

Evaluation of Mass Transportation System: A Case Study of Porbandar City

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Abstract - Mass transportation systems play a vital role in shaping urban mobility, accessibility, and sustainability, particularly in rapidly growing Indian cities. The present review synthesizes existing research on public transport performance and evaluation frameworks to derive lessons applicable to Porbandar city. Studies across Ahmedabad, Surat, Vadodara, Rajkot, Anand, Mehsana, and Dahod highlight critical factors such as affordability, accessibility, reliability, and operational efficiency. Multiple decision-making tools, including Analytic Hierarchy Process (AHP), Analytic Network Process (ANP), Data Envelopment Analysis (DEA), GIS-based optimization, and logit-based travel behavior models, have been employed in evaluating transport systems. Findings reveal that while larger cities have adopted structured frameworks such as BRTS, medium and small cities struggle with inefficiency, inadequate coverage, and growing dependency on private vehicles. The paper identifies research gaps in integrating GIS-based planning, service quality evaluation, and commuter travel behavior modelling for cities like Porbandar. Lessons from prior studies are synthesized to propose a systematic framework for evaluating Porbandar's mass transportation system.

Key Words: Mass Transportation, Public Transport, Bus System, GIS, AHP, Service Quality, Porbandar

1. INTRODUCTION

Urban transport is a fundamental driver of economic growth and social well-being. In India, rapid urbanization and motorization have increased pressure on existing transportation systems, leading to congestion, air pollution, and reduced mobility. Medium-sized cities like Porbandar face unique challenges due to limited infrastructure, unorganized transport services, and overdependence on private vehicles.

To address these issues, researchers have applied diverse evaluation methods—ranging from performance metrics (speed, fuel efficiency, passenger load) to user satisfaction indicators (safety, affordability, accessibility). Recent studies demonstrate the value of multi-criteria decision-making

techniques and GIS-based optimization in improving transport planning. This review synthesizes key findings from past literature and identifies research gaps for developing a comprehensive evaluation framework tailored to Porbandar.

2. Literature Review Synthesis

2.1 Service Quality and Operational Efficiency

The evaluation of a mass transportation system is fundamentally driven by Service Quality (SQ) and Operational Efficiency (OE). Studies across major Indian cities consistently highlight that commuter satisfaction and ridership are tied to specific key performance indicators¹.

- Ahmedabad (AMTS): Research by Bhatti et al. utilized the Analytic Hierarchy Process (AHP) to rank bus routes in Ahmedabad Municipal Transport Service (AMTS)². The study stressed that decisive service quality factors include affordability, safety, punctuality, and reliability³. Critically, this research aimed to address efficiency gaps in conventional bus operations by applying a robust framework that successfully combines quantitative criteria (e.g., fuel usage, distance between stops, timeliness) and qualitative criteria (e.g., road conditions, safety, passenger comfort) for a comprehensive route performance assessment.
- Chaudhary (2020) reinforced that affordability, safety, and dependability are primary determinants of commuter satisfaction, particularly in Bus Rapid Transit System (BRTS) cities like Surat⁵. Furthermore, Patel et al. (2014) confirmed that regularity and punctuality are crucial for establishing commuter trust in public transport systems.
- The gap identified in Surat in the early 2010s showed that only state-run (GSRTC) and private bus services were in operation, leading to a proposal to introduce advanced public transport modes like BRTS or Light Rail Transit (LRT), demonstrating the evolution of efficiency frameworks in larger cities.

2.2 GIS and Geo-informatics in Transport Planning

Geo-informatics, including Geographical Information Systems (GIS) and Global Positioning Systems (GPS), has emerged as an indispensable tool for analyzing, planning, and optimizing urban transit networks.

- Ahmedabad (Speed Evaluation): Jain et al. demonstrated the utility of geo-informatics by using GPS data logged by transit vehicles to assess the performance and compare the link travel speed of conventional AMTS buses and the BRTS⁷. This approach provided crucial insight into the spatio-temporal variability in travel speed and helped policy-makers identify congestion hot spots, confirming that the dedicated lanes of the BRTS provided a significant speed advantage over conventional buses operating in mixed traffic.
- Anand and Mehsana (Route Optimization): Studies on smaller urban centers have successfully applied geo-informatics for route and network planning. Patel & Dave (2015) used Trans CAD software to analyse the accessibility and reliability of bus routes in Anand City, concluding that the existing network had routes with very low passenger loads that required optimization or extension⁹. In Mehsana, an assessment using Google Earth and Origin-Destination (O-D) surveys led to the conclusion that specific routes, like Route number 8, required extensions to include key locations (ONGC Office, GPERI College) to enhance connectivity and reduce travel time and cost.
- Dahod (Viability Assessment): Shaikh et al.'s study in Dahod used transportation planning tools (including Trans CAD to generate O-D matrices) to design new bus routes and concluded that a public transportation system was feasible for the city, indicating the basic planning utility of GIS-based tools for small-city network design.

