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Availability and Accessibility Assessment of the Public Transit System in Jaipur City

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Abstract: *Efficient and equitable public transportation is a cornerstone of sustainable urban development in rapidly growing Indian cities. Jaipur, the capital of Rajasthan, has experienced significant demographic expansion and motorization over the past two decades, placing substantial pressure on its transport networks. This study evaluates the availability and accessibility of Jaipur's public transit system using a mixed-methods approach that integrates Geographic Information Systems (GIS), Public Transport Accessibility Levels (PTAL), pedestrian infrastructure audits, and commuter satisfaction surveys. Findings indicate pronounced spatial disparities: central zones demonstrate high stop density (4–6 stops/km²), frequent bus services (10–15 minutes), and PTAL values between 4 and 6, while peripheral zones remain underserved with low stop density (0.5–1.5 stops/km²), infrequent services (30–45 minutes), and PTAL scores of 0–2. Pedestrian accessibility further limits effective transit reach, with 80% of roads lacking continuous footpaths and only 18% of intersections offering safe pedestrian crossings. Survey responses (n=820) identify low frequency, long walking distances, overcrowding, and safety concerns—particularly among women—as major deterrents to transit use. Recommendations include targeted route expansion, pedestrian corridor upgrades, feeder integration with metro stations, transit-oriented development (TOD) zoning, and safety-oriented service improvements. Implementing these measures can increase Jaipur's average PTAL from 2.3 to 3.2, double daily transit ridership to 2.5 million by 2035, reduce underserved populations from 35% to under 10%, and contribute to substantial emission reductions. The paper concludes with a strategic, phased implementation framework aligned with sustainable urban mobility goals.*

Key Words: *Public transit, Accessibility, Availability, PTAL, GIS, Urban mobility, Transit-oriented* development

1. INTRODUCTION:

Public transportation plays a pivotal role in enhancing urban livability, promoting social equity, and reducing the environmental burdens associated with motorized travel. As Indian cities continue to urbanize rapidly, achieving an efficient, accessible, and reliable public transit system becomes increasingly essential for sustainable development. Jaipur, one of India's fastest-growing metropolitan areas, exemplifies both the opportunities and challenges associated with modernizing transit systems amid rapid population growth and rising private vehicle ownership. The city's population has surpassed 3 million, with annual growth rates between 2.8% and 3.2%. Correspondingly, private motorization has intensified, with two- and three-wheelers constituting nearly 80% of registered vehicles. Despite the introduction of the Jaipur Metro in 2015 and expanding bus services operated by Jaipur City Transport Services Limited (JCTSL), public transit currently serves only 20–30% of total trips, overshadowed by the rapid increase in private vehicle use.

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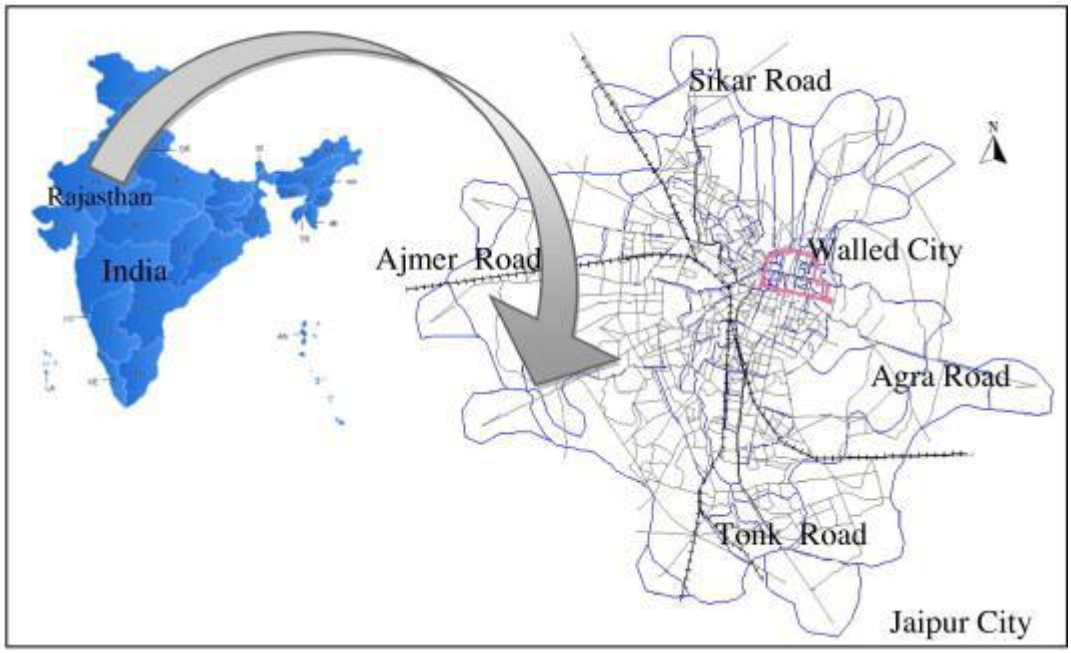

Figure 1. Plan of Jaipur city

The primary challenge Jaipur faces is not merely transit availability, but *transit accessibility*—the ease with which residents can reach and use transit services. Accessibility issues often stem from inadequate stop density, limited last-mile connectivity, poor pedestrian infrastructure, and inequitable spatial distribution of transit services. These barriers disproportionately affect low-income residents, women, elderly users, and persons with disabilities. This research therefore conducts a comprehensive assessment of Jaipur's public transit system focused on two central questions:

1. What is the current state of public transit availability in Jaipur in terms of network coverage, frequency, and stop distribution?
2. How accessible is the system for different socioeconomic and geographic segments of the population?

