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An Urban Public Transit System Planning Study for Bhopal City's Metro Project

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I. INTRODUCTION

1.1 GENERAL

The motivation behind this thesis is briefly described in the introduction. A brief introduction is provided in this section. This section also discusses the goals of the master's thesis as well as its constraints. To provide the reader with a more comprehensive understanding of the current state of affairs, Bhopal's public transport system is described. An outline of the master's thesis will be presented in the last part. The thesis's introduction is expanded upon in the points that follow.

Since most Indians don't possess personal vehicles, there is a significant need for public transport in Indian cities. With the exception of a few major cities, most residents use public transportation frequently because the percentage of people who own their own cars is rather low. Lower-class individuals will forgo comfort in favour of less expensive transportation options, but middle-class and upper-class individuals who own cars will prioritise comfort and quality of service.

1.2 BHOPAL (A BRIEF OUTLOOK)

One of India's greenest cities, Bhopal serves as the capital of the state of Madhya Pradesh and the administrative centre of the district and division. The city is known for its many man-made and natural lakes. It ranks 131st in the globe and 16th in size in India. Bhopal offers a unique blend of modern urban planning, old world charm, and scenic beauty. This lovely city is also known as the "City of Lakes." In spite of its modernity, Bhopal has grown into a city that retains the noble aura of its former rulers. The city has developed into a multipurpose regional centre for sociopolitical and economic activity over time.

 The city of Bhopal can be split into two sections: the newly created region with commercial, industrial, institutional, and residential activities, and the old city. In Madhya Pradesh, Bhopal is the second-most populous district after Indore. Approximately 1,433,875 people live in Bhopal district, which spans 2,772 square kilometres, according to provisional Census of India population totals from 2011. The population density is 854 people per square km on average. The district has an 82.3% literacy rate. In the city, bus services are the main provider of public transportation options. Buses run the most passenger km per day when only the city's automated transit systems are taken into account.

There is a significant opportunity to increase the modal share of buses by enhancing bus service in Bhopal city, even though buses provide the highest passenger-kilometer travel. This is because buses have a relatively low modal share in terms of person-trips. Nonetheless, throughout the past 20 years, there has been a steady increase in the number of people using public transport.

As a result of the introduction of contemporary technologies, easy access to government programmes, and Bhopal's status as the state capital, a sizable population began to migrate there in an effort to improve their quality of life and career prospects.

Mohan, 2008 explained about Metro rails are rail-based, mass rapid transit systems that operate on an exclusive right-of-way, which is separated from all modes of transport in an urban area. Most often, the right-of-way is either underground or elevated above street level. These systems generally operate at an average speed of 20–35 km/h, and are characterized by their high capacity (50,000–75,000 passengers per hour, per direction) and high frequency of operation. The capital cost of construction is between 20–30 times that of the Bus Rapid Transit system, depending on whether the metro systems are underground or elevated (Mohan, 2008). There has been a growing interest among policymakers about the relevance of rail-based systems in India, to address the mobility needs of the expanding population in the cities. While evaluating different mass transit options for Indian cities, metro systems are often given preference due to the belief that road-based bus systems cannot cater to capacity requirements as much as metro systems. In addition to this, metr rails are perceived to have higher levels of comfort, speed and efficiency, than bus systems, making them more attractive to both policymakers and

potential users of the system. Promoters of metro systems often claim that one of the benefits of the metro is reduced congestion, due to the users' shift from road-based motorized modes to metro systems. This mode shift is then claimed to result in reduced air pollution and road accidents. However, the experience of metro rails in low and middle income counties around the world shows otherwise (Mohan, 2008). Due to the induced demand, the available road space fills up with motorized vehicles, and the modal shift to metro does not result in the reduction of congestion or air pollution.

Jain and Tiwari, 2011 summarized in their study done by the Centre for Science and Environment (CSE) on pollution levels in Delhi illustrates that in 2001 (Delhi Metro started in 2002) the annual average level of respiratory suspended particulate matter (RSPM, or PM10) in residential areas stood at 149 microgram per cubic metre. After registering a drop in 2005, the level rose to 209 microgram per cubic metre in 2008. The concentration is approximately three times higher than safe levels. Similarly, the eight-hourly maximum current level of carbon monoxide (CO) is touching 6,000 microgram per cubic metre – way above the safe level of 2,000 microgram per cubic metre – though the annual levels have registered a drop. Overall, these figures illustrate that the operation of the Delhi Metro has not led to a reduction in pollution levels in the city (Randhawa, 2012). Due to the limited coverage of the city by rail-based systems1 , as opposed to road-based bus systems, a metro commuter spends significant time during access (from origin to metro station) and egress (metro station to destination). As a result of this additional time, even though the average main-haul (in-vehicle) speed of the metro is above 30 km/h, the average door-to-door travel speed gets reduced for a short trip on the metro system – as compared to a road-based system. Hence, metro systems have been found to be most favourable, in terms of saving time, if the trips are 10 km or longer. Due to mixed land-use and the polycentric nature of Indian cities with multiple central business districts (CBDs), however, the majority of trips remain below 5 km.

However, the public's ability to access the metro rail project will determine how effective it is, so efforts should be made to complement it with a Bhopal road transit system. The Bhopal Metro will provide the city with reasonably priced, dependable transportation while cutting down on travel time and pollution. The table on the following page displays the city's statistics as of the 2011 census.

