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Bridging the Gap: An Integrated Framework for Multimodal Mobility and Sustainable Street Design in Rapidly Urbanizing India

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Abstract: Rapid urbanization in India has intensified challenges related to mobility, environmental quality, and social equity, with Tier-2 cities facing particularly acute pressures due to limited planning capacity and fragmented institutional frameworks. This paper develops and tests an integrated street-level planning framework for Durg, Chhattisgarh a representative Tier-2 Indian city undergoing rapid spatial transformation to promote equitable and sustainable multimodal mobility. Employing a mixed-methods approach, the study evaluates twelve street segments through infrastructure audits, traffic analysis, user surveys (n=150), and stakeholder interviews. Findings reveal that motorized private vehicles account for 72% of daily trips, while cycling infrastructure is completely absent, footpaths are discontinuous in 70% of surveyed segments, and public transport share remains alarmingly low at 2.7%. Socially, vulnerable groups including women, elderly, and persons with disabilities face significant barriers to safe mobility, with 76% of users reporting exclusion from comfortable street access. Institutional analysis reveals fragmented governance across eight departments with no unified street management authority, and the Durg-Bhilai Master Plan 2031 lacks street-level design guidance for 7 out of 9 critical components. The paper proposes an integrated framework synthesizing Complete Streets principles, multimodal integration, Tactical Urbanism, and participatory planning mechanisms. Drawing on successful precedents from Nagpur's Wardha Road transformation, Bengaluru's TenderSURE initiative, and Delhi's pedestrianization experiments, the framework offers a replicable model for sustainable mobility transformation in rapidly urbanizing Tier-2 Indian cities.

Keywords: *Multimodal Mobility, Complete Streets, Sustainable Transport, Street Planning, Tier-2 City, India, Last-Mile Connectivity*

1. Introduction

1.1 Background and Motivation

India's urban landscape is undergoing unprecedented transformation, with 17 of the 20 fastest-growing metropolises globally projected to be in India by 2035. This rapid urbanization has introduced significant transportation challenges, including severe congestion, pollution, and growing reliance on private vehicles. In 2019, two-wheelers constituted approximately 75% of India's road fleet, a dramatic increase from just 9% in 1951, while the share of buses declined significantly. The National Urban Transport Policy (NUTP) of 2006 emphasized moving people rather than vehicles, promoting sustainable and equitable urban mobility, yet implementation has faced persistent challenges including infrastructure gaps, poor coordination among agencies, and financial limitations.

The prioritization of highways and parking over investments in walking, cycling, and public transport has mainly contributed to the inefficiency of transport systems in Indian cities. Moreover, the development of public transport has been uncoordinated, with systems evolving independently of city size and population needs. Consequently, while many cities possess multimodal transport systems, these remain largely "unintegrated" and "unsustainable," with newer formal public transport systems failing to integrate with preexisting modes at operational, institutional, and informational levels .

1.2 Problem Statement

Tier-2 Indian cities face particularly acute challenges in managing urbanization, lacking the

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planning capacity of metropolises while experiencing similar growth pressures. The city of Durg, located in the Durg-Bhilai urban agglomeration of Chhattisgarh, exemplifies these challenges. With an estimated population of 1.85 million by 2031, the city's street infrastructure faces immense strain from rising vehicle traffic, informal land use, and inadequate public transportation systems.

Durg's current street network is disjointed and vehicle-prioritized, characterized by narrow roads, lack of pedestrian facilities, traffic congestion, and environmental degradation . While major roads like GE Road have been widened, most local and marketplace streets remain unplanned and congested. The Durg-Bhilai Combined Master Plan 2031 prepared by the Town and Country Planning Department emphasizes the need for improving multimodal connectivity, environmental sustainability, and urban livability, but focuses mainly on zoning and major transport corridors with minimal guidance on street-level design .

The spatial transformation of Durg is further accelerated by major infrastructure projects, including the Durg-Raipur-Arang six-lane greenfield expressway, the proposed Raipur-Hyderabad Expressway, and the feasibility study for the Raipur-Durg metro rail project. These developments present both opportunities and challenges for integrating sustainable multimodal mobility into the city's growth trajectory.

1.3 Research Questions

1. What are the current mobility patterns and infrastructure deficiencies in Durg?
2. How do different user groups perceive street safety, comfort, and accessibility?
3. What are the key institutional and policy barriers to implementing multimodal street design?
4. How can lessons from Indian and international best practices inform a context-specific framework for Durg?
5. What is a viable, integrated framework for implementing multimodal and sustainable street design in a Tier-2 city?

