Modern Roadway Network for Effective Mass Transit System and Analysis at Eastern Region of Pune City

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***Abstract*—The rapid urbanization of Pune city, particularly in its eastern region, has intensified the demand for a robust and efficient mass transit system. This study focuses on the development and analysis of a modern roadway network connecting Kothrud Depot to Warje Bridge via SNDT and Karve Statue. Aiming to enhance transit efficiency and reduce congestion. Data was collected manually through meticulous field surveys and observation, enabling the identification of critical issues such as traffic density, bottlenecks, and transit delays. The analysis highlights the significance of manual methods in capturing localized and detailed insights often overlooked by automated tools. Findings underscore the importance of strategic roadway design, effective traffic management solutions, and environmentally sustainable practices to create a better-connected and more efficient transit system. The study also explores the socioeconomic benefits and environmental implications of implementing the proposed roadway improvements.**

***Index Terms*—Traffic Congestion, Mass Transit System, Traffic Flow, Passenger Car Unit (PCU)**

I. INTRODUCTION

Pune, often referred to as the "oxford of the east" due to its educational prominence, has experienced significant urbanization and economic growth in the past few decades. With the rapid expansion of the it sectors and various industries, the city has witnessed a sharp increase in population and vehicular traffic. According to data from the PUNE MUNICIPAL CORPORATION (PMC), Pune'spopulation has grown from 2.5 million in 2001 to over 7 million by 2024, and this surge has placed immense pressure on the existing transportation infrastructure.

The city's road network was originally designed for a much smaller population and has struggled to keep up with the demand. Traffic congestion, frequent road accidents, and inefficient public transportation are now daily challenges for commuters. The lack of efficient mass transit options, coupled with an increase in personal vehicle ownership, has resulted in longer commute times and higher levels of air pollution.

Fig 1 Traffic Congestion at Warje Bridge

An effective mass transit system is crucial for urban development and sustainability, particularly in rapidly growing cities like Pune, India. This project focuses on analyzing and proposing a modern roadway network to enhance the mass transit system in Pune, specifically examining the route from Kothrud Depot to Warje Bridge via SNDT and Karve Statue.

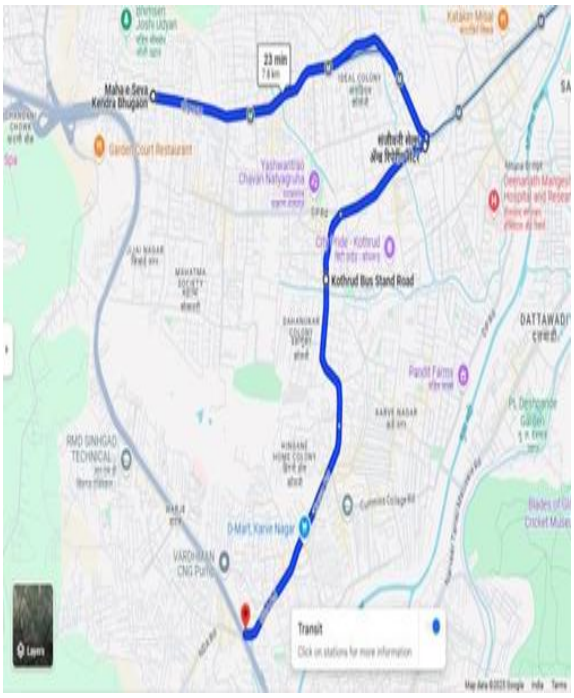


Fig 2 Route Kothrud Depot-Warje Bridge (Via SNDT & Karve Statue)

By focusing on this specific route, the study aims to provide a detailed analysis that can serve as a model for future improvements across the city's transportation network. The findings and recommendations from this project can contribute to the development of a more sustainable, efficient, and user-friendly mass transit system in Pune, ultimately improving the quality of life for its residents and supporting the city's economic growth.

II. RELATED WORK

Pune's rapid urbanization has led to increased traffic congestion, causing delays and inefficiencies in transportation. The current road infrastructure is under immense pressure due to the rising vehicle population. This study focuses on two key objectives:

1. Traffic Volume Analysis & Forecasting – Evaluating whether the existing road infrastructure can accommodate current and future traffic loads.
2. Proposing a Suitable Mass Transit System – Recommending efficient transit solutions based on the traffic study.

III. PROPOSED METHOD

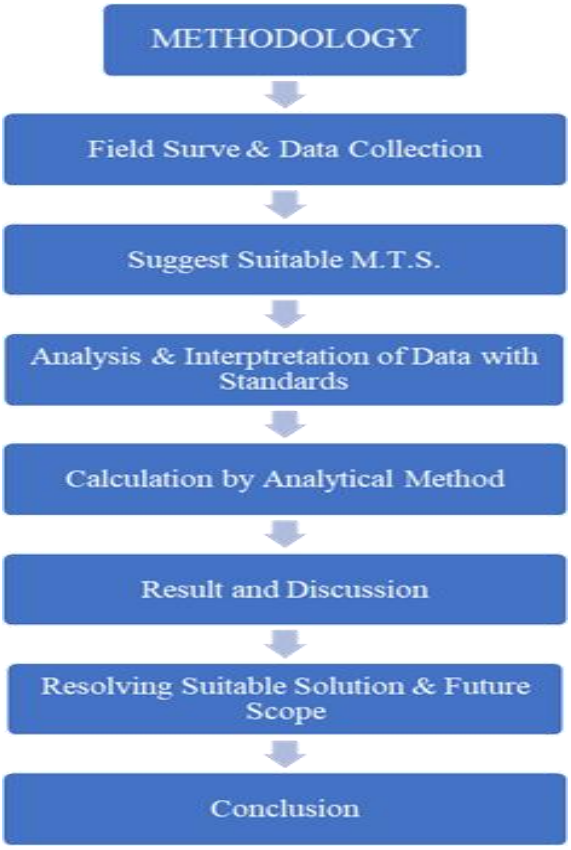


Chart 1 Block diagram of Proposed System

A. Field Survey and Data Collection

- Manual Counting: Used at key intersections along Kothrud Depot to Warje Bridge

Traffic data was collected at peak and off-peak hours through manual counting and video surveillance. The major data points include:

Vehicle Classification: Two-wheelers, 3 Wheelers (auto- rickshaws), 4 Wheelers (Car), buses/Trucks.

Location : Kothrud Depot				
Time	Vehicles			
	2 Wheelers	3 Wheelers	4 Wheelers (Car)	Bus / Truck
Date : 10/10/2024				
9:30 - 10:30 AM	1518	145	238	13
12:30 - 1:30 PM	1109	93	212	9
2:30 - 3:30 PM	918	94	154	8
5:00 - 6:00 PM	1307	134	307	11
8:00 - 9:00 PM	1197	108	247	6
Total	6049	574	1158	47

Table 1 Traffic Count

B. Traffic Volume Analysis & Road Feasibility Assessment

- Average Daily Traffic (ADT): - Average Daily Traffic (ADT) refers to the total volume of vehicle traffic on a roadway or specific location over a given period, divided by the number of days in that period. It is typically measured over a year, making Annual Average Daily Traffic (AADT) a common variation.

Average Daily Traffic (ADT)= [Number of Vehicles in Week / 7] V e h /day

For ex. – Location (Kothrud Depot)

ADT = [36399 / 7]

= 4349 Veh / day

- Passenger Car Unit (PCU):- A Passenger Car Unit (PCU) is a metric used in traffic engineering to express the impact of different types of vehicles on road capacity in terms of an equivalent number of passenger cars. Since different vehicles occupy different amounts of road space and move at varying speeds, PCUs help standardize traffic flow analysis.
  - Typical PCU Values:
- Passenger Car / Light Vehicle = 1.0 PCU
- Motorcycle / Scooter = 0.5 PCU
- Auto-Rickshaw = 1.0 PCU
- Bus / Truck = 2.2 PCU
- Bicycle = 0.4 PCU