Table 1 Showing population of Bhopal city

City	Bhopal
State	Madhya Pradesh
District	Bhopal
Total Population	1,433,875
Total Male	755,685
Total Female	678,190
Total Male (0-6 Age Group)	105,034
Total Female (0-6 Age Group)	98,314
Total Literates	1,433,875
Total Male Literates	755,685
Total Female Literates	678,190

Indian Census Department (2011)

Even though only 33% of Indians live in cities, the 2011 Census shows that private vehicles are already congealing our cities' roadways. 60% of people will live in cities by 2050, according to government estimates. This will increase the load on the transport system's infrastructure. The fact that not every urban agglomeration can benefit from a certain transport system paradigm exacerbates the issue. With turnaround times getting longer every day, running bus services in crowded streets has grown more challenging in crowded networks. In almost all public projects, fleet sizes have decreased rather than increased to keep up with demand.

With all these challenges, India faces a severe transportation dilemma. We must find answers quickly if we wish to avoid getting into a serious situation where we are stuck.

The predicted and current issues in the older metropolises, such New Delhi, Mumbai, Kolkata, Bangalore, etc., were researched and experienced in light of the impending metro train project in Bhopal. One of the main problems with the system that was discovered was that the road network connecting the metro stations to the public transport system couldn't keep up with the needs of these cities' constantly growing populations.

The board of customer satisfaction defines a higher challenge by those service providers

Irrational stop placement: When planning a route, it is important to consider the stops' locations in order to support the bus network set up to cover it and to ensure that links to other routes are accessible.

• Inefficient bus design – When designing a bus, it's important to take into account the space in which it will be used to transport passengers. Buses that are too small will carry too few passengers, which will lead to the issue of overcrowding, and buses that are too big will cause traffic congestion.

• There is a lack of rigorous adherence to the schedule and frequency of operation. The buses should rotate in accordance with the schedule in order to inform passengers of the general timings of each route. Additionally, it is important to consider the frequency of services so that a customer who unintentionally misses a bus won't have to wait for a long time.

• Terminal facilities are subpar – In order to facilitate passengers and, by extension, the entire bus transportation network, terminal facilities need to be closely monitored and maintained.

II. LITERATURE REVIEW

This chapter will introduce the concept of customer satisfaction and perceived service quality by public transport users. To understand the parameters which influencing the mode choice, previous studies in the field of study of mode choice behaviour analysis and identified to method to develop the model for change in ridership. For this purpose review of relevant literature and research works are necessary to be performed. In this section, concept and different methods of modal split techniques can be examined and also to understand that which the different parameters are which help in improving the transport facilities and making those facilities an asset for the passengers travelling in it. In this literature review of previous case studies and research works are included which demonstrate the different methods of evaluation of mode choice analysis. These references proved to be a great advantage for us to effectively undergo our survey and give a factual result and up to the mark achievement.

Ajay Pratap Singh, Dr. Varun Singh, Dr. A.K. Sharma, Dr. A. Sharma, 2014 described in their paper about the ancient time, Public Transit provides a basic mobility service to the persons without access to personal vehicle. Now-a-day Public Transit is an integrated part of human life. From traditional means of palanquins to modern means of Public Transit, the face of Indian Public Transit system has progressed at a rapid pace since the inception of economic liberalization of the 1990s. India's public transit system which is rising by almost 10% a year are among the most heavily used in the world but the access to these modes of transit has not been uniform and are still riddled with problems due to poor or outdated infrastructure and lack of investment. Just like India, growth of Public Transit System in Bhopal city is also very rapid. Bhopal's public transit system is a combination of low floor buses, mini-buses, autos and the odd structured tempos that are playing as major contributor of pollution for this growing city. Under the scheme of JNNURM, low floor buses are operated by Bhopal City Link Limited with the help of Municipal Cooperation, which are under GPS navigation. In addition, around 600 mini buses are run by private operators. Metro or Radio Taxis and auto rickshaws are another major means of transit. In some parts in the old as well as new city, the new Tata Magic Vans are running successfully and have replaced the older and bigger diesel rickshaws known as "Bhat". Bhopal is also

with multiple central business districts (CBDs), however, the majority of trips remain below 5 km.

Rahul Tiwari et al. 2021 published in their research paper Growing urban population has led to recognition of urban sprawl as a serious planning concern, especially in developing countries. Urban economists identify three major responsible forces that interact together and lead to spatial urban sprawl. First, the population growth is resulting in outward expansion of urban areas; second, rising income levels attracting citizens to procure larger living space. These residences are generally located where land prices are less expensive i.e., suburban areas located at the outskirts of metropolitan areas. Interestingly, the third, force responsible for inducing urban sprawl identified in literature is decreasing commuting costs produced by investments in transportation infrastructure which fuel outward expansion of development. Therefore, through review of literature, it is understood that urban sprawl tends to occur where property values are lower on the periphery of urban centres and low-cost public transport availability is one of the major factors that contribute to the sprawling of people from the city centre to the suburbs of the city. Bhopal, the capital city of central state of India implemented bus based public transport facility in year 2005 under National Urban Renewal Mission (NURM) and has till date many folds expanded the service to suburban regions targeting people living there. Notably the municipal area of city has also increased from 265 square kilometres in year 2005 to 463 square kilometres in year 2020. This research study attempts to explain the relationship between public transport expansion and urban sprawl, taking the case study of Bhopal. Spatial data for Bhopal was developed for the years ranging from 2005 to 2020 using ArcGIS and Google Earth Pro, in order to understand the changing city footprint along with details of public transport network over the corresponding period from Bhopal Municipal Corporation (BMC). Standard urban spatial singlemode model to incorporate public subsidies for one mode, i.e., bus based public transport was used. Comparative statistical analysis of model produces empirically testable hypotheses and identified the relation between expansion of city and public transportation available in city by observing the all maps of past to present years of Bhopal. At the end of the research paper, it has been highlighted how public transport expansion impacts urban sprawl by means of the correlation coefficients and spatial analysis. Our most important theoretical result is that the transit subsidies on the suburban areas are directly related to urban sprawl. Arguably, public transport which was targeted as strategy to promote sustainable urban development has resulted in sprawl. The paper ends with a recommendation to examine and analyse the impact of public transport service expansion to sub-urban regions in light of city expansion.