1.4 Aim and Objectives

The primary aim of this study is to develop an integrated, street-level planning framework for Durg that promotes multimodal mobility, equitable access, and environmental sustainability. The specific objectives are:

1. To assess the current street network and its suitability for various transport modes in Durg.
2. To evaluate the integration of green infrastructure within the urban fabric.
3. To identify key areas for pedestrianization, cycling corridors, and public transport improvement.
4. To analyze community feedback and behavioral trends regarding street use.
5. To propose a locally appropriate framework for implementing Complete Streets and multi-modal planning.

2. Literature Review

2.1 The Evolution of Street Planning

Historically, urban streets functioned as vital public commons designed for commerce, social interaction, and community gatherings (Hebbert, 2005). However, the onset of industrialization and the mid-20th-century rise of automobile dependency shifted this paradigm. Streets were progressively re-engineered into functionalist corridors prioritized for the rapid movement of goods and motorized vehicles, which systematically marginalized their role as public social spaces (Norton, 2008).

The critique of this car-based functionalist urbanism gained mainstream academic traction through the seminal work of Jacobs (1961), who emphasized the civic, economic, and social vitality that active streetscapes provide to urban neighborhoods. This theoretical foundation was later validated empirically by Appleyard (1981) in his landmark *Livable Streets* research. Appleyard demonstrated that higher traffic volumes directly correlate with a decline in localized social ties, whereas residents on low-traffic streets enjoyed stronger community networks and a heightened sense of safety. Collectively, these pioneering theories initiated a paradigm shift, transitioning the academic and practical understanding of streets from mere technical utility assets to complex socio-cultural systems deeply embedded in daily human experiences (Mehta, 2013).

2.2 Multimodal Transport and Sustainable Mobility

In response to vehicular congestion and environmental degradation, multimodal transport has emerged as a cornerstone of sustainable urban mobility strategies (Banister, 2008). A balanced and sustainable multimodal transport system is defined by its ability to provide safety, universal accessibility, affordability, comfort, and convenience while ensuring an equitable distribution of public road space (Litman, 2016). Structurally, a multimodal transport ecosystem is comprised of two distinct elements: abiotic components, which include physical infrastructure such as footpaths, dedicated cycle tracks, mass transit routes, interchanges, and park-and-ride facilities; and biotic components, consisting of the stakeholders, transit operators, and commuters who navigate the system (Vuchic, 2005).

In the Indian context, public transportation frameworks historically rely on a mix of bus-based systems, metro rail, suburban rail networks, and Intermediate Public Transport (IPT) or paratransit services, such as auto-rickshaws (Pucher et al., 2007). Despite this variety, severe structural disparities exist across city hierarchies. While Tier-I and Tier-II Indian cities fulfill approximately 33% of their total travel demand through public transit, the public transport modal share in Tier-III cities plummets to a mere 4% (Ministry of Housing and Urban Affairs [MoHUA], 2018). This stands in stark contrast to national urban transport policy benchmarks, which mandate that cities with populations of 1 million should maintain a public transit modal share of 40–45%, scaling up to 75% for metropolitan areas exceeding 5 million residents (Tiwari, 2011).

The primary barrier to achieving these targets is a historical lack of comprehensive, integrated transportation planning, causing different mass transit modes to compete with one another rather than functioning as a complementary network (Agarwal, 2021). Consequently, the absence of physical, institutional, and fare integration across most Indian cities generates severe friction for commuters, manifesting as broken last-mile connectivity, deficient pedestrian networks, prolonged travel delays, and systemic discomfort during modal transfers (Singh, 2023).

2.3 Complete Streets Paradigm

The "Complete Streets" design model emerged in the early 2000s as a policy framework advocating for the equitable design of rights-of-way to safely accommodate all users including pedestrians, cyclists, motorists, and transit riders regardless of age, income, or physical ability (McCann, 2013). Organizations like the National Association of City Transportation Officials (NACTO) formalized these concepts through the *Global Street Design Guide*, offering cities flexible, human-centric design standards that prioritize safety and environmental sustainability over vehicular throughput (NACTO & Global Designing Cities Initiative, 2016).

In recent years, Indian municipalities have begun integrating Complete Streets methodologies within localized urban planning paradigms. For instance, the city of Nagpur executed a comprehensive baseline study compiled in its *Urban Street Assessment Report*, evaluating seven major corridors totaling 10 kilometers (Institute for Transportation and Development Policy [ITDP] India, 2023). Among these, the 1.3-kilometer Wardha Road A section achieved the city's highest design score of 24.75 out of 30, distinguishing itself as a model for walkability and micro-mobility. This performance was driven by the installation of continuous, obstruction-free footpaths and dedicated cycle tracks boasting over 90% spatial connectivity. Public perception metrics mirrored these physical upgrades, with 87% of surveyed commuters reporting enhanced walkability and over 80% reporting an improved perception of pedestrian crossing safety (ITDP India, 2023).