Passenger Car Unit (PCU) = [Traffic Volume * PCU Conversion Factor]

= 4346*0.5

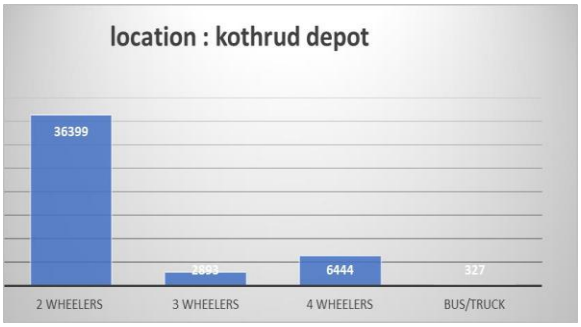
= 2174.5

Following is the table shows the Average Daily Traffic (ADT) and final values of Passenger Car Unit (PCU)

Location : Kothrud Depot					
Date	Vehicles				Total
	2 Wheelers	3 Wheelers	4 Wheelers	Bus/Truck	
10-10-2024	6049	574	1158	47	7828
12-10-2024	6055	420	1114	58	7647
13-10-2024	6835	706	1251	66	8858
14-10-2024	5995	450	1172	59	7676
15-10-2024	5588	349	832	47	6816
16-10-2024	5877	394	917	50	7238
Total :	36399	2893	6444	327	46063

ADT	4349	345	758	38	5492
PCU Conversion Factor	0.5	1	1	2.2	
Passanger Car Unit	2174.5	345	758	83.6	3361.1

Table 2 Calculation of ADT & PCU



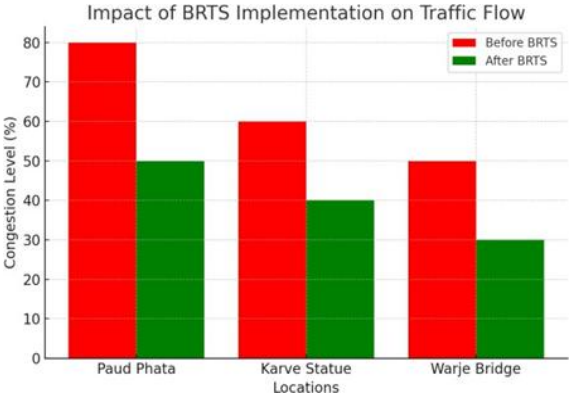
Graph 1 Vehicle Count

IV. PROPOSED MASS TRANSIT SYSTEM

Based on the forecasted traffic trends, we propose the following solutions:

A. Bus Rapid Transit System (BRTS) Enhancement

- Dedicated lanes for buses to reduce delays.
- Real-time bus tracking and scheduling for efficiency.
- Increased frequency of buses during peak hours.



Graph 2: Impact of BRTS Implementation on Traffic Flow

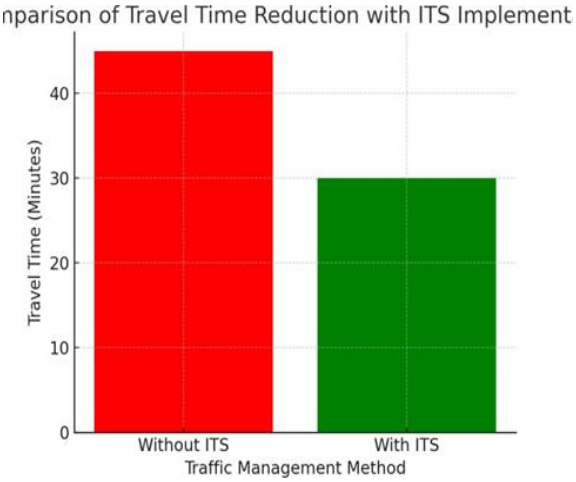
A. Metro Feeder Services

- Last-mile connectivity between Pune Metro and bus stops.
- Introduction of electric feeder buses for environmental sustainability.

- Designated metro-bus interchange hubs.

