Figure-18. Tram infrastructure



Assuming we expect to be that that is valid, transports are as yet the least expensive - you can run them on the current streets as well, and their capacity to "stoop" down at kerbs implies you truly simply need a substantial cushion and a transport haven to make for an available framework, instead of stage stops. However, expecting that it is valid, trackless trams would address a tremendous expense saving contrasted with traditional trams (Newman *et al.*, 2019).

Interviewing Transportation Specialists.

Table-4. Interview of Transport Specialists

S No.	Interview with Transportation Expert and their job title	Discussion
1	Interview 1 Transport executive	Had a significant conversation with one of the transport executives in the transportation sector of Lahore. According to him, Lahore has a good network of transportation around the area. He has the task of carrying out day-to-day logistics according to the requirement provided to him.
2	Interview 2 Logistics Coordinator	Interviewed one of the logistics coordinators of Lahore who conducts transportation of various goods, processes different orders, and oversees the fulfillment of various orders. He believes in the need of implementing a light train system in Lahore. However, he knows that the process will be very difficult.
3	Interview 3 Strategic Account Manager	This individual is responsible for managing the strategic account of the Lahore's transportation sector. He oversees if the relationship with the customers is good and satisfying and responsible to fulfill the requirements and different needs of the customers.
4	Interview 4 Rider Ops Support	This person involves in Rider Ops Support and possesses every bit of knowledge regarding logistic management. He believes that the implementation of the light train would be a very difficult process in Lahore as it would disrupt several other transportation services.
5	Interview 5 Fleet and Vehicle Controller	The individual is responsible for controlling the fleet and vehicle inside Lahore. He ensures the capacity planning for transport optimization.
6	Interview 6 Logistics executive	This person is in the position of logistic executives and is responsible for managing the shipments coming from all over the world through sea and air. He also mentioned that Lahore transportation sector is very effective, however, the light train system would be a difficult process of implementation in Lahore
7	Interview 7 Supply Chain and Logistic Manager	One of the supply chain and logistic managers in the transportation sector of Lahore. He oversees and facilitates different online orders and manages the shipments coming into the region. He believes that the transportation sector is very effective, however, there is plenty of room for improvement.
8	Interview 8 Logistic Operation Coordinator	This individual is responsible to coordinate with the warehouse for the deliveries as well as shipments to customers as per the needed time. He also believes that the implementation of the light train system in Lahore would be a very difficult procedure.
9	Interview 9 Chartering Manager	This person is responsible for the charter of the vessels and operations and vessels for several vessels consisting of different petrochemical and chemical products. He considers Lahore's transportation sector is very effective.

11. Comparison between Lahore LRT and Lahore MRT

11.1. MRT

The Metro will be fully integrated into a network maintained by the Roads and Transport Authority (RTA), a company founded in 2005. Trails are arranged around the spine provided by the rail system. This framework development of Lahore Economic Vision of 2030 shows its main economic development strategy that caters to various sectors of future growth, competitiveness among globally renowned developed and developing countries, enterprises of growth driven states, and socio-economic distribution revolving around regional and social groups. Its next focuses on policy and regulatory enablers such as business environments, labor policy, fiscal policy, and

financial policy. The resource enablers of these include the infrastructure and services development, human resource management development, and financial capital development.

Figure-19. Dubai MRT



11.2. LRT

The Lahore Light Rail Project is a unique opportunity to transform city transport into a world-class, secure and comprehensive service. The project is an integral part of the Lahore 2030 Master plan, which will ensure the city's economic, cultural and environmental goals by meeting the urgent need for modern and sustainable public transport infrastructure.

The stations use minimal fumigation and cooling 'chimneys', which absorb fresh air in shelters.

12. Why is it so Difficult to Implement a Light Train System Inside Lahore?

"Rail is a great way to transport high-volume goods: commodities, containers, aggregates, cement, and sulfur. The railway can do it better than anything," says Richard Bowker.

"In most of the places in the world, you always have to deal with things sorted out 100 years ago," "But here there is an opportunity to learn from the best of the best and apply that in a way for the best possible results in the Lahore."