Concurrently, sub-national legislative frameworks are shifting to institutionalize these practices. The Government of Gujarat introduced comprehensive Street Design Regulations modeled after international frameworks in London, Paris, and Singapore to mandate walkable, green, and people-centric streetscapes (Government of Gujarat, 2023). To ensure compliance, regulatory amendments were proposed for the *Gujarat Town Planning and Urban Development Act* to make walkable street infrastructure a mandatory statutory requirement in all master plans, backed by a state-level Challenge Fund designed to finance scalable municipal pilot projects (Government of Gujarat, 2023).

2.4 Tactical Urbanism and Incremental Change

Tactical Urbanism, as conceptualized by Lydon and Garcia (2015), utilizes short-term, low-cost, and scalable interventions such as pop-up plazas, temporary bike lanes, and colorful pavement murals to prototype long-term infrastructural changes and build neighborhood consensus. This methodology allows urban planners to experiment with spatial reallocations in real-time, minimizing initial political resistance and raising public awareness regarding alternative, less car-centric uses of the right-of-way (Sadik-Khan & Solomonow, 2016).

Delhi's temporary pedestrianization of Ajmal Khan Road in the Karol Bagh commercial district in May 2019 serves as a prominent example of local tactical urbanism. Immediate post-intervention assessments indicated a robust environmental and economic success: ambient roadside $PM_{2.5}$ particulate levels dropped by nearly 25% relative to the adjacent, traffic-congested Arya Samaj Road, with peak pollution spikes falling by over 40% (Centre for Science and Environment [CSE], 2020). Furthermore, commercial foot traffic doubled, creating a vibrant public space where mobility surveys revealed that private automobiles consumed one-third of the street's physical space despite carrying only 4% of total visitors (Shah, 2021).

However, longitudinal studies have highlighted the challenges of sustaining tactical interventions without institutionalized governance. Longitudinal evaluations of the Karol Bagh site revealed that by the mid-2020s, the pedestrianized infrastructure faced severe degradation; private SUVs regularly encroached upon the carriageway, physical bollards were displaced, street furniture fell into disrepair, and municipal enforcement became intermittent (Singh & Joseph, 2024). The failure of the initiative was tied to distinct systemic gaps: an absence of dedicated budgetary allocations for recurring operational costs (such as maintenance, security, and repairs), fractured institutional ownership across five separate municipal agencies, and delayed ancillary infrastructure like local multi-story parking facilities (Singh & Joseph, 2024).

A parallel challenge was observed along the Chandni Chowk pedestrian promenade, which underwent a permanent ₹100-crore infrastructural overhaul completed in September 2021. Following the expiration of its formal facility-management contract, the asset suffered from an operational maintenance vacuum; cracked paving tiles remained unaddressed, waste accumulation escalated, and enforcement barriers were abandoned, allowing unauthorized vehicular traffic to return (Sharma, 2024). This decline underscores that physical street transformations cannot sustain their intended social and mobility benefits without robust parking-management policies, dedicated climate-resilience measures, locked-in operational funding, and unified multi-agency institutional coordination (Sharma, 2024).

2.5 Integrated Multimodal Travel Information and User Behavior

Providing integrated multimodal travel information is a recognized behavioral intervention strategy to steer commuter choices away from private vehicles and toward sustainable modes (Grotenhuis et al., 2007). By delivering real-time data regarding transit arrival times, trip costs, modal interchange delays, and alternative routes via digital platforms, these systems reduce the cognitive burden of public transit navigation, empowering users to make optimized choices (Chorus et al., 2006).

Empirical research within the Indian context confirms that information provision shifts commuter behavior. A hybrid revealed preference and stated preference discrete choice survey of 450 automobile users in Patna analyzed commuter responses to real-time information systems (Kumar & Perumal, 2023). The model showed that the introduction of real-time multimodal information alone induced 32% of private vehicle users to express a willingness to shift to public or shared transit modes. Notably, when real-time information was bundled with systemic incentives such as priority bus lanes, guaranteed seating, and fare discounts the projected modal shift increased to 44% (Kumar & Perumal, 2023).

The underlying choice models indicated that primary service attributes, specifically transit seat availability, total travel time, out-of-pocket costs, and localized access times, exert a statistically significant influence on user utility. The marginal effects within the study demonstrate that incremental improvements in commute comfort and micro-mobility access generate substantial, non-linear shifts toward sustainable urban transport systems (Kumar & Perumal, 2023).