2.3 Decision-Making and Multi-Criteria Evaluation

Multi-Criteria Decision-Making (MCDM) tools provide the necessary framework to evaluate complex transport scenarios that involve competing technical, economic, and social objectives.

- Saaty (2008) established the Analytic Hierarchy Process (AHP) as a robust MCDM tool that is widely adopted for transport evaluation due to its ability to structure and solve complex decision problems.
- As seen in the Ahmedabad and Rajkot studies (Jadeja et al., Gohel et al.), AHP is employed for ranking route performance by balancing quantitative factors (speed, fuel utilization, passenger load factor) and qualitative factors (safety, comfort, road condition, service reliability).

- Beyond AHP, advanced models such as Fuzzy AHP and Data Envelopment Analysis (DEA) have been adapted in urban transport research to handle complexity, uncertainty, and the multi-parameter nature of efficiency evaluations¹⁴. These frameworks are essential for moving beyond simple performance metrics to holistic system analysis.

2.4 Commuter Travel Behaviour and Mode Choice

Understanding the factors that drive mode choice is critical for developing strategies to shift commuters from private to public vehicles.

- Vadodara (Logit Modelling): Javeed et al.'s study on Vadodara, which operates under mixed traffic conditions, applied disaggregate mode choice models¹⁵. They utilized the Logit Model, noting its widespread acceptance for predicting traveller behaviour due to its accurate formulations and mathematical simplicity¹⁶. The analysis identified dominant factors in mode choice, categorized as socio-economic characteristics (age, gender, income, car ownership) and trip characteristics (travel time, travel cost, and distance).
- Surat city studies confirm that reliance on private vehicles is often a direct consequence of inadequate or incomplete public bus services, highlighting the direct link between service quality failure and poor mode share¹⁸. This underscores the importance of mode choice modelling to quantify the elasticity of demand and potential shift under improved service conditions.

2.5 Integration and Future Mobility

The seamless integration of different transport modes is a crucial area of focus for achieving sustainable urban mobility.

- Mirza & Jain (2020/2024) reviewed public transport integration strategies, emphasizing that integration is necessary to address issues of expanding urbanization, congestion, and environmental sustainability.
- The review stresses the necessity of using reliable modelling strategies to enhance and optimize urban mobility networks. The study examines notable case studies of cities that have made substantial efforts to integrate multiple modes of transportation to enhance urban mobility, focusing on overcoming challenges like institutional fragmentation and weak feeder connectivity.
- International and national research collectively recommend combining core bus systems (including BRTS) with non-motorized and intermediate public transport modes (rickshaws, shared autos) to ensure

first- and last-mile connectivity, thereby moving toward a truly holistic and sustainable urban mobility network.

3. Research Gap Identification

From the reviewed literature, the following gaps are identified:

- Medium and small cities (like Porbandar) remain under-researched compared to larger urban centers.
- GIS-based route optimization has been successfully applied in Anand, Dahod, and Mehsana but has not yet been systematically applied to Porbandar.
- Commuter behaviour modelling is limited; Porbandar lacks mode choice analysis, essential for understanding the dominance of private modes.
- Integration of quantitative (speed, load factor) and qualitative (comfort, safety) criteria in a single framework is rare in small-city contexts.
- First- and last-mile connectivity issues have not been addressed in Porbandar's transport planning.

4. Discussion

Synthesizing past studies, it is evident that cities adopting structured evaluation frameworks (e.g., Ahmedabad, Surat, Rajkot) demonstrate higher efficiency and commuter satisfaction. GIS and AHP emerge as consistent tools for identifying weaknesses and prioritizing improvements. However, smaller cities like Porbandar, Dahod, and Mehsana show fragmented systems with poor integration, irregular routes, and heavy reliance on private modes.

A systematic evaluation for Porbandar should therefore integrate:

- GIS-based accessibility mapping to identify underserved areas.
- AHP or hybrid MCDM models for ranking route performance.
- Commuter behaviour surveys to capture demand, affordability concerns, and mode shift potential.
- Integration strategies connecting buses with non-motorized transport (rickshaws, shared autos, bicycles).

5. Conclusion

- The review highlights that mass transportation systems in India face challenges of efficiency, accessibility, and integration, especially in medium-sized cities like Porbandar. Lessons from Ahmedabad, Surat, Vadodara, Rajkot, Anand, and Mehsana demonstrate the value of applying GIS tools, multi-criteria decision-making techniques, and commuter behaviour models for systematic evaluation.

- For Porbandar, a comprehensive framework combining operational efficiency analysis, GIS-based route optimization, commuter satisfaction surveys, and mode choice modelling is proposed. Such an approach can help decision-makers design a sustainable, efficient, and inclusive public transport system, reducing reliance on private vehicles and enhancing urban mobility.

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