By integrating spatial analysis, PTAL scoring, infrastructure audits, and user surveys, the paper identifies key disparities and proposes evidence-based strategies that can help Jaipur move toward inclusive, sustainable mobility.

2. LITERATURE REVIEW:

2.1 Transit Availability and Accessibility

Transit availability refers to the supply-side characteristics of public transport, including coverage, service frequency, and capacity. Accessibility, on the other hand, reflects the user's ability to reach and use transit, considering walking distance, safety, comfort, pedestrian infrastructure, and affordability. Gahlot et al. (2013) conducted early GIS-based accessibility assessments of Jaipur, highlighting significant gaps in coverage and service frequency. More recent studies emphasize the importance of integrating land use with transport planning, advocating for multimodal systems that reduce dependence on private vehicles (Cervero & Dai, 2014).

2.2 Public Transport Accessibility Levels (PTAL)

PTAL, first developed in London, measures transit access based on walking distance and service frequency. Shrivastava (2025) adapted PTAL for Jaipur, demonstrating disparities between central areas (PTAL 4–5) and peripheral zones (PTAL 1–2). PTAL provides a consistent framework for comparing zones and identifying accessibility inequities.

2.3 Last-Mile Connectivity and Pedestrian Infrastructure

Studies across Indian cities reveal that poor pedestrian infrastructure often increases effective transit access distance by up to 35% (Indian Institute of Public Health, 2022). In Jaipur, footpath discontinuity, encroachments, unsafe crossings, and lack of signage significantly deter transit use.

2.4 Equity and Gender Dimensions

Accessibility inequity disproportionately affects low-income households, women, elderly individuals, and persons with disabilities. Women often experience safety concerns during evening travel, inadequate lighting, and overcrowding (UN Habitat, 2024). Persons with disabilities encounter incomplete accessibility features at metro stations and bus stops.

2.5 Transit-Oriented Development (TOD)

TOD frameworks promote compact, mixed-use development around transit stations, improving ridership and reducing carbon emissions. In India, TOD has been promoted through national policies, but implementation is often hampered by fragmented land governance and inconsistent zoning (Ministry of Housing & Urban Affairs, 2023).

3. METHODOLOGY:

A mixed-methods approach was adopted, integrating spatial analysis, PTAL scoring, infrastructure audits, and commuter surveys.

3.1 GIS-Based Availability Assessment:

- Network analysis of JCTSL bus routes and Jaipur Metro
- Stop density mapping across 500m × 500m grid cells
- Frequency-weighted accessibility buffers (800m primary radius)

3.2 PTAL Calculation:

- Weighted access time (walking + waiting)
- Service frequency categories
- Network accessibility index for bus and metro

3.3 Pedestrian Infrastructure Audit

- 320 km of corridors evaluated
- Parameters: footpath continuity, obstructions, lighting, signage, crossings

3.4 User Satisfaction Survey

- Sample size: 820 respondents
- Stratified sampling across central, intermediate, and peripheral zones
- Variables: frequency satisfaction, comfort, safety, waiting time, affordability

3.5 Data Integration

All datasets were synthesized to produce zone-wise accessibility profiles and inequity indicators.

4. STUDY AREA

Jaipur is divided into central, intermediate, and peripheral zones with varying land-use patterns. Key characteristics include:

- **Central Zone:** Dense commercial and institutional core; high transit demand.
- **Intermediate Zone:** Expanding residential and mixed-use areas.
- **Peripheral Zone:** Rapidly urbanizing, low-density fringe with inadequate transit.

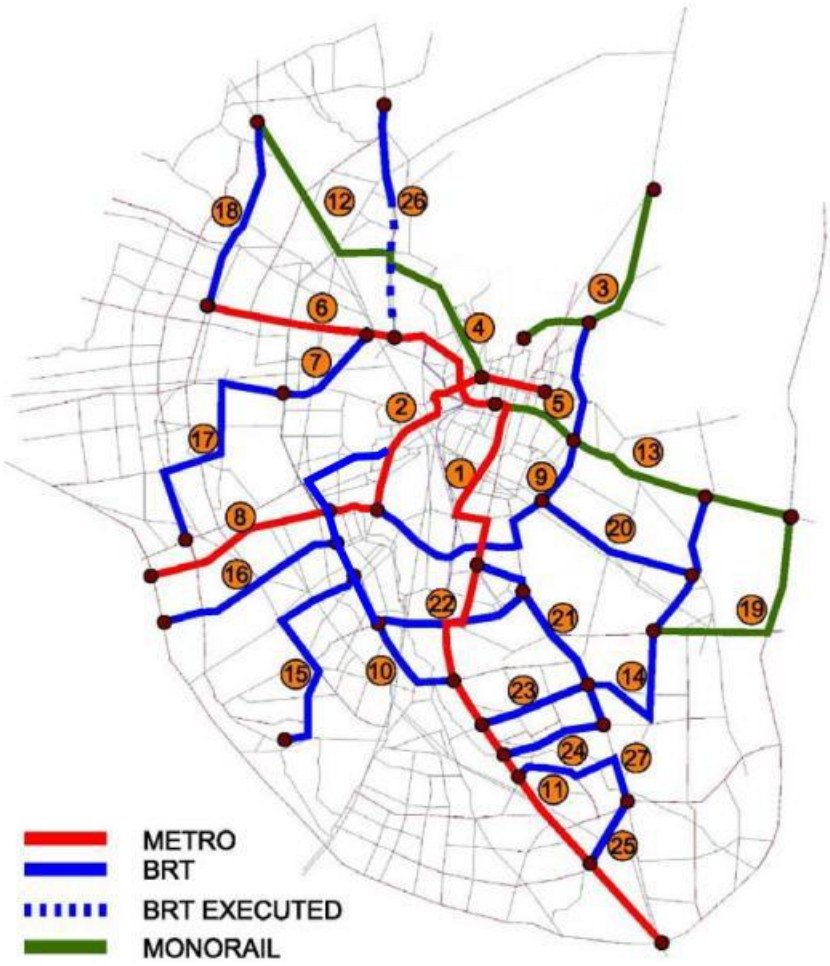

Figure 2. Public transport network

The public transit system comprises:

- 400 JCTSL buses operating on 32 routes
- 11 metro stations across an 18 km corridor
- Limited formal integration between modes

5. RESULTS AND DISCUSSION

5.1 Transit Availability

5.1.1 Stop Density

- Central zone: 4–6 stops/km²
- Intermediate zone: 2–3 stops/km²
- Peripheral zone: 0.5–1.5 stops/km²

Peripheral areas severely lack transit coverage, with average stop spacing exceeding 1.2 km.

5.1.2 Service Frequency

High-frequency corridors operate at <15-minute headways, while peripheral feeders exceed 30–45 minutes. Limited metro feeders further reduce effective accessibility.

5.2 Transit Accessibility (PTAL)

Zone	PTAL Range	Average PTAL	Interpretation
Central	4–6	4.4	Good–Excellent
Intermediate	2–4	2.6	Moderate
Peripheral	0–2	1.1	Poor

Citywide average PTAL = **2.3**, below the threshold of "moderate accessibility."

5.3 Pedestrian Accessibility

Key findings include:

- **Footpath continuity:** 20% citywide, 65% only in central areas
- **Safe crossings:** Present at only 18% of major junctions
- **Accessibility features:** 92% of bus stops lack tactile paving

Without safe and continuous pedestrian facilities, effective access to transit stops decreases significantly.

5.4 User Satisfaction Analysis

Survey results show:

- Frequency satisfaction: **2.8/5**
- Safety satisfaction: **2.4/5**
- Women's safety satisfaction: **1.9/5**
- Average trip time: **42 minutes**

Top complaints include overcrowding, long access distances, and unpredictable schedules.

5.5 Equity and Socioeconomic Disparities

Low-income households spend 12–18% of income on transportation. Peripheral residents face longer commute times (68 minutes vs. 32 minutes in central areas). Women experience higher time and safety burdens.

6. RECOMMENDATIONS

6.1 Route Expansion

- Add 18 new routes in underserved areas.
- Increase bus fleet by 100 buses in two phases.
- Integrate 12 metro feeder routes.

6.2 Pedestrian Infrastructure

- Develop 180 km of continuous footpaths.
- Improve 150 intersections with pedestrian signals.
- Provide universal design features at all stops.

6.3 Service Quality Enhancements

- Real-time arrival information systems.
- CCTV and lighting at all stops.
- Women-only services during peak hours.

6.4 Transit-Oriented Development (TOD)

- Increase FSI by 50–100% around metro stations.
- Reduce parking requirements.
- Mandate 15–20% affordable housing in TOD zones.

6.5 Metro Expansion

- Implement Phase 1D to improve east–west connectivity.
- Plan Phase 2 corridor linking employment centers.

7. CONCLUSION:

This study demonstrates that Jaipur's public transit system exhibits substantial disparities in both availability and accessibility, particularly across its peripheral and low-income neighborhoods. While central zones benefit from dense networks, frequent services, and high PTAL scores, peripheral areas remain underserved, relying heavily on private and informal modes. Pedestrian infrastructure deficiencies further restrict transit use, especially among vulnerable groups such as women, elderly individuals, and persons with disabilities.

A coordinated strategy—combining route expansion, pedestrian improvements, metro integration, TOD-based land use planning, and service quality enhancements—can significantly improve Jaipur's transit ecosystem. Implementing the proposed interventions can double ridership, reduce congestion, improve equity, and contribute to long-term environmental sustainability. The findings and recommendations offer a roadmap for Jaipur to evolve into a more inclusive and accessible urban mobility system by 2035.

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