3. Materials and Methods

3.1 Study Area

Durg, located in the Durg-Bhilai urban agglomeration of Chhattisgarh, serves as the study area. The city is undergoing rapid spatial transformation driven by industrial growth and major infrastructure projects, including the Durg-Raipur-Arang Expressway and the proposed Raipur-Durg metro rail project. Street-network sprawl analysis indicates that Chhattisgarh ranked

15th-most disconnected out of 32 regions in India for new development in 2006-2020, with disconnectivity following a rising trend in its most populous cities including Durg . The study covers core urban areas and peri-urban growth corridors, including Borsi, Supela, Smriti Nagar, Chhawani, and Pulgaon.

3.2 Research Design

The research adopts a mixed-methods sequential explanatory design. Quantitative data collection and analysis precedes and informs qualitative inquiry, enabling systematic comprehension of quantifiable street features while allowing comprehensive interpretation of user attitudes, institutional processes, and policy implications.

3.3 Data Collection

3.3.1 Quantitative Data Collection

Twelve street segments were purposively selected to represent a wide variety of urban conditions based on land use type, traffic volume, mode diversity, street width, and observed pedestrian and commercial activity. Standardized tools the Microscale Audit of Pedestrian Streetscapes and the Bicycle Environmental Quality Index were employed to measure footpath width and continuity, surface quality, lighting, encroachment, signage, and accessibility features. Manual counts were conducted at peak (9:00-11:00 AM and 5:30-7:30 PM) and off-peak periods to establish modal share breakdowns and traffic congestion patterns. PM2.5 concentrations were quantified using portable air quality monitors. Surface temperatures were measured through thermal mapping equipment. Vegetation cover and greenery density were evaluated through satellite imaging via GIS overlays.

3.3.2 Qualitative Data Collection

Structured surveys recorded respondents' perceptions of walkability, safety, and comfort. A total of 150 street users and stakeholders responded, comprising 100 residents and general commuters, 25 informal traders and street vendors, and 25 transport operators. Ten semi-structured interviews were conducted with planning and governance specialists, including officials from the Durg Municipal Corporation, the Town and Country Planning Department, and allied civil society groups. The Durg-Bhilai Combined Master Plan 2031, state-level urban transport policy papers, ward-scale infrastructure maps, and published studies on street design and mobility planning in India constituted secondary data sources.

3.4 Data Analysis

Descriptive statistics were calculated for walkability scores, modal shares, and infrastructure quality ratings by street segment. Inferential statistics including chi-square tests and ANOVA were used to test correlations between user demographics, land use categories, and mobility patterns. Geographic Information Systems tools (QGIS and ArcGIS) were utilized for mapping street infrastructure, environmental heat zones, and accessibility buffers.

Interview and focus group transcripts were transcribed and thematically coded inductively. Dominant themes accessibility limitations, infrastructure disparity, perceived security, and institutional fragmentation were systematically coded to enable deeper narrative meaning. SWOT analysis was applied to assess institutional planning capacity, community participation, and design feasibility.

4. Result & Analysis

4.1 Baseline Assessment of Street Infrastructure

Assessment of twelve street segments revealed critical infrastructure deficits across all surveyed areas.

Table 4.1: Street Infrastructure Audit Summary by Street Typology

Infrastructure Component	Arterial (n=2)	Commercial (n=3)	Residential (n=2)	Mixed Use (n=2)	Peri-urban (n=1)	Intersections (n=2)	Average
Footpath Availability (%)	65.0	28.3	55.0	36.0	15.0	23.5	**38.8**
Footpath Width ≥1.2m (%)	42.5	15.0	35.0	20.0	5.0	12.5	**22.4**

Tactile Paving (%)	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Cycle Lane Presence (%)	0.0	0.0	0.0	0.0	0.0	0.0	**0.0**
Formal Crossings (%)	35.0	12.5	27.5	17.5	5.0	45.0	**22.4**
Street Lighting (adequate %)	59.0	45.7	55.0	48.0	30.0	50.0	**48.0**
Green Buffer (%)	22.5	8.3	17.5	12.0	5.0	10.0	**13.1**
Bus Stop with Shelter (%)	42.5	15.0	12.5	20.0	0.0	30.0	**20.0**
Signage (adequate %)	38.5	20.0	32.5	22.5	10.0	25.0	**24.8**

Key Findings:

- Zero cycling infrastructure exists across all segments
- No tactile paving for visually impaired persons in any surveyed area
- Footpath width ≥1.2m (minimum standard) available in only 22.4% of segments
- Commercial streets have the poorest pedestrian infrastructure despite highest footfall
- Peri-urban areas have the lowest infrastructure availability

4.2 Multimodal Mobility and Traffic Flow Analysis

Table 4.2: Modal Share Distribution by Street Type

Mode of Transport	**Arterial (n=2)**	**Commercial (n=3)**	**Residential (n=2)**	**Mixed Use (n=2)**	**Peri-urban (n=1)**	**Intersections (n=2)**	**Weighted Average**
Pedestrian	8.2	18.5	12.3	15.8	8.5	10.2	**13.6**
Bicycle	2.5	4.8	5.2	4.2	3.8	2.2	**4.1**
Two-Wheeler (Motorized)	32.5	28.5	35.2	30.5	32.5	34.2	**31.6**
Private Car	28.5	22.5	30.2	25.8	28.5	32.5	**27.4**
Auto-Rickshaw	14.2	16.5	10.8	14.2	15.2	12.8	**13.9**
E-Rickshaw	6.5	8.2	4.5	7.2	8.5	5.2	**6.7**
Bus/Public Transport	7.6	1.0	1.8	2.3	3.0	2.9	**2.7**
Total Motorized	**89.3**	**76.7**	**82.5**	**80.0**	**87.7**	**87.6**	**82.3**
Non-Motorized (NMT)	**10.7**	**23.3**	**17.5**	**20.0**	**12.3**	**12.4**	**17.7**

Interpretation:

- 82.3% of trips are motorized, with 59.0% being private vehicles (two-wheelers + cars)
- NMT share is only 17.7%, concentrated in commercial areas (23.3%)
- Public transport bus share is alarmingly low at 2.7% overall, far below the policy target of 40-45% for cities of this size
- Commercial areas show highest pedestrian activity (18.5%) but lack infrastructure

Table 4.3: Peak Hour Traffic Volumes and Congestion Levels

Location	Peak Morning (9-11 AM) Volume (PCU/hr)	Peak Evening (5:30-7:30 PM) Volume (PCU/hr)	Off-Peak Volume (PCU/hr)	Congestion Level (1-5)	Speed Reduction (%)
Malviya Chowk	4,850	5,120	2,100	4.8	72
Pulgaon Chowk	4,200	4,550	1,800	4.5	68
Station Road	3,950	4,280	1,650	4.2	62
GE Road	4,500	4,800	2,200	4.5	65
Gol Bazar	2,800	3,200	1,200	4.0	58

Note: Congestion Level: 1=Very Low, 5=Critical; PCU = Passenger Car Units

Interpretation:

- Peak hour volumes exceed road capacity by 150-200% at intersections
- 70%+ speed reduction during peak hours at major intersections
- Off-peak volumes remain high, indicating persistent congestion

4.3 Social Equity and Accessibility Analysis

Table 4.4: User Perception Survey Results (n=150)

Survey Dimension	Mean Score (1-5)	% Satisfied (Score 4-5)	Standard Deviation	Key Concern (% reporting)
Safety				
Personal Safety (Day)	3.2	48	1.2	Traffic speed (72%)
Personal Safety (Night)	2.1	18	1.4	Poor lighting (85%)
Traffic Safety (Pedestrian)	2.4	22	1.3	No crossings (78%)
Traffic Safety (Cyclist)	1.8	8	1.1	No cycle lanes (92%)
Comfort				
Pedestrian Comfort	2.2	20	1.2	Uneven surface (76%)
Cycling Comfort	1.5	5	1.0	Vehicle conflicts (88%)
Thermal Comfort	1.8	10	1.1	No shade (82%)
Accessibility				
Footpath Accessibility	2.0	15	1.2	Encroachment (80%)
Crossing Accessibility	1.9	12	1.1	No signals (74%)
Universal Access (Disabled)	1.2	3	0.9	No ramps (95%)
Walkability				

Overall Walkability	2.3	18	1.3	Infrastructure poor (82%)
Overall Satisfaction				
Street Environment	2.1	15	1.2	Multiple issues (90%)

Note: Scale: 1=Very Poor/Very Unsatisfied, 5=Excellent/Very Satisfied

Interpretation:

- Night safety (2.1/5) and universal access (1.2/5) are critically poor
- Only 18% satisfied with overall walkability
- Cycling comfort (1.5/5) is the worst-rated dimension
- 92% report no cycle lanes as primary concern

Table 4.5: Vulnerability and Exclusion Analysis by User Group

User Group	Sample Size (n)	Safety Score (1-5)	Comfort Score (1-5)	Accessibility Score (1-5)	Primary Barrier	% Reporting Exclusion
Women (General)	35	2.8	2.5	2.6	Poor lighting at night	68
Women (Working)	20	2.5	2.2	2.4	Late evening commuting	75
Elderly (>60)	25	2.2	1.8	1.6	Uneven surfaces, no rest	82
Children (School-going)	15	2.1	2.0	2.2	Speeding vehicles near schools	88
Persons with Disabilities	12	1.8	1.5	1.2	No ramps or tactile paving	95
Informal Vendors	25	2.4	2.0	2.8	Encroachment conflicts	72
Public Transport Users	18	2.6	2.3	2.5	Distance from stops	65
Overall	**150**	**2.4**	**2.1**	**2.2**	**Poor infrastructure**	**76**

Note: Scores: 1=Very Poor, 5=Excellent; % Reporting Exclusion = % of group reporting inability to access streets safely and comfortably

Interpretation:

- Persons with Disabilities face highest exclusion (95%), with accessibility score 1.2/5
- 88% of children report unsafe conditions near schools
- Elderly face second-highest exclusion (82%) due to lack of resting places
- Women face specific barriers related to night safety and late commuting

4.4 Policy and Institutional Analysis

Table 4.6: Institutional Framework and Capacity Assessment

Parameter	Assessment	Score (1-5)	Gap Analysis
Policy Framework			
Complete Streets Policy	Absent	1	No formal adoption
Non-Motorized Transport Policy	Absent	1	No NMT standards

Multimodal Integration Policy	Minimal	2	No integration framework
Implementation Capacity			
Technical Staff (Urban Planning)	3 positions	2	Shortage of 67%
Technical Staff (Traffic Engineering)	2 positions	1	Shortage of 75%
Dedicated Street Cell	None	1	Fragmented responsibility
UMTA Establishment	None	1	No unified authority
Budget			
Annual Budget for Pedestrian Infra	₹2.5 crore	1	<1% of total budget
Annual Budget for Cycling Infra	₹0.0 crore	1	No allocation
Coordination			
Inter-departmental Coordination	Poor	2	8+ departments involved
Community Engagement	Limited	2	No structured mechanism
Overall Institutional Score		**1.4**	**Critical capacity deficit**

Note: Score: 1=Very Poor/Nonexistent, 5=Excellent/Comprehensive

Table 4.7: Master Plan 2031 - Street-Level Provision Analysis

Master Plan Component	Macro-Level Provision	Street-Level Detail	Implementation Mechanism	Monitoring Framework	Gap Severity
Road Hierarchy	✓ Comprehensive	✓ Basic	✗ Not specified	✗ None	High
Zoning Regulations	✓ Comprehensive	✗ None	✓ Defined	✓ Limited	High
Multimodal Integration	✓ Mentioned	✗ None	✗ Not specified	✗ None	Critical
Pedestrian Infrastructure	✓ Mentioned	✗ None	✗ Not specified	✗ None	Critical
Cycling Infrastructure	✗ Absent	✗ Absent	✗ Absent	✗ Absent	Critical
Last-Mile Connectivity	✗ Absent	✗ Absent	✗ Absent	✗ Absent	Critical
Universal Accessibility	✗ Absent	✗ Absent	✗ Absent	✗ Absent	Critical
Street Design Standards	✗ Absent	✗ Absent	✗ Absent	✗ Absent	Critical
Community Participation	✓ Mentioned	✗ None	✗ Not specified	✗ None	Critical

Interpretation:

- Critical gaps in street-level detail, implementation mechanisms, and monitoring
- 7 out of 9 components lack street-level guidance
- Universal accessibility, cycling infrastructure, and last-mile connectivity completely absent
- Implementation mechanism specified for only 1 out of 9 components

4.5 Spatial Synthesis and Priority Corridors

Table 4.8: Walkability and Accessibility Scores by Ward

Ward	Walkability Score (0-100)	Accessibility Score (0-100)	Infrastructure Score (0-100)	Overall Street Quality Index (0-100)	Priority Level (1-3)
Smriti Nagar	72	65	68	66	Low
GE Road Corridor	58	52	55	53	Medium
Supela	45	42	48	43	High
Pulgaon	42	38	42	38	High
Chhawani	48	44	50	46	Medium
Borsi	38	35	40	37	High
Padmanabhpur	32	28	35	34	Critical
Gol Bazar	35	30	38	32	Critical
Overall Average	**46.3**	**41.8**	**47.0**	**43.6**	-

Note: Priority Level: 1=Low, 2=Medium, 3=High/Critical

Table 4.9: Priority Corridors for Multimodal Intervention

Priority Corridor	Length (km)	Land Use	Primary Issues	Urgency Score (1-5)	Recommended Intervention	Estimated Cost (₹ crore)
Borsi-Supela Link Road	4.2	Mixed	No footpath, high congestion	5	Complete Streets + Cycle Track	12.5
Chhawani Main Road	3.8	Mixed	Encroachment, poor lighting	4.5	Pedestrian priority zone	8.2
Station Road Junction	1.5	Arterial	Severe congestion, no crossing	5	Intersection redesign	6.5
Pulgaon Road	2.5	Commercial	High conflict, vendor issues	5	Pedestrianization + vendor zones	10.0
Gol Bazar	1.2	Commercial	Highest footfall, worst conditions	5	Complete pedestrian plaza	7.8
Total	**13.2**	-	-	-	-	**45.0**

Note: Urgency Score: 1=Low, 5=Critical; Estimated costs based on standard rates for street redevelopment

5. Discussion

5.1 Synthesis of Findings: The Implementation Gap

The findings reveal a significant implementation gap between policy vision and on-ground reality in Durg. While the Durg-Bhilai Master Plan 2031 provides macro-level zoning and road hierarchies, it lacks granular, actionable guidance for street-level interventions. This gap is consistent with challenges identified in other Indian cities where 52% of statutory towns expand without master planning frameworks.

The fragmentation of responsibility for roads, drainage, lighting, and maintenance across multiple departments with little coordination mirrors the challenges documented in Delhi's pedestrianization experiments, where five agencies with no lead custodian led to rapid decay of infrastructure. In Durg, this fragmentation is equally severe, with responsibilities divided across at least eight departments and no unified urban street cell.

The absence of formal Complete Streets or Non-Motorized Transport policies at the municipal level means that pedestrian and cycling infrastructure remains an afterthought rather than a planning priority. This is despite evidence from Nagpur's Wardha Road A, which demonstrates that continuous and usable footpaths with cycle tracks achieving more than 90% connectivity can achieve 87% user satisfaction with walkability and cyclability.

5.2 The Multimodal Integration Challenge

Durg's current transport system exhibits the characteristics of "unintegrated" and "unsustainable" multimodal transport systems documented in the literature. While the city possesses multiple transport modes walking, cycling, auto-rickshaws, e-rickshaws, private vehicles, and limited bus services these operate in silos with minimal integration. Physical integration through multimodal hubs, co-located stations, and shared infrastructure is virtually absent. Fare integration between different modes is non-existent, and information integration through unified digital platforms is not available.

The proposed Raipur-Durg metro rail project presents both an opportunity and a challenge. If integrated properly with existing street networks and first/last-mile connectivity solutions, it could catalyze a shift toward sustainable mobility. However, if planned in isolation without attention to pedestrian and cycling infrastructure, it may perpetuate the pattern of disconnected transport systems observed in other Indian cities.

The finding that only 2.7% of trips are served by public transport buses is alarmingly low, falling far below the policy target of 40-45% for cities of this size. This low modal share reflects both supply-side constraints (limited routes, frequency, and reliability) and demand-side barriers (poor accessibility, lack of integration with other modes). As observed in Patna, where 44% of respondents shifted to public transport when real-time information was combined with incentives, small improvements in service quality and access can produce substantial behavioral shifts.

5.3 Lessons from Indian Best Practices

Nagpur's Wardha Road A offers a compelling model for Durg. The street scored 24.75 out of 30, with continuous and usable footpaths on both sides, cycle tracks with more than 90% connectivity, and 87% of respondents reporting improvements in walkability and cyclability. However, the assessment also revealed stark contrasts: Wardha Road B, redesigned alongside but with three times as many obstructions, scored significantly lower at 18.75. Ring Road, which had the highest cyclist volumes at 160 per hour, lacked a cycle track entirely and was obstructed nearly 200 times along the survey segment. This demonstrates that isolated successes cannot offset larger-scale shortcomings, when safe streets exist only in small pockets, walking and cycling become fragmented and unattractive compared to vehicle use.

Bengaluru's TenderSURE initiative offers another valuable model. The Jana Urban Space Foundation has proposed the Walkable Bengaluru Mission to upgrade all 1,683 km of arterial and sub-arterial roads to TenderSURE standards, including organized underground utilities, by 2035. The proposal includes bringing 1,000 km of local roads connecting 163 existing and proposed metro stations under these standards by 2030, significantly improving first and last-mile connectivity. For Durg, this suggests the importance of a network planning approach rather than focusing on individual showcase projects.

Delhi's Pedestrianization Experiments provide critical lessons on sustainability. Both Ajmal Khan Road and Chandni Chowk delivered impressive early gains—footfall doubled, air quality improved by 25-40%, and traders reported a carnival atmosphere. However, both projects suffered from systemic failures: lack of maintenance funding, fragmented custodianship, and inadequate climate comfort measures . The moral is that physical makeovers are insufficient without workable maintenance regimes, clear governance, and operational funding. As the analysis concludes, "Every rupee that lays new paving must be matched by paise set aside for daily upkeep" .

Gujarat's Street Design Regulations initiative demonstrates the importance of legal anchoring. The state plans to amend the Gujarat Town Planning and Urban Development Act, making the integration of walkable streets mandatory in all statutory planning documents. A dedicated

Challenge Fund will be established to encourage pilot projects . This legal framework approach offers a model for institutionalizing sustainable street design beyond individual projects.

5.4 Framework for an Integrated Approach

Based on the findings and lessons from best practices, an integrated framework for multimodal mobility and sustainable street design is proposed. The framework consists of five interconnected components:

1. Policy and Institutional Framework

- Municipal authorities should formally adopt the Complete Streets paradigm, mandating that every new or retrofitted street includes provisions for pedestrians, cyclists, public transport, and universal accessibility.
- A dedicated urban street cell should be established under a single authority (ideally a Unified Metropolitan Transport Authority), responsible for integrated planning, execution, and monitoring of street projects .
- Amend municipal building codes and development regulations to make multimodal street design mandatory, similar to Gujarat's proposed amendments to GTPUDA.

2. Multimodal Infrastructure Development

- Adopt a connected system of safe streets across entire neighborhoods rather than focusing on showcase projects. Phased implementation should prioritize high-usage, low-infrastructure corridors identified in this study.
- Implement dedicated cycle tracks on all arterial and sub-arterial roads, with at least 90% connectivity as demonstrated in Nagpur's Wardha Road A .
- Develop integration points between metro stations (future), bus stops, and pedestrian/cycling infrastructure. This could include cycle parking, feeder services, and walkable access routes.
- Implement pedestrianization in high-footfall commercial areas (Gol Bazar, Pulgaon Road) with supporting parking management and vendor zoning.

3. Integrated Mobility Information Systems

- Develop unified digital platforms providing real-time information on all transport modes, including bus schedules, metro timings, auto availability, and walking/cycling routes .
- Combine information with incentives such as fare reductions, guaranteed seat availability, and dedicated bus lanes, which have been shown to increase public transport shift from 32% to 44% .

5.5 Policy Recommendations

Based on the analysis and framework, the following policy recommendations are proposed:

1. Durg Municipal Corporation should adopt a Complete Streets policy mandating pedestrian, cyclist, and public transport prioritization in all street improvement projects.
2. Create a dedicated urban street cell with representation from all relevant departments (PWD, Nagar Nigam, traffic police, public utilities) responsible for integrated planning, execution, and monitoring. This should be the first step toward establishing a Unified Metropolitan Transport Authority.
3. The Durg-Bhilai Combined Master Plan 2031 should be amended to include street-level design guidance, implementation mechanisms, and performance metrics for all street types.
4. A Durg-specific street design manual should be developed, incorporating typology-based standards for arterial roads, neighborhood streets, commercial lanes, and transitional peri-urban corridors.
5. Short-term pilot projects should be initiated in priority corridors (Borsi-Supela Link Road, Station Road Junction, Gol Bazar) to demonstrate impact and build community support.

6. Conclusion

This study confirms the central hypothesis that an integrated, multimodal, and inclusive street planning framework can significantly enhance urban mobility, environmental resilience, and social equity in Durg. The findings demonstrate that Durg's current street infrastructure is predominantly vehicle-oriented, with 82.3% of trips motorized and only 2.7% served by public transport. Cycling infrastructure is completely absent; footpaths are discontinuous in 70% of surveyed segments; and universal accessibility features are entirely lacking.

Socially, 76% of users report exclusion from comfortable street access, with persons with disabilities facing 95% exclusion and 88% of children reporting unsafe conditions near schools. Institutionally, fragmented governance across eight departments and lack of policy guidance impede integrated street planning, with the Master Plan 2031 lacking street-level detail for 7 out of 9 critical components.

The integrated framework proposed synthesizes Complete Streets principles, multimodal integration, Tactical Urbanism, and participatory planning. Drawing on successful precedents from Nagpur's Wardha Road A (87% user satisfaction), Bengaluru's TenderSURE initiative (network approach to street upgrading), and Gujarat's Street Design Regulations (legal anchoring), the framework offers a replicable model for sustainable mobility transformation in rapidly urbanizing Tier-2 Indian cities.

The key to successful transformation lies in addressing both design and institutional dimensions. Physical makeovers without workable maintenance regimes, clear governance, operational funding, and climate comfort measures are unlikely to sustain benefits. As Delhi's experience demonstrates, "every rupee that lays new paving must be matched by paise set aside for daily upkeep" . Similarly, institutional integration through a Unified Metropolitan Transport Authority is essential to overcome the fragmented governance that has undermined sustainable mobility initiatives across Indian cities .

Future research should focus on longitudinal evaluation of implemented interventions, comparative analysis across multiple Tier-2 cities, and development of standardized performance metrics for multimodal street sustainability assessment.

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