B. Intelligent Traffic Management

- Adaptive traffic signals to optimize flow and reduce wait times.
- IoT-based vehicle monitoring for dynamic traffic control.
- Digital signboards for real-time traffic updates and alternate route suggestions.



Graph 3: Comparison of Travel Time Reduction with,ITS Implementation

Non-Motorized Transport (NMT) Improvement

- Expansion of pedestrian pathways and cycle lanes to promote sustainable transport.
- Introduction of dedicated e-rickshaw zones for short-distance travel.

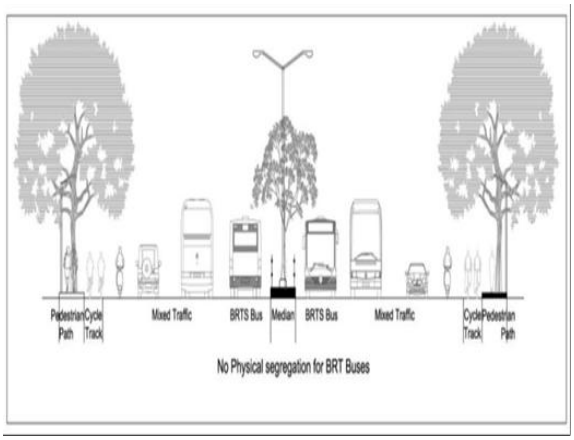
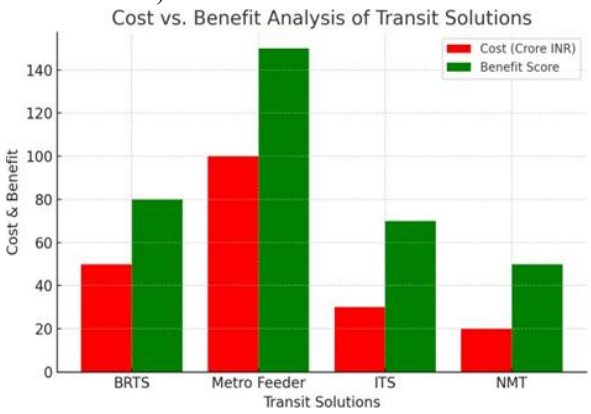


Fig 3: Proposed Bicycle Lane and Pedestrian-Friendly Zones

To evaluate the feasibility of the proposed transit systems, a cost-benefit analysis was conducted comparing:

- Infrastructure costs
- Reduction in travel time
- Environmental impact (reduction in CO2 emissions)



GRAPH: COST VS. BENEFIT ANALYSIS OF TRANSIT SOLUTIONS

The Cost-Benefit Analysis (CBA) of the project indicates reduced traffic congestion, lower fuel consumption, improved public transport efficiency, and enhanced road safety, leading to economic and environmental benefits. If the Cost-Benefit Ratio (CBR) > 1, the project is viable and beneficial for Pune's urban mobility.

V. CONCLUSION

The Modern Roadway Network for Effective Mass Transit System and Analysis at Pune City evaluates traffic conditions and proposes sustainable transit solutions for the Kothrud Depot to Warje Bridge corridor**.** The study'**s** Traffic Volume Analysis & Forecasting highlights increasing congestion, leading to longer travel times, higher fuel consumption, and environmental degradation. To address these issues, the Mass Transit System Proposal suggests Bus Rapid Transit (BRT), improved pedestrian pathways, cycling lanes, and traffic signal optimization to enhance mobility and safety.The Cost-Benefit Analysis (CBA) indicates that implementing these solutions will significantly reduce congestion, lower emissions, and promote economic growth. A Cost-Benefit Ratio (CBR) greater than 1 confirms the project's viability and long-term benefits. By

encouraging public transport use, the study aligns with Pune's Smart City goals and supports sustainable urban development. In conclusion, a multi- modal transport strategy is essential to creating an efficient and commuter-friendly transit system. The findings serve as a valuable resource for urban planners and policymakers, guiding the development of a sustainable, well-integrated roadway network to meet Pune's future mobility demands.

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