Its 2030 economic development plan calls for the emirate to boost several industries, including alternative energy and tourism, while also spending billions to beef up infrastructure such as rail.

"The development of an integrated railway network signifies the inception of a new chapter of transport in the Lahore," says Nasser. "The rail network will form an imperative part of the country's infrastructure and promote integration between various methods of transportation, both current and planned for the future."

Overall, the railway network, stations to the western part of the country and from the dense ports of Lahore to the north coast. The trains will supply 50 million tons of various goods in the first few years. Although the railways have long been part of the global transportation system, such a network has recently emerged.

Although they have decided to use diesel instead of electric engines, Rail officials say the network will improve the environment compared to trucks. The second phase of the network, operated by First Phase Engineering, will set up Lahore tracks, approximately 240 kilometers west of the city of Lahore.

"There is strong potential demand for passenger service. But we have a colossal amount of work to do to get the first stage running. It's all about priorities."

When it comes to engineering and construction infrastructure, the railway system paves the way for life from housing and commerce to a time when the global economy is in the throes of recession. According to the research company, LRT it is a good way to keep a company that separates the railways from being overpowered in that large sector. Political unrest in the Middle East did not prevent Lahore from pursuing a development agenda.

13. Overview

Public transport in the Lahore was non-existent until the 1970s when the first bus service was opened in Lahore. The first train system was built around the same time. However, these were not passenger trains; they were used to construct adequate roads. Construction and use of rail systems remain limited in the Lahore. Low petroleum prices encourage private use of cars and airplanes. The technical challenges of building, running, and maintaining rail network operation in sandy environments discourage construction. The main commodity produced by the nation is oil, which is moved more easily and cheaply by pipeline.

Rail transport, however, looks set to become increasingly common in the Lahore and across the Middle East. Industrialization, urban development, tourism, worsening traffic problems, and the need for a more effective, sustainable, and environmentally-friendly network for public and freight transport have boosted railways' appeal.

14. Regulations and Best Practices to be Considered when Starting a Project

As is the case in every nation, and on most types of infrastructure projects, a necessary pre-condition for success is having and adhering to the appropriate legislative and regulatory framework. The Lahore government has developed a clear vision and a carefully planned strategy in pursuit of playing a leadership role in rail transport. Development in this sector is to be achieved through regional and international collaboration, developing and re-shaping policies, and enacting laws to promote rail efficiency and safety.

15. The Legislative Framework in Lahore

The rail sector in Lahore is governed by the following laws:

- Planning, designing, and developing the public railway network in Lahore.
- Regulating works that establish, develop, operate and maintain the railway network in Lahore and
- Regulating the construction, development, operation, and maintenance of private rail networks within

Lahore.

The organizational unit within the Rail Transit Authority, which has the responsibility to, among other things:

- issue Safety Status Certificates;
- issue Operational Safety Certificates;
- stipulate railway safety conditions; and
- Investigate accidents.

The Agency, on the other hand, is responsible for, among other things:

- issuing No Objection Certificates (NOCs);
- issuing verification of compliance with the relevant requirements;
- recommending land to be reserved for the public railway network;
- adopting land reserved for the public railway network; and
- Determining the principles and standards of qualification and approval of contractors, consultants, and operators.

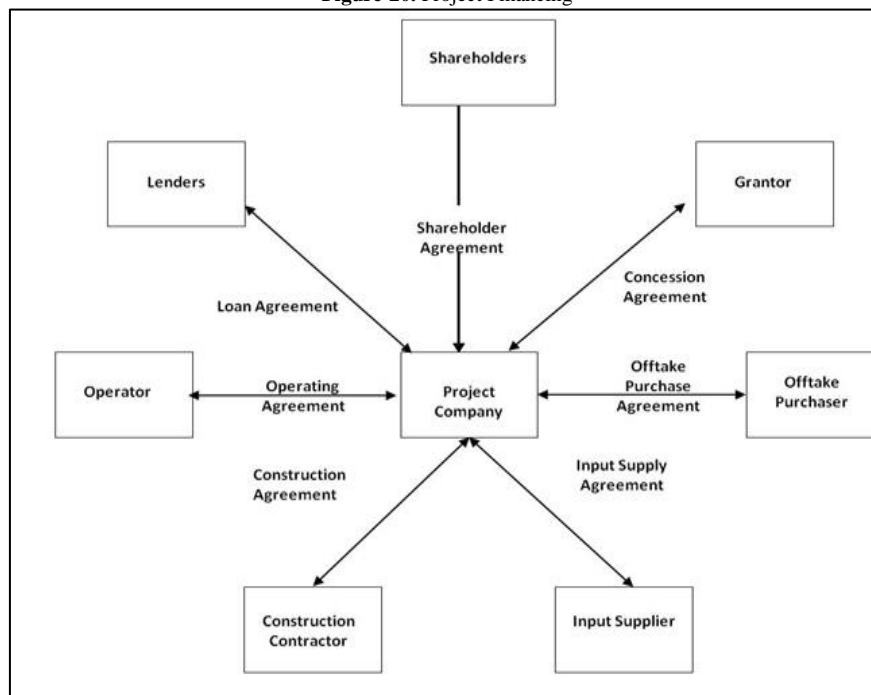
After a brief review of the developer project, the RTA may request additional information or specifications to be addressed by the developer. Once the RTA is satisfied with the information, it issues a development NOC. After the NOC design phase has been released, the engineer can hire a suitable RTA designer for the concept design project. The developer must ensure that the specified business (s) is known/approved by the RTA, have an RTA pre-qualification NOC, and are licensed by the Lahore Municipality. Failure to do so will result in rejection of the RTA for submitted or completed work.

In Lahore, the Department of Transport (DOT) is responsible for all aspects of transport development and policy. Currently, the DOT does not have any rail networks within its responsibility.

15.1. How Projects are Financed

How a project is funded depends on its scale. Small projects are often funded by lenders with 'corporate' or 'full support'. Large projects often require 'project funding'. It usually involves limited income for the specific purpose of building a large, expensive project, where the borrower has a special purpose vehicle (SPV). Payment terms are below the scope of the economy. Usually, major project loan agreements are based on standard financial statements from the Loan Market Association.

Figure-20. Project Financing



15.2. How to Prepare for the Right Deals

Although the number of railway projects in the Lahore is limited, engineers use: construction only; design and construction; And Project delivery contract model delivery. In contrast to railway projects, major developers often use public-private partnerships (PPPs) (although limited to the Lahore to date), which include private sector investment and / or technology. When deciding which model is most appropriate, many factors must be considered, including the type, size and complexity of the project, the amount and availability of funds, group risk and commercial, legal and technical.

Construction contract only this is a typical contract model used in the Lahore railway sector. It involves a technical consultant who creates and directs the work and an employer who employs a contractor to do the work. The designer is responsible for the management of the railway project and the contractor is responsible for the work. As long as there is a construction defect, the contractor will not be obliged to repair it.

16. Conclusion

This examination has been worried about transport especially light rail transit in the Lahore. Transport has had a significant impact on the idea of geological examples like monetary action, social action and other related perspectives. In this concept, uncommon thought has been given to the connection between the improvement of transport and financial improvement in, Lahore which has most intentionally taken advantage of the lucky breaks for extension which proficient transport techniques are hypothetically expected to work with this concept.

From the above study, it can be concluded that the light rail is opposing economic and completion time milestone challenges. Still, this will be well planned to grow the economy and increase the transportation facility in the city. The client (Transportation department) is thoroughly inspecting every inch of the project to conserve the designed sustainability of the project. Theses series of project include the highway improvements, facilitated advance technology, traffic solutions and enhance connections. The project makes some theoretical contributions to urban regeneration and project management.

The light rail system project is designed based on the unique social-cultural and environmental considerations. And the goal is to make a world-class transportation system and to make a role model for other cities in the world. The Lahore government plans to create an environmentally friendly city, protect society, preserve and promote the culture and tourism industry. In 2030 the Lahore city will be well designed on every angle. This city will be economically stable and environmentally sustainable. It will be a highly livable city among other great cities in the world.

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