Report Published in 2019 Bhopal, the capital of Madhya Pradesh state in India, is a fascinating amalgamation of scenic beauty, old historic flavor and modern urban planning. It is also known as the "City of Lakes". The city has emerged as a multifunctional regional hub of socio-political and economic activities. Bhopal city can be divided into two parts - the old city and newly developed area with administrative, institutional, industrial, commercial and residential activities. The Government of India, Ministry of Urban Development and Poverty Alleviation (MoUD & PA) has classified Bhopal as a "National Priority City" in the report of National Commission on Urbanization. Bhopal enjoys a strategic location in the state of Madhya Pradesh. The other important towns of the state, namely, Sehore, Indore, Berasia, Bairagarh, Hoshangabad, Vidisha, Narsingarh, etc. lies in close proximity to Bhopal. Mandideep is an upcoming industrial development while the township of Kolar is gradually growing. The national capital, New Delhi is about 741 km away, while Mumbai is at a distance of about 789 km. The study area considered for the SUTI Indicators is the Bhopal Planning Area spanning over 813 sq.km and houses a population of 2.018 million people. The study area considered includes the planning area of 505 sq.km, municipal area of 258 sq.km

and the surrounding villages of 50 sq.km. The population and density values under the different boundaries has been summarized in the table below. The Bhopal Municipal Corporation area is further divided into 70 administrative wards. The ward boundaries are further aggregated into 14 planning zones.

Rishabh Jaina and Kolluru Hemanth Kumar, 2013 explained that Transport is an important part of nation's economy. In the interims, public transport has always been the primary mode of transport for most of the population, and India's public transport systems are one among the most heavily used in the world. The main problem faced irrespective of the cities of any country around the world including India is at some point of time they have to face problems associated with passenger mobility and connecting the city verge with central part, in urban areas and found few innovative solutions to overcome this problems. Urban Planners, Engineers and Urban Administrator have found Bus Rapid Transit System (BRTS) as efficient, cost effective and simple as compare to other Light Rail Transit (LRT) and Metro Rail solution to provide 'life line' to city. Thisis one of the type of public transport which is a bus based mass transit system. Generally it is described as a "surface subway", BRTS aims to combine the capacity and simplicity of a bus system. BRTS is best suited in mid-size cities like Bhopal with deficient bus services, where the middle class basically forms the social structure, where there is high demand irrespective of availability of Right Of Way, as it can operate in a mixed traffic situation also. BRTS basic concept is to relieve road space by reducing individual vehicles with low occupancy, by carrying them in a comfortable, fast, mass transit mode. We discussed about the vehicular growth and modal split in India and the needs for choosing BRTS as the best option for cities in India as one of the public transport system. At last we presented the observational study on Bhopal BRTS to analyze the actual condition of Transport System.

Mukti Advani and Geetam Tiwari, 2003 in their research paper say that If a very good, coordinated, well-organized feeder system is provided to the Metro, accessibility of metro will increase. DMRC is planning for an integrated ticket. If the integration works out, the same ticket will be valid in metro trains as well as buses. However, this will translate to higher rider-ship only if commuters are willing to accept the added transfer time and transfer costs.

Metro systems have been planned to reduce congestion on the roads. However systems planned in India shows that cost overrunning and under utilization of capacity. Methodology and arguments used to justify these systems needs careful analysis. High capacity system does not necessarily generate high demand. Estimation of passenger demand for transit services should consider complete journey of commuters including access time.

Additionally **Junjun Wei, Kejun Long, Jian Gu, Qingling Ju and Piao Zhu 2020** in their research paper point the importance of the complimenting nature of Bus and metro lines. In most cases, metros were built and added upon the completed and complex bus network. The interactions will come out on the operation of the original public transport network after the metro construction. In order to improve the overall operating efficiency, metro and bus lines should be integrated into one unified system.

From findings described in this paper, it is possible to clarify that, theoretically, the factors that affect the co-opetition degree between metro and bus include: the geographical space relation, the transport capacity, passenger demand distribution, etc. Therefore, the calculation becomes very complex and requires massive basic data.

M. Bagchi and P. R. White, "The potential of public transport smart card data, " Transport Policy, vol. 12, no. 5, pp. 464–474, 2005 talk about the applications of the smart card in understanding the flow of passengers and developing the road transit system accordingly. Smart card data can also be used to analize travel behaviour and extract the pattern of travelling of transit users. The travel behavior in transit networks can be investigated accordingly in such a way that the city planners can come up with integrated road transit systems keeping it in accordance with the transit ridership and origin-destination choices and the mode of transport preferred. Based on the investigation of travel behaviours, many studies are conducted to extract individuals' spatial/temporal travel patterns and mobility patterns. The dynamics of travel behaviours and the variation of travel pattern were also studied. Some other studies focused on the regularity of individual travel pattern, using smart card data to classify transit passengers.

III. CASE STUDY

3.1 GENERAL

By 2050, India is expected to be a superpower, and what is a superpower if its people aren't organised in a methodical way?

It has become urgently necessary to develop new strategies and integrate the current systems in the transit scenario due to the growing population in cities. To accommodate its constantly expanding population, India (like many other developing nations) has fallen behind in building a metro rail transit system.

While studies indicate that public transit should have a modal share of over 70%, in India's major cities, this percentage is closer to 35%–40%. This is caused, however, by the metro railway line's failure to successfully connect to the city's major areas, and the public transport system takes advantage of this flaw to profit from its own connectedness. A prosperous city always makes the most of its resources by combining excellent engineering and planning to create a well-planned, elegantly laid out city where all of its resources complement one another.

Having spent a significant amount of time in Delhi, I have personally encountered numerous issues with the city's connectivity and the way the roads are connected to the metro stations. The time it takes to walk to the metro station is often wasted because bus stops are sometimes positioned distance from the station. Additionally, it caused some discomfort, so as a passenger, I frequently chose the more comfortable modes of transportation, such as taxis or rickshaws. Given how much time and money I'm spending on my journey, I might experience more discomfort if there is an emergency.

The main reason of many of these issues is that when it comes to designing our cities' road transit systems, urban planners frequently overlook different factors. A passenger's quality of life can be greatly improved with small adjustments and significant improvements to the way our transportation system is designed, since roughly 30% of a working person's or citizen's time is spent travelling within cities or commuting.

Even the Delhi Metro, which is regarded as the most prosperous in our nation, has only little success.

In the national context, India's public transport networks aren't particularly effective.

There was only one metro system in existence before to the creation of the Delhi metro system, and that system was established in Kolkata in 1984. A mass rapid transportation system has been discussed extensively for more than 25 years, but it wasn't really created until 2002.

The Mumbai Local, also known as the Mumbai Suburban Railway, is a very successful rail transit system, yet it is not as sophisticated as one would desire for commuting.

Other major cities with metro rapid transit systems include Bangalore, Mumbai, Gurugram, Jaipur, Chennai, Kochie, and Lucknow. These cities' metro systems are relatively new, serve a small region, and as a result, have minimal ridership. Evaluating the success of these metro systems is still extremely early.

3.2 ABSTRACT OF THE CASE STUDY

This article presents the findings of a study based on the Bhopal metro plan, along with a proposal for an effective transportation system to support the forthcoming metro rail project. The majority of the research conducted here is based on my own well-researched and well-considered viewpoints. My goal is to develop a clear understanding of how the transportation system should be modified to improve passenger comfort and prevent project failure. Because the success of the entire project depends on how frequently the Bhopal Metro Rail transit system is used, the Customer Satisfaction Index is necessary in all of this.

The index makes it possible to track service quality, pinpoint the reasons behind consumer contentment or discontent, and establish plans for raising service quality. Compared to other methods used to measure service quality, the suggested methodology has some advantages because urban planners may apply it with ease. I must state that the CSI research serves just as a proving point for the entire investigation; it has no direct bearing on what I have said.

3.3 INTRODUCTION TO METRO RAIL TRANSIT SYSTEM

By 2050, India is expected to be a superpower, and what is a superpower if its people aren't organised in a methodical way?

It has become urgently necessary to develop new strategies and integrate the current systems in the transit scenario due to the growing population in cities. However, in order to accommodate its rapidly expanding population, India (like with many other emerging nations) has fallen behind in building a metro rail transit system.

According to research, the optimal modal share of public transport, or MRTS, should be over 70%; however, in Indian metropolises, this percentage is only between 35% and 45%. This is caused, however, by the metro railway line's failure to successfully connect to the city's major areas, and the public transport system takes advantage of this flaw to profit from its own connectedness. A prosperous city always makes the most of its resources by combining excellent engineering and planning to create a well-planned, elegantly laid out city where all of its resources complement one another. Having spent a significant amount of time in Delhi, I have personally encountered numerous issues with the city's connectivity and the way the roads are

connected to the metro stations. The time it takes to walk to the metro station is often wasted because bus stops are sometimes positioned distance from the station. Additionally, it caused some discomfort, so as a passenger, I frequently chose the more comfortable modes of transportation, such as taxis or rickshaws. Given how much time and money I'm spending on my journey, I might experience more discomfort if there is an emergency. Many of these issues derive from the fact that urban planners frequently overlook different factors while designing the road transport network in our cities. Since a working person or citizen spends about 30% of his or her time commuting or travelling inside a city, a passenger can greatly improve his or her quality of life with a few small adjustments and significant modifications to the way our transportation system is designed. Even the most successful metro in our nation, the Delhi Metro, is just mediocrely successful.

In the context of the country, India lacks an effective transportation infrastructure. The only city with a metro system prior to the creation of the Delhi metro system was Kolkata, which has had one since 1984.

Although there have been extensive discussions about a mass rapid transit system for more than 25 years, it wasn't until 2002 that the system actually came into being.

The Mumbai Suburban Railway, also referred to as the Mumbai Local, is a very effective rail transit system, yet it is not as advanced as one would want for commuting.

Other major cities with metro rapid transit systems include Bangalore, Mumbai, Gurugram, Jaipur, Chennai, Kochie, and Lucknow. These cities' metro systems are relatively new, serve a small region, and as a result, have minimal ridership. One could argue that evaluating the effectiveness of these systems at this early stage of their development would be premature.

Integrating the road transit system with its nodal points in accordance with the current nodal points in the road transportation is one of the most effective ways for a city to utilise its major transit system, or the ideal modal transit system, which is the metro rail.

IV. METHODOLOGY ADOPTED

4.1 MODEL CONSTRUCTIONS

Studies carried out in several parts of the city revealed a need to investigate prospective demand. The potential demand for a link can be further defined as the ratio of the link's origin to its destination, which could be a rail transport system station, and the traffic demand of the associated aggregated region. There is an increased need for feeder bus utilisation in farther-flung places. The average passenger distance to be drawn to that connection stop was found to be inversely related to this prospective demand. But it's crucial to remember that convenience plays a big role in driving demand for these kinds of buses. This indicates that there is less demand for passengers on the feeder buses due to the bus lines' regular frequency.

One potential solution to this peculiar survey issue is to develop an integrated feeder bus and metro rail system that employs the city's existing bus fleet to serve as a feeding pod for metro stations. This eliminates any possibility of confusion for passengers when choosing a bus, which in turn makes it easier for them to recognise metro and bus lines as part of a single, cohesive urban transportation system.

4.2 PROBABILITY SAMPLING

Probability Samples Because you may determine the likelihood that a participant will be chosen from a population, these techniques are also known as probability sampling techniques. You can be quite certain that your sample is representative of the population if you obtained it using probability approaches. To obtain comparable samples, others may, at minimum, duplicate your selection process. sampling sampling is the process of drawing a sample so that every member of the population has an equal chance of being included in the sample.

The likelihood that any particular person will be included in the sample is 1 divided by the population's dimensions, or population size. If the population was small, we could put the names of all the participants in a hat, mix it up, and keep adding names until we reached the desired number for our sample. It is obvious that if our population is enormous, this will not always work. An appendix containing a table of random numbers is common in statistics textbooks. This table is frequently used to choose sample individuals from the population. Many statistical procedures are predicated on the notion that sampling has been random, despite the fact that few researchers actually employ this process.

Table 2 The regional area and the travel demand

Area name (462)	016	024	011	023	008
Area (sq.km)	1.75	1.93	1.78	2.10	3.50
Rail passenger demand (Person/day)	1236	1285	1620	1978	2451

The size stated in square kilometres does not represent the entire area falling under a pin code; rather, it represents the area that was the subject of a survey that was carried out in that specific pin code area.

-Based on a survey that was carried out among residents in the 462016–462008 area, we learned that passengers use taxis and rickshaws or the pre-existing bus line as their convenient mode of transportation because there is no other option.

-When the sample people were shown the metro line routes, they also mentioned how convenient it would be for them if there were buses that could connect their neighbourhoods to the nearby metro station. They would definitely take advantage of this. After the population samples in the aforementioned areas were randomly selected, the following questionnaire was created for interviews.

4.3 QUESTIONNAIRE

For lengthy trips, which would you rather use—the current transit system or your own car?

• Why do you use the current transport system for roads?

• For long-distance travel, is your preference the current transit system or your own car?

•How do you find the routes and buses that you wish to take?

1. How comfortable do you feel about your personal security while on board?

2. How hygienic are buses and bus stops?

3. How long did it take you to get from your starting point to your destination via bus?

4. How Often Do Buses Happen?

5. How simple is it to identify buses and routes?

• How can the poorly run transit system in Bhopal help with the current issues, in your opinion?

• How frequently are you going to use the free Smart Card for the metro and buses?

• In the event that a road transit system connected you directly from your starting point to the Metro Station, how frequently would you use the Metro Rail? (Those who commute in their own cars were asked this question) • Is it simpler for you to recall the bus identification based on the routes or the colour of the buses?

• Would you find it convenient to use the current transit system if it served as a feeder for the planned rail project and was coloured in accordance with the route's colour scheme?
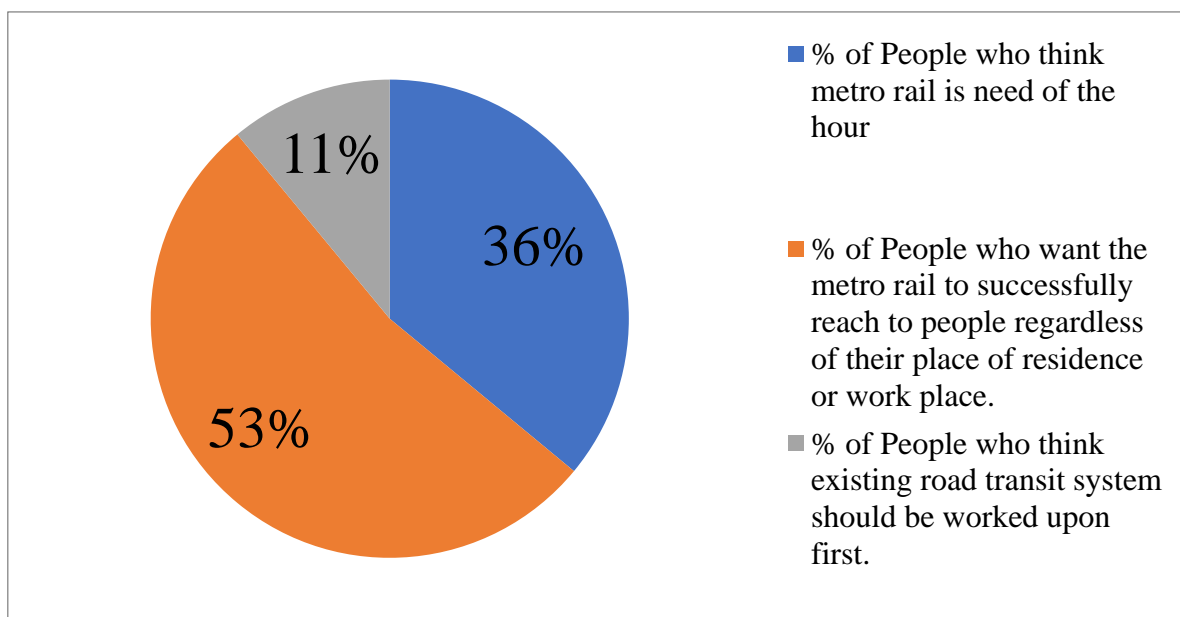
4.4 FINDINGS OF THE SURVEY
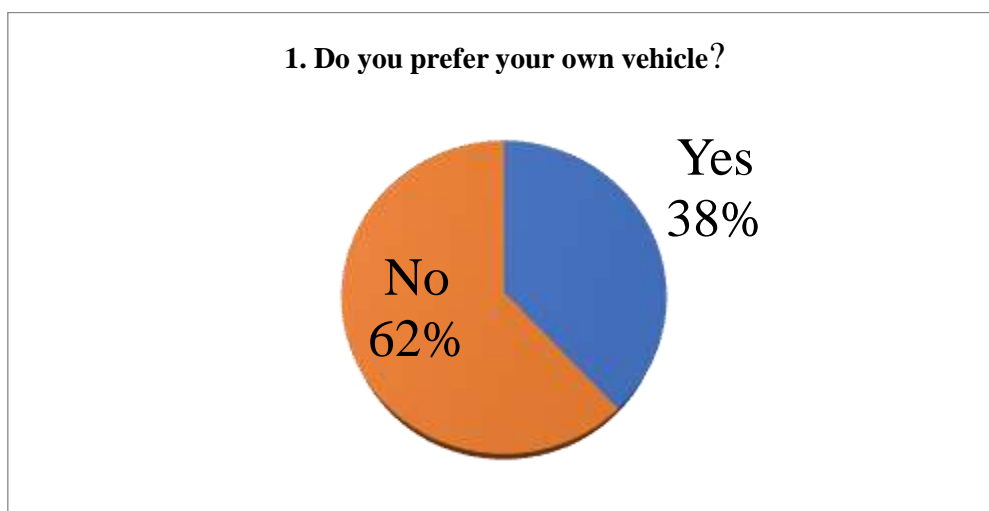
Graph 1 Findings of Survey

2. Are customers satified with existing plan of Road Transit System ?
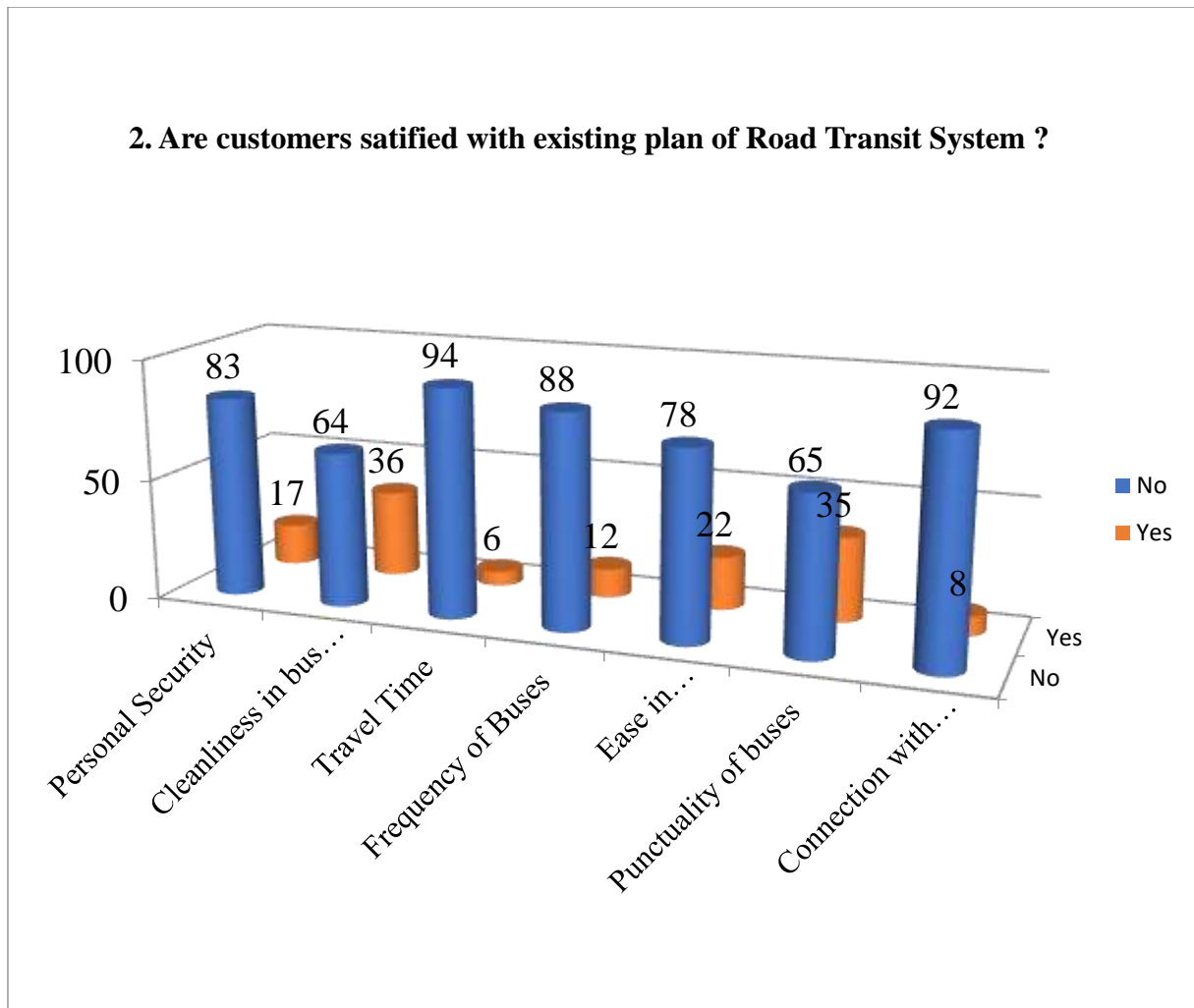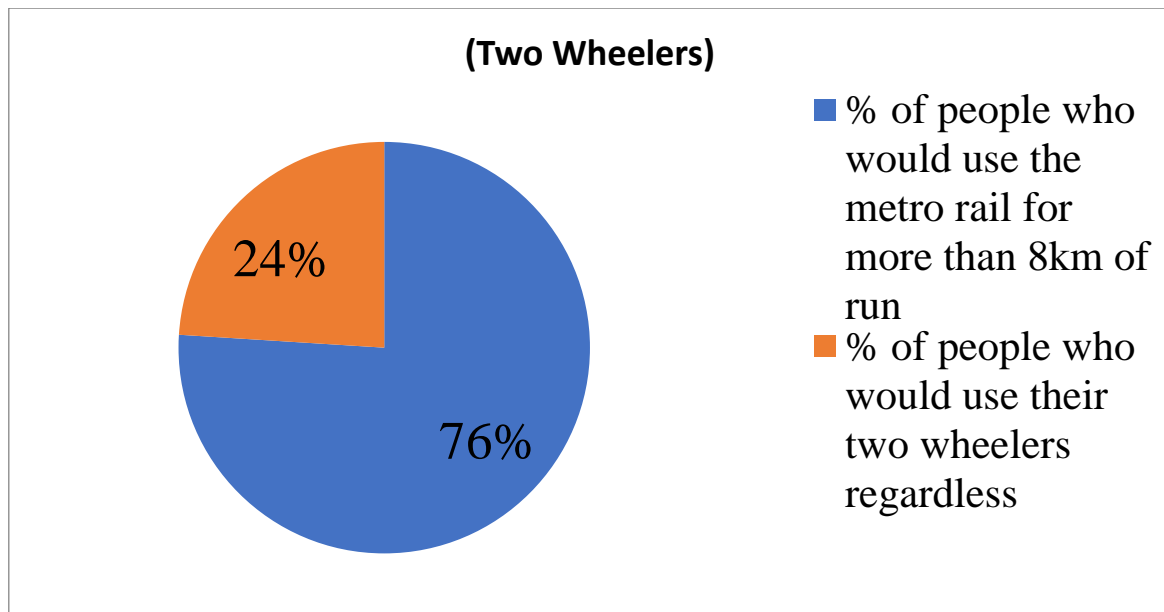

Graph 2 Graphical representation of customer survey about Road Transit System

3. How do you think Metro Rail will solve the existing problems of mismanaged transit system of roads?
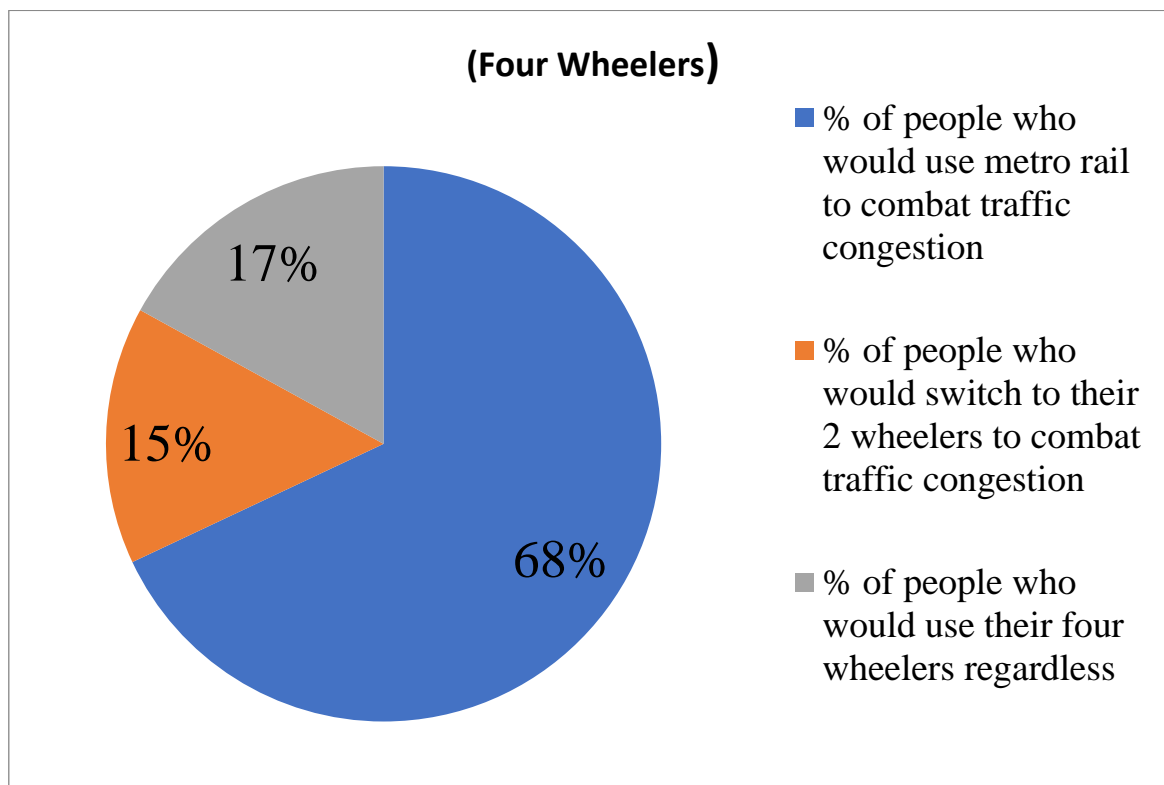

Graph 3 Graphical representation of customer survey about Metro Rail

4. How often will you use the metro rail services if there was a road transit system linking you directly from your origin point to the metro station? (this question was asked to people who use their own vehicle for commuting.)

Graph 4 Graphical representation of customer survey about Two Wheelers

76% of people who use their own two wheelers said that they would use the metro rail for more than 8 km of run. Rest 24% would use their two wheelers regardless.

Graph 5 Graphical representation of customer survey about Four Wheelers

According to 68% of four-wheeler users, they would take the metro rail if it meant they could reach their destination more quickly because of the growing traffic congestion and lengthy lineups at traffic lights.

According to 17% of four-wheeler users, switching to a two-wheeler makes it easier for them to manoeuvre through traffic during the busiest times of the day.

Fifteen percent of those who ride four wheels indicated they would utilise them in any situation.

The reason for this is most likely that they feel safe and secure because they have their own private space on their four-wheelers and don't have to worry about it being invaded, which is common in public transportation.

5. RESULTS, CONCLUSION AND RECOMMENDATION FOR FUTURE RESEARCH

5.1 RESULT SUMMARY

Suggestion: Feeder buses should be color-coded based on the metro station they serve to reduce confusion for passengers.

Proposal for a unified control unit to manage both bus and metro systems and unify fare collection for smoother integration.

Utilization of leftover buses from a failed BRTS for feeder buses along planned metro lines.

Implementation of smart cards for passengers to pay fares and minimize corruption by conductors, ensuring revenue for the government.

Smart cards used to track passenger routes, enhancing research on commuter behavior.

Process: Passengers scan their smart cards upon boarding the feeder bus to record the origin point and again when exiting at the metro station to record the destination point.

To further elaborate on the proposal for organizing feeder buses and integrating fare systems with the metro to enhance transportation efficiency and revenue collection, consider the following expanded details:

Implementation of a color-coded scheme for feeder buses aligned with the metro lines to aid passengers in identifying the correct bus route easily.

Development of a centralized control unit to manage both bus and metro systems, streamlining operations and fare collection with a unified approach.

Repurposing unused buses from a previous failed BRTS (Bus Rapid Transit System) for feeder bus services along designated metro routes, optimizing existing resources.

Deployment of passenger smart cards for fare payments, providing a convenient and cashless transaction method while reducing instances of corruption by bus conductors or drivers.

Utilization of smart card data for route tracking and analysis, enabling authorities to gain insights into commuter behavior patterns and optimize services accordingly.

Operational process: Passengers scan smart cards upon boarding a feeder bus to record the origin point, and scan again upon reaching the metro station to validate the destination point, ensuring accurate fare calculation.

Potential benefits: Increased revenue generation for the government, improved transparency and accountability in fare collection, enhanced commuter experience through seamless transit connections, and data-driven decision-making for future transportation planning.

5.2 CONCLUSION

This study examined road connection urban design and identified the possible demand that connects feeder bus services. An ideal bus system that allows passengers to quickly access resources and use them effectively was developed using a circular route concept. A small portion of line 2 at the future metro station was chosen as a case study in order to survey and validate the model's validity. According to the survey results, passengers choose the most convenient mode of transportation. In the lack of such resources, they are forced to use the current road transit system model, which disregards factors like cost, time, distance, and convenience. As Bhopal's metro system develops, it will have numerous stations surrounded by residential buildings, colonies, large employment areas, state highway bus stops, and railway stations. The system's service area will benefit both long-term residents and newcomers to the city by offering convenience to both. A customer satisfaction survey was conducted in order to give the essential amenities that bus commuters may find highly desirable, hence driving up demand and correspondingly driving down supply. As a result, the study's findings may be examined in greater detail, which will enable the development of more practical transport options and raise city residents' standards of living—two goals that urban planners constantly pursue.

5.3 RECOMMENDATION FOR FUTURE RESEARCH

The study's findings suggest that customer satisfaction assessments are impacted by a diverse range of factors, indicating a complexity that deserves further exploration. To enhance the understanding of these influences, future studies should delve deeper into additional aspects that contribute to customer satisfaction metrics. Increasing the number of respondents participating in in-depth interviews and brainstorming sessions can potentially provide richer insights, leading to the development of more relevant and comprehensive metrics for measuring customer satisfaction.

Moreover, the study hints at the potential to encourage car drivers to consider taking public buses as a mode of transportation. Future research can concentrate on identifying strategies to persuade individuals to switch from private vehicles to public buses, with a focus on analyzing the specific features of public bus services that align closely with passengers' needs and preferences. By understanding and addressing these aspects effectively, it may become more viable to change people's transportation preferences towards public bus usage.

A key emphasis for future endeavors should be on enhancing convenience and conducting regular surveys to address these intricate issues. By streamlining processes, making services more accessible and user-friendly, and actively seeking feedback through frequent surveys, transportation providers can iteratively improve their offerings to better align with customer expectations and preferences. This proactive approach can contribute significantly to resolving challenges, improving customer satisfaction, and ultimately increasing the adoption of public transportation options.

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