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FROM THE EDITOR-IN-CHIEF

India's urbanisation trend mirrors the rapid urbanisation witnessed in most of the African and Asian countries. It is estimated that India's urban population would be 40% of the total population by 2036 and nearly 50% by the end of 2047. What India does in the next two decades in terms of urban transformation through its Urban Local Governments (ULGs) would therefore determine its transition into becoming a developed country by 2047, the 100th year of its independence. As per World Bank's estimates, by 2036 an investment of $840 billion or an average of $55 billion per annum would be required in infