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Urban Development in Prayagraj City: A Comprehensive Sectoral Evaluation

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Abstract

This paper undertakes a comprehensive sectoral evaluation of urban development in Prayagraj City, Uttar Pradesh, India — one of the nation's oldest and most strategically significant urban centres. Drawing exclusively on secondary data from statutory planning documents, government reports and peer-reviewed literature, the study examines six principal elements of urban development: housing, transport, water supply and sanitation, recreational amenities, health facilities, and electricity infrastructure. Guided by the Prayagraj Master Plan 2031 and allied policy frameworks, the analysis reveals a city in active transition. Significant infrastructural investments across all sectors have improved service coverage and physical connectivity, yet persistent challenges remain in spatial inequity, ageing infrastructure, demand–supply deficits and institutional fragmentation. The paper identifies critical gaps — particularly in sewage network coverage, primary healthcare capacity and energy supply during peak demand — and offers evidence-based policy recommendations for more equitable, sustainable and resilient urban growth. The findings are of direct relevance to planners and policymakers engaged with medium-sized Indian cities undergoing rapid urbanisation.

Keywords

urban development, Prayagraj, housing, transport, water supply, sanitation, health infrastructure, electricity, Master Plan 2031.

1. Introduction

There are few urban centres in India as vital or as historically layered as Prayagraj, formerly known as Allahabad. Situated at the sacred confluence (Triveni Sangam) of the Ganga, Yamuna, and the mythical Saraswati in the state of Uttar Pradesh, the city has evolved from a site of profound religious and cultural significance into a major contemporary metropolis. Its trajectory encapsulates the dual character of South Asian urbanisation: a rich historical legacy pressing against the imperatives of modern city-building, with administrative importance further amplified by its inclusion in the Government of India's Smart Cities Mission (Mishra et al., 2017).

The pace and scale of Prayagraj's urban growth are instructive. Built-up area has more than doubled over three decades — from 40.22 km^2 in 1990 to 85.89 km^2 in 2020 — and is projected to reach 118.66 km^2 by 2040. Urban population is forecast to touch 1.625 million by 2028, placing growing pressure on land, infrastructure, and services. A 10.03 per cent rise in built-up land between 1988 and 2018

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underscores the urgency of systematic evaluation if growth is to yield equitable and sustainable outcomes (Sarif et al., 2024).

Beyond its administrative function, the city's designation as a Smart City is an acknowledgement of its role as a laboratory for scalable urban solutions relevant to a broad class of medium-sized Indian cities. Institutional analysts examining governance reform and modernisation regularly look to Prayagraj as a representative case — one that illuminates both the obstacles to effective service delivery and the opportunities that come with concerted policy action (Sharma & Singh, 2025). How the city manages its infrastructure gaps and delivers services to a diverse and rapidly expanding population carries direct lessons for urban planning across the subcontinent (Gabril et al., 2019).

Despite the significance of this urbanisation process, there remains a notable absence of comprehensive, sector-wise evaluations of Prayagraj's development that synthesise planning data, government records, and scholarly research into a single analytical framework. This paper addresses that gap. By examining the principal elements of urban development — housing, transport, water and sanitation, recreation, health, and electricity — against the backdrop of the Prayagraj Master Plan 2031, the study seeks to identify spatial patterns and infrastructural strengths, expose service delivery shortfalls, and articulate the planning challenges that lie ahead. The overarching aim is not merely to document the current state of urban development, but to probe what it means for the city's sustainability, liveability, and inclusivity.

2. Objective

The study aims to evaluate the existing status and spatial distribution of major urban infrastructure facilities in Prayagraj City, with particular emphasis on housing, transportation, water supply, sanitation, recreational amenities, healthcare infrastructure, and electricity services. It seeks to assess the availability, adequacy, and spatial variations of these facilities across different parts of the city to understand the current level of urban development and identify areas requiring infrastructural improvement.

3. Study Area

Prayagraj City is located in the central-eastern part of Uttar Pradesh, India, at approximately 25.27°N latitude and 81.87°E longitude. Positioned at the confluence of the Ganga and Yamuna rivers — with the Sangam lying at its eastern extremity — the city occupies a physiographically prominent position on the Indo-Gangetic Plain. Administratively, it serves as the headquarters of both Prayagraj District and the Prayagraj Division. Governance of the city is shared between the Prayagraj Nagar Nigam (PNN), which oversees 80 municipal wards within the core urban area, and the Prayagraj Development Authority (PDA), which holds jurisdiction over a considerably larger planning area encompassing peripheral towns and transitional settlements.

Prayagraj carries exceptional functional significance: it is a major educational centre — home to the University of Allahabad (est. 1887) and numerous national institutions — a key administrative and judicial hub hosting the Allahabad High Court, and the world's most frequently attended pilgrimage destination, hosting the Kumbh Mela every twelve years and the Magh Mela annually. This unique combination of permanent and transient populations distinguishes Prayagraj from most Indian cities of comparable size and makes robust, scalable urban infrastructure an especially pressing necessity (Gabril et al., 2019).

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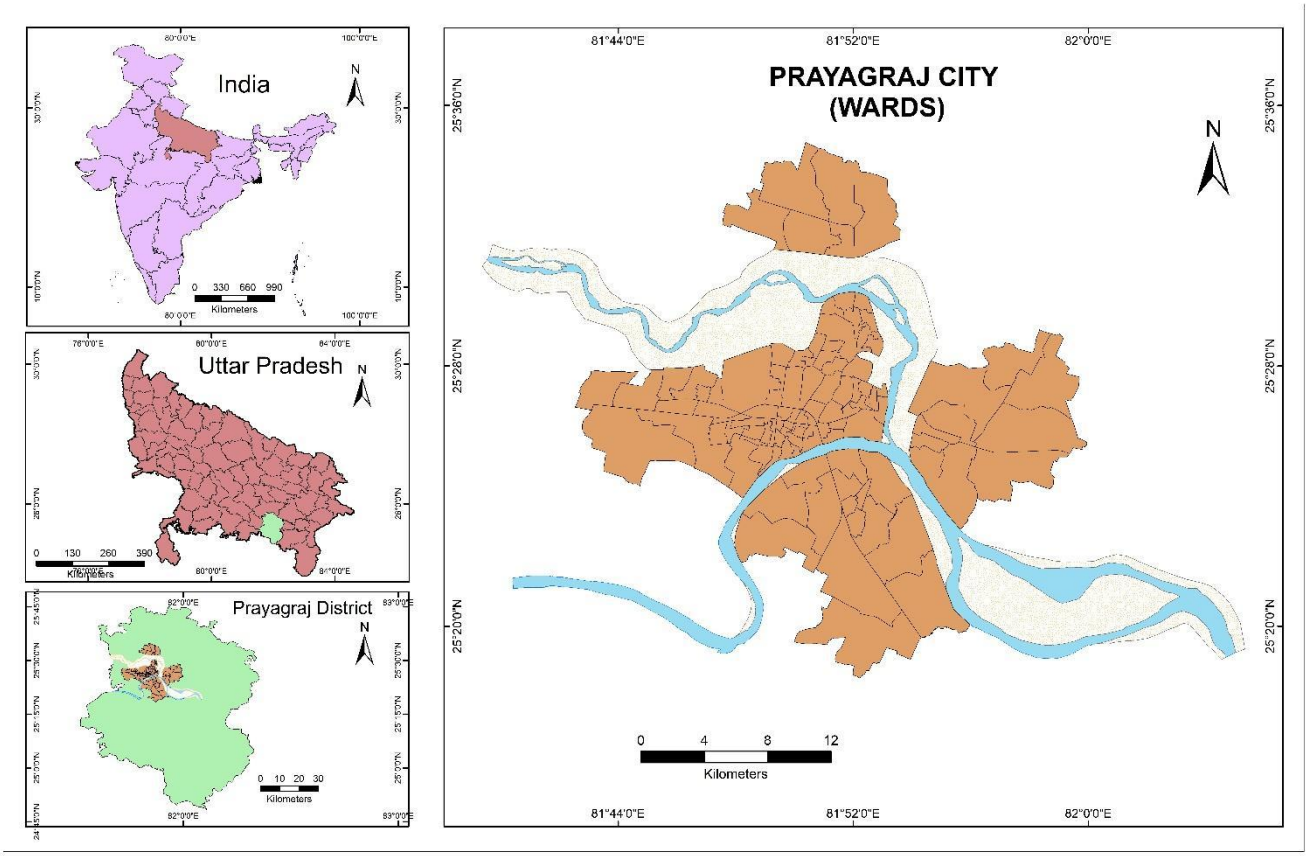
Climatically, the city experiences a subtropical monsoon regime with hot summers (temperatures exceeding 45°C), a monsoon season from June to September, and mild winters. Average annual rainfall is approximately 1,020 mm, the bulk of which falls during the monsoon

Figure 1: Location Map of the study Area



quarter. These climatic conditions have direct implications for water management, drainage capacity, and public health infrastructure — all of which are examined in subsequent sections.

4. Database and Research Methodology

4.1 Data Sources

The study relies exclusively on secondary data assembled from a range of official, statutory, and scholarly sources. The Prayagraj Master Plan 2031, published by the Prayagraj Development Authority (PDA, 2031), serves as the primary planning reference, providing detailed prescriptions on land use, zoning, infrastructure standards, and future strategies. Demographic data — including population composition, household structure, and service access levels — are drawn from the Census of India (2001, 2011), supplemented by recent projected estimates from peer-reviewed modelling studies (Sarif et al., 2024).

Transport data were obtained from the National Highways Authority of India (NHAI, 2024) and the Ministry of Road Transport and Highways. Health facility data were sourced from the Chief Medical

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Officer (CMO) Office, Prayagraj District Health Status Report 2023–24 (CMO Prayagraj, 2024). Water supply and drainage data were drawn from the Prayagraj Jal Sansthan (2022), the National Mission for Clean Ganga (NMCG, 2024), and the Central Pollution Control Board (CPCB, 2024). Electricity infrastructure norms and projections were derived from the Uttar Pradesh Building Construction and Development Bye-laws (Government of Uttar Pradesh, 2018). Progress reports for Prayagraj Smart City Limited (2018) provided data on ongoing civic investments. Recreational and cultural facility information was obtained from the Prayagraj Nagar Nigam Parks Division, the Archaeological Survey of India (ASI, 2024), and the Ministry of Tourism, Government of India (2024).

4.2. Research Methodology

The methodological approach is descriptive, analytical, and interpretive in character. A sector-wise framework structures the analysis, with each major element of urban development examined independently before synthesis. Data were screened for consistency and organised into quantitative tables and qualitative assessments. Service indicators were evaluated against standard planning norms — particularly those prescribed in the Master Plan 2031 and national standards — to gauge adequacy, coverage, and spatial equity.

Temporal analysis was applied where data permitted, enabling trends in infrastructure growth and service access to be traced over time. Projections for electricity substation requirements were developed using population estimates for 2011, 2021, and 2031 alongside normative ratios specified in the Uttar Pradesh Building Bye-laws (Government of Uttar Pradesh, 2018). For water and sanitation, a gap analysis compared installed treatment capacity against actual throughput and identified the quantum of untreated effluent discharging to the riverine system. The overall interpretive framework is grounded in planning theory and the political economy of urbanisation, ensuring that quantitative findings are contextualised within broader questions of governance, environmental sustainability, and social equity.

5. Results and Discussion

5.1. Housing Development

Housing development in Prayagraj City constitutes perhaps the most visible index of its urban growth, reflecting a gradual transition from organic, unplanned expansion toward regulated and institutionally guided development. The Prayagraj Development Authority operates as the principal agency steering this transformation under the broad mandate of the Prayagraj Master Plan 2031 (PDA, 2031). Its stated objectives — to contain urban sprawl, bring order to peripheral expansion, improve residential quality, and promote affordability — are pursued through a combination of integrated township development, facilitation of private-sector participation, and delivery of subsidised units for economically weaker sections.

Among the most significant public-sector initiatives is the Aero City project, a contemporary integrated township proposed by the PDA near Jhalwa on the Airport Road corridor. The project envisions a full complement of civic infrastructure — internal roads, green spaces, commercial and residential units — leveraging its location along key transport links and proximity to the airport to attract private investment while providing modern yet relatively affordable housing. Its intent is partly decongestive: by providing attractive residential options on the urban periphery, the project aims to redistribute population pressure away from the saturated city core and stimulate more balanced spatial development (PDA, 2031).

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The Pradhan Mantri Awas Yojana (PMAY) represents a complementary effort to address the housing deficit among low-income and economically weaker section groups. The scheme has attracted a large number of applications in Prayagraj, a direct indicator of suppressed demand for formal, affordable housing. By delivering structurally sound units with basic services — piped water, sanitation, electricity — PMAY simultaneously reduces dependence on unauthorised settlements and advances the city's goal of socially equitable urban development (Ministry of Housing and Urban Affairs [MoHUA], 2023).

The residential stock of Prayagraj encompasses a wide range, from high-end private townships developed by firms such as Omaxe — offering multi-bedroom units and villas for middle- and upper-income buyers — to public-sector plot and flat schemes administered online by the PDA. Civil Lines remains the city's prestige residential address, with well-maintained roads, retail infrastructure and premium amenities. Localities such as Kareli, Rajapur, Allahpur, and Jhansi serve middle-income demand, valued for their proximity to educational and employment nodes. The housing development picture is nonetheless one of systemic contrasts. Spatial inequality between the inner city and periphery, escalating land values in well-connected localities, and the persistence of informal settlement beyond the reach of PMAY and PDA programmes point to the limitations of the current policy mix. A more genuinely inclusive housing agenda will require stronger cross-subsidisation mechanisms, aggressive slum upgrading, and tighter integration between housing policy and transport planning.

5.2. Transport Development

Transport infrastructure constitutes the structural backbone of Prayagraj's urban development, conditioning the spatial distribution of economic activity, residential choice, land value, and quality of life. The Prayagraj Master Plan 2031 has guided a range of major investments across multiple transport modes, united by the aim of decongesting the urban core, improving multi-modal connectivity, and laying the foundation for future growth (PDA, 2031).

5.2.1. Prayagraj Metro System

The proposed Metro rail system represents a qualitative shift in the ambition of Prayagraj's urban mobility planning. An initial Metrolite proposal was upgraded to a full Metro in recognition of the city's rapid population growth and its stature as an educational, administrative, and religious centre. The system is planned across two corridors extending some 44 kilometres — one running from Bamrauli to Jhunsi and the other from Shantipuram to Cheoki — connecting commercial and residential zones, major educational institutions, and railway termini. When operational, the Metro is expected to reduce private vehicle use on key arterial roads, particularly during peak hours and the Kumbh Mela season (Prayagraj Smart City Limited, 2018).

5.2.2. Ring Road and Expressway Connectivity

The 103-kilometre Inner Ring Road, being executed by the National Highways Authority of India, is conceived as a greenfield bypass corridor designed to divert heavy and long-distance freight traffic away from the congested urban core. Beyond its primary decongestive function, the Ring Road is expected to catalyse industrial and residential development along its fringe. At the regional scale, the Ganga Expressway — a high-speed east–west arterial connecting Meerut to Prayagraj and eventually extending to Haridwar and Ballia — significantly enhances the city's integration into Uttar Pradesh's broader development corridor (NHAI, 2024).

Figure 2: Road Network and Major Transport Map of Prayagraj City

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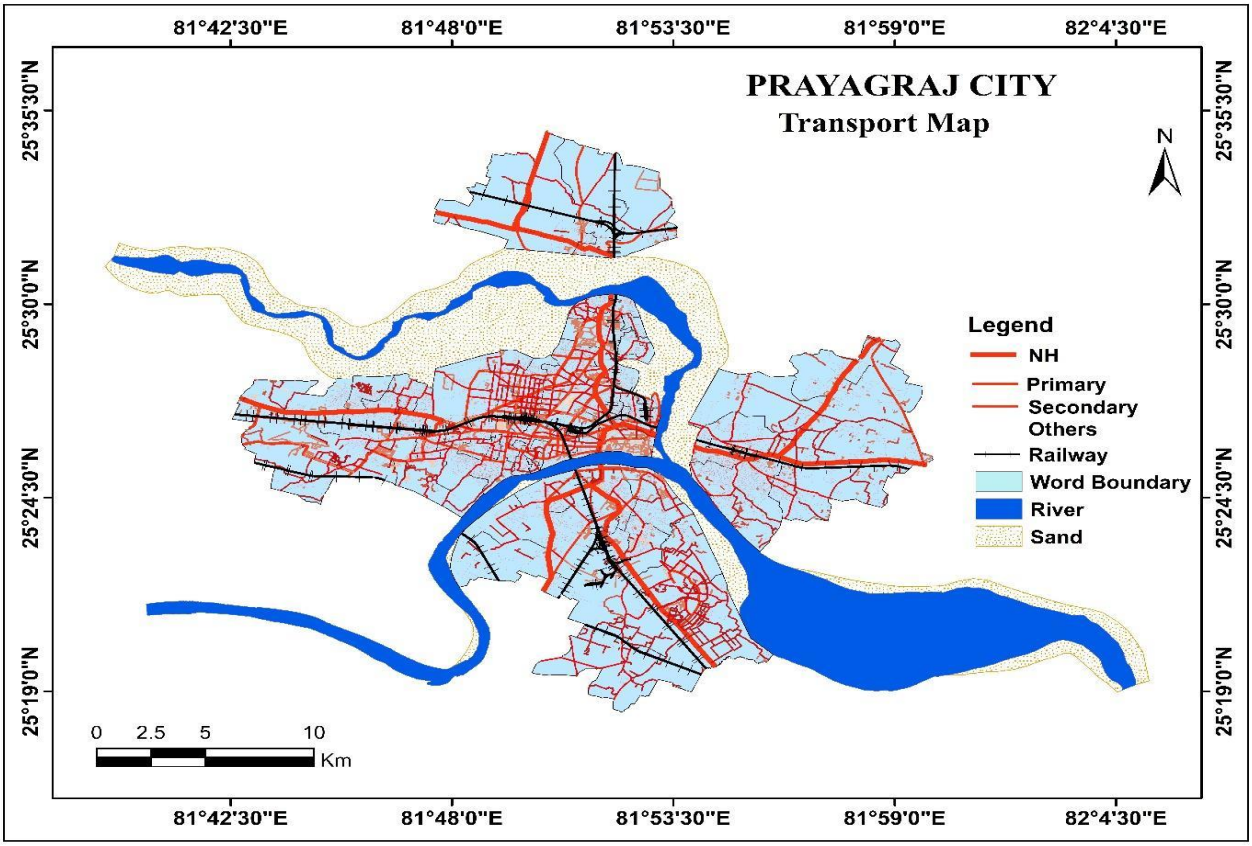

5.2.3. Road Network and National Highways

Prayagraj benefits from an unusually dense convergence of national and state highways. Five National Highways — NH-30, NH-35, NH-19, NH-135C, and NH-330 — pass through or adjoin the city, while State Highways SH-95 and SH-138E strengthen intra-state linkages. This network underpins the city's role as a regional transport node and facilitates commodity circulation across northern India. Recent road-widening and beautification programmes by the PDA and municipal bodies have improved traffic flow on key corridors and elevated the quality of the street environment (NHAI, 2024).

Table 1: Major National Highways and Connectivity of Prayagraj City

National Highway	Route Connectivity
NH-30	Lucknow – Raebareli – Prayagraj – Rewa
NH-35	Prayagraj – Mirzapur – Hanumangarh
NH-19	Prayagraj – Chandauli
NH-135C	Varanasi – Azamgarh

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NH-330	Prayagraj – Bela Pratapgarh – Ayodhya Dham

Source: Adapted from National Highway Network Data (NHAI, 2024).

Table 2: Road Distances from Prayagraj to Major Cities

S.No.	City	Distance (km)
1	New Delhi	668
2	Lucknow	200
3	Varanasi	120
4	Mirzapur	94
5	Rewa	129
6	Kanpur	198
7	Jaunpur	99
8	Raebareli	121
9	Ayodhya	161

Source: Adapted from National Highway Network Data (NHAI, 2024).

5.2.4. Rail and Air Connectivity

Prayagraj Junction stands as one of northern India's most strategically positioned railway interchanges, located at the intersection of the Howrah–Gaya–Delhi main line, the Howrah–Mumbai trunk route, and the Prayagraj–Gorakhpur corridor. It serves as the headquarters of the North Central Railway Zone, a designation that reflects both the volume of traffic it handles and its centrality to the national rail network. Recent modernisation works at Prayagraj Junction and Naini Junction — encompassing new platforms, lifts, escalators, and improved passenger facilities — have increased throughput and passenger comfort.

Prayagraj Airport (IATA: IXD), located approximately 12 km northwest of the city centre at Bamrauli, operates as a joint facility of the Indian Air Force and the Airports Authority of India (AAI, 2024). Under normal operating conditions, the airport serves around seven cities through 20 scheduled daily flights. Its capacity undergoes dramatic seasonal transformation during the Maha Kumbh: the 2025 event saw 17 direct destinations, 132 direct flights, and over 80,000 monthly seats, with total passenger traffic

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exceeding 5.59 lakh over 46 days. The record was set on 25 February 2025, when 262 flights carried 27,673 passengers in a single day. Post-Kumbh, services contracted sharply, underscoring the challenge of sustaining air connectivity in a city whose demand is deeply episodic. Future plans include addition of international routes, night landing facilities, and expanded terminal capacity to 2,050 passengers per hour (AAI, 2024).

5.3. Water Supply and Sanitation

Water supply and sanitation represent the most striking paradox in Prayagraj's urban development profile. The city is flanked by the Ganga to the north and the Yamuna to the south — two of northern India's most voluminous perennial rivers — yet urban water management is characterised by over-dependence on groundwater, inequitable distribution, and an inadequate sewage network that allows large quantities of untreated wastewater to discharge into those very rivers (NMCG, 2024).

5.3.1. Water Supply System

The city's piped water supply system covers all municipal wards, supplemented by handpumps and tubewells for areas with intermittent network access. To manage distribution, Prayagraj is divided into twelve water supply zones. Of these, three — Lukerganj, Khusro Bagh, and Attala — are served by treated surface water drawn from the Yamuna, while zones including Colonelganj, Daraganj, Naini, Phaphamau, and Jhunsi rely entirely on groundwater (Prayagraj Jal Sansthan, 2022).

The total daily supply stands at 308 MLD, of which 238 MLD (77%) is sourced from tubewells and 70 MLD (23%) from the Yamuna at the Karela Bagh pumping station. Per capita supply within the Prayagraj Nagar Nigam area amounts to 253 litres per capita per day (lpcd), which exceeds the national planning norm of 135 lpcd for Class-I cities. However, this aggregate figure conceals significant spatial disparities: residents of informal settlements and low-income areas frequently depend on public standposts, tanker deliveries, and handpumps that deliver far less than this average implies. Storage capacity of 22.5 MLD distributed across 18 underground and overhead reservoirs provides a buffer for distribution management (PDA, 2031).

Table 3: Water Supply Zones and Source Types, Prayagraj City

S.No.	Zone	Source Type
1	Lukerganj	Surface Water
2	Khusro Bagh	Surface Water
3	Attala	Surface Water
4	Civil Lines	Surface & Groundwater
5	Kidganj	Surface & Groundwater

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6	Colonelganj	Groundwater
7	Daraganj	Groundwater
8	Rasulabad	Groundwater
9	Sulemsarai	Groundwater
10	Naini	Groundwater
11	Phaphamau	Groundwater
12	Jhunsi	Groundwater

Source: Adapted from City Development Plan, Prayagraj 2031 (PDA, 2031); Prayagraj Jal Sansthan (2022); Prayagraj Smart City Limited (2018).

Table 4: Sources of Water Supply and Quantity, Prayagraj City

S.No.	Source	Quantity (MLD)	Share (%)
1	Yamuna River (Surface Water)	70	22.7
2	Tubewells (Groundwater)	238	77.3
Total	—	308	100.0

Source: Calculated by the author from City Development Plan, Prayagraj 2031 (PDA, 2031).

5.3.2. Sewerage System and River Pollution

Prayagraj operates one of northern India's oldest sewerage systems, dating to 1910. Total sewage generation is estimated at 246 MLD, against an installed treatment capacity of 340 MLD distributed across ten sewage treatment plants (STPs). Despite this nominal surplus, the sewer network reaches only 22 per cent of the city's area, as documented in the JICA Sewerage Master Plan (as cited in PDA, 2031). Consequently, a large proportion of the urban population relies on septic tanks, soak pits, or open defecation, contributing to groundwater contamination and river pollution.

Of the 81 drains discharging into the Ganga and Yamuna, only 37 are fully tapped — intercepted and directed to STPs. Twenty-three drains in the Ganga catchment and fifteen in the Yamuna catchment remain untapped, together contributing approximately 63.64 MLD of untreated effluent directly to the rivers (NMCG, 2024; CPCB, 2024). Even among installed STPs, actual hydraulic loading is considerably below installed capacity: sewer networks deliver only 178.31 MLD to the plants, leaving 161.69 MLD

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largely untreated. This shortfall is a primary driver of water quality degradation in both the Ganga and Yamuna at Prayagraj, with critical implications for public health and the ecological integrity of the Sangam.

Table 5: Status of Drains Discharging into the Ganga and Yamuna, Prayagraj

River	Total Drains	Discharge (MLD)	Tapped (No.)	Untapped (No.)	Untapped Discharge (MLD)
Ganga	48	167.70	22	23	55.41
Yamuna	33	122.28	15	15	8.23
Total	81	289.98	37	38	63.64

Source: Adapted from NMCG Drain Status Report, Prayagraj (NMCG, 2024); CPCB Inventory of STPs, Uttar Pradesh (CPCB, 2024).

Table 6: Existing Sewage Treatment Plants in Prayagraj City

S.No.	Location	Capacity (MLD)	% of Total
1	Numayadahi	50	14.71
2	Naini	80	23.53
3	Rajapur	60	17.65
4	Kodra	25	7.35
5	Ponghat	10	2.94
6	Salori–1	29	8.53
7	Naini–2	42	12.35
8	Phaphamau	14	4.12
9	Salori–2	14	4.12
10	Jhunsi	16	4.71

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Total	—	340	100.00

Source: Compiled from Prayagraj Municipal Corporation and Jal Nigam STP records (as cited in PDA, 2031). Percentages calculated by the author.

5.4. Recreational Amenities

Recreational infrastructure is a fundamental dimension of urban liveability, contributing to physical health, social cohesion, cultural continuity, and environmental quality. In Prayagraj, recreational provision reflects the city's distinctive character: a blend of planned modern urbanism and historically layered cultural heritage, drawing on its riverfront setting, Mughal-era gardens, freedom movement landmarks, and contemporary sports facilities (Ministry of Tourism, Government of India, 2024).

5.4.1. Parks and Open Spaces

Prayagraj maintains several significant parks and open spaces that combine ecological, recreational, and historical functions. Chandrashekhar Azad Park, Alfred Park, Minto Park, and the Mughal-period Khusro Bagh provide green lungs for the inner city, while newer Model Parks developed under the Smart Cities Mission are being designed with eco-friendly and child-friendly amenities. These spaces serve both the permanent population and the substantial tourist and pilgrim flow the city attracts year-round (Prayagraj Nagar Nigam, 2024; PDA, 2031).

Table 7: Major Parks and Gardens in Prayagraj City

S.No.	Park / Garden	Key Facilities
1	Chandrashekhar Azad Park	Jogging tracks, play areas, historical monuments, Hanuman Temple
2	Minto Park	Heritage walks, maintained gardens, historical pillar
3	Khusro Bagh	Mughal-era heritage garden, photography, morning strolls
4	Bharadwaj Park	Play equipment, walking paths, neighbourhood recreation
5	Model Parks (Smart City)	Under development; eco-friendly design, children's zones

Source: Adapted from Prayagraj Nagar Nigam Parks Division; Ministry of Tourism, Prayagraj Destination Guide (Ministry of Tourism, Government of India, 2024); PDA (2031).

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5.4.2. Sports Facilities

Sports infrastructure has expanded substantially, anchored by the Amitabh Bachchan Sports Complex, which provides an international-standard athletics track, cricket ground, football field, swimming pool, and multiple indoor sports courts. The Madan Mohan Malaviya Stadium and K. P. College Sports Ground supplement these facilities. Such infrastructure promotes a healthy urban lifestyle and engages the youth population, serving as community assets beyond competitive events (Prayagraj Smart City Limited, 2018).

5.4.3. Waterfront, Cultural, and Commercial Recreation

The city's riverfronts — particularly the Triveni Sangam, the Yamuna Riverfront, and the Boat Club — serve a dual recreational and spiritual purpose, hosting boat rides, religious ceremonies, and evening cultural programmes. Heritage sites including Allahabad Fort, the Bade Hanuman Ji Mandir, and All Saints Cathedral attract pilgrims and tourists alike (ASI, 2024). Cultural venues such as Anand Bhawan, Swaraj Bhawan, the Allahabad Museum, and the Jawahar Planetarium extend the recreational offer into the educational and heritage domain (Ministry of Culture, Government of India, 2024). Shopping districts — Civil Lines, Katra Market, Vinayak City Centre Mall, and the Chowk area — function as key zones of social and commercial recreation, completing a diverse urban leisure landscape that, while rich in offer, requires more equitable spatial distribution across peripheral and low-income areas (PDA, 2031).

5.5. Health Facilities

Healthcare infrastructure is a direct determinant of urban well-being, productivity, and social equity. Prayagraj's health system has developed under the combined influence of state investment, private-sector growth, and the National Health Policy, which mandates strengthened infrastructure, human resources, financial protection, and technological integration. The Prayagraj Master Plan 2031 designates health as a priority sector, recognising the dual challenge the city faces: reliable service provision to a large permanent population and healthcare capacity for millions of pilgrims during religious gatherings (PDA, 2031).

Service delivery is organised on a three-tier model. At the primary level, 64 Primary Health Centres (PHCs) and 23 Urban Primary Health Centres (UPHCs) provide immunisation, maternal and child health services, and basic curative care. The secondary tier comprises 23 Community Health Centres (CHCs) with inpatient and outpatient specialist services. Tertiary care is concentrated in a cluster of specialised hospitals and in the Motilal Nehru (MLN) Medical College, where the expansion of super-speciality blocks has materially increased the city's advanced care capacity. Private multi-speciality hospitals — Phoenix, Srijan, and others — serve higher-income groups and have elevated the overall quality of diagnostics and surgical services (CMO Prayagraj, 2024).

Table 8: General Health Facilities in Prayagraj City

S.No.	Facility Type	No. of Units	No. of Beds
1	Community Health Centres (CHC)	23	610

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2	Primary Health Centres (PHC)	64	128
3	Urban Primary Health Centres (UPHC)	23	0
4	Sub-Area Dispensaries (SAD)	14	0
5	30-bed MCH Wings	3	90
6	100-bed Hospital, Bhagwatpur	1	100
Total	—	128	928

Source: Adapted from District Health Status Report (CMO Prayagraj, 2024).

Table 9: Specialised Health Facilities in Prayagraj City

S.No.	Institution	Beds
1	T.B. Sapru Hospital	226
2	Tuberculosis Hospital	150
3	MLN Hospital	156
4	District Women's Hospital (DWH)	146
5	SRN Hospital	120
6	Children's Hospital	150
7	MDI Hospital	150
8	SNCU	60
9	100-bed Hospital, Bhagwatpur	100
Total	—	1,258

Source: Adapted from District Health Status Report (CMO Prayagraj, 2024).

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Under normal operating conditions, the aggregate bed count and facility network are adequate for the resident population. The structural weakness of the system becomes apparent during the Kumbh Mela and related mass gatherings, when millions of pilgrims converge on the city over a compressed period. Temporary medical camps and mobile units are deployed to manage this surge, but they cannot replicate the diagnostic and specialist capacity of permanent institutions. Post-event evaluations consistently identify emergency response, specialist care availability, and sanitation as areas requiring deeper preparation. Additionally, the absence of inpatient beds in the UPHC network limits the ability of primary facilities to absorb caseload independently, creating persistent upward pressure on secondary and tertiary institutions (CMO Prayagraj, 2024).

5.6. Electricity Infrastructure

Electricity is a foundational pillar of urban development, undergirding household welfare, economic activity, transport, water supply, health services, and the digital infrastructure that increasingly defines urban life. In Prayagraj, electricity demand has risen sharply in recent years, driven by population growth, commercial expansion, the proliferation of household appliances, and the infrastructure demands of Smart City projects. The Prayagraj Master Plan 2031 accordingly prioritises the modernisation and expansion of generation, transmission, and distribution networks (PDA, 2031).

The city's primary power source is the Panki Thermal Power Project, located approximately 40 km from the urban centre. As Table 10 shows, the city's aggregate demand — between 462 and 500 MW under normal load conditions — consistently exceeds the 405–450 MW currently supplied. This deficit is most acutely felt during summer peak loads and large-scale religious events, when demand spikes sharply. Load shedding, voltage instability, and widespread reliance on diesel generators and inverter systems are the practical consequences, particularly in lower-income neighbourhoods and unplanned settlements (Prayagraj Smart City Limited, 2018).

Table 10: Electricity Demand and Supply Position, Prayagraj City

Power Source	Distance (km)	Demand (MW)	Supply (MW)
Panki Thermal Power Project	40	462–500	405–450

Source: Adapted from PCHB Town Release; Smart City Proposal Report (Prayagraj Smart City Limited, 2018).

Projected substation requirements reveal the scale of infrastructure investment needed to keep pace with urban growth. The number of 11 kV substations — the neighbourhood-level distribution tier — is projected to rise from 103 in 2011 to 178 by 2031, an increase of 75 units. At the higher-capacity tier, 66 kV substations are expected to grow from 31 to 53, and 220 kV units from three to five. Meeting this demand will require a total land allocation of approximately 65 hectares across all substation types, with 66 kV installations accounting for the largest share at 32.09 hectares (Government of Uttar Pradesh, 2018).

Table 11: Projected Electricity Substation Requirements, Prayagraj Development Area

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Sub-Station	Standard	2011	2021	2031	Increase (2011–2031)
11 kV	1 per 15,000 pop.	103	140	178	75
66 kV	1 per 50,000 pop.	31	42	53	22
220 kV	1 per 500,000 pop.	3	4	5	2
Total	—	137	186	236	99

Source: Projections compiled and calculated by the author based on Building Construction and Development Bye-laws (Government of Uttar Pradesh, 2018).

The city's energy resilience is further compromised by its near-total dependence on a single thermal source and by ageing distribution infrastructure in older residential zones, where overloaded transformers and antiquated cabling contribute to transmission losses and supply interruptions. The Master Plan 2031 recommends network modernisation, renewable energy integration (particularly rooftop solar on public and institutional buildings), and the adoption of smart metering as a package of remedies, but implementation remains at an early stage (PDA, 2031).

6. Conclusion

This paper has undertaken a systematic, sector-wise evaluation of urban development in Prayagraj City, examining housing, transport, water supply and sanitation, recreational amenities, health facilities, and electricity infrastructure against the backdrop of the Prayagraj Master Plan 2031 and allied policy frameworks. The evidence assembled from statutory planning documents, government reports, and peer-reviewed literature reveals a city in active and consequential transition — one that has made real infrastructural progress over the past three decades while carrying forward structural challenges that will define the quality of urban life in the decades ahead.

In the housing sector, the shift toward PDA-led planned development and the introduction of PMAY-subsidised units represent meaningful gains in formal residential provision (MoHUA, 2023). Yet spatial inequality between the inner city and the periphery, rising land prices, and the persistence of informal settlements indicate that current policy instruments are insufficient to deliver inclusive housing at the scale the city requires. Transport has received substantial investment across all modes — the Ring Road, the Ganga Expressway, rail modernisation, and the Metro — but the system remains under severe stress during mass-gathering events and has not yet delivered the integrated, seamless multi-modal experience that sustainable urban mobility demands (NHAI, 2024; Prayagraj Smart City Limited, 2018).

The water and sanitation analysis exposes the most glaring paradox of Prayagraj's urban condition: a city positioned at the confluence of two great rivers that nonetheless over-mines its groundwater and discharges large volumes of untreated sewage into those same rivers. While aggregate water supply and treatment capacity are nominally adequate, spatial inequity in distribution and the severe under-coverage of the sewer network — reaching only 22 per cent of the city — translate these paper

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adequacies into real deprivation for large population segments and genuine damage to the riverine ecosystem (NMCG, 2024; CPCB, 2024; Prayagraj Jal Sansthan, 2022).

Recreational infrastructure is varied and culturally rich, anchored by heritage parks, riverfronts, and sports complexes, but equitable distribution across all residential zones requires active planning attention as the city expands (PDA, 2031). Health services have developed a credible three-tier structure that functions adequately under routine conditions, but the episodic, massive demand generated by the Kumbh Mela reveals structural limits in emergency capacity and geographically balanced facility distribution (CMO Prayagraj, 2024). Electricity supply has expanded its reach considerably, yet a persistent demand–supply deficit and ageing distribution infrastructure constrain both everyday service quality and the city's ability to attract investment (Government of Uttar Pradesh, 2018).

Taken together, the evidence points to a Prayagraj in which the scale of urbanisation has consistently outpaced the capacity of governance institutions and infrastructure investment to respond in a timely, coordinated, and equitable manner. What is required is not simply more investment in individual sectors, but a more integrated approach to urban development — one that ties land-use planning, infrastructure provision, and environmental management into a coherent framework, and that places equity and sustainability alongside efficiency as organising principles. Strengthening the institutional capacity of the PDA, improving coordination between the Nagar Nigam, Jal Sansthan, and sectoral line departments, and ensuring that Master Plan prescriptions translate into time-bound, funded implementation programmes are the preconditions for more balanced and sustainable urban growth (Mishra et al., 2017; Sharma & Singh, 2025).

The city's designation as a Smart City offers a platform for catalytic action, but the evidence of this study suggests that the most pressing needs — sewage network extension, primary healthcare scaling, electricity supply augmentation, and affordable housing delivery — are fundamentally issues of public investment and political will rather than technological innovation alone. If Prayagraj is to realise its full potential as a liveable, equitable, and sustainable city, it must match the ambition of its planning documents with the institutional capacity and fiscal commitment to deliver on them (Sarif et al., 2024; Gabril et al., 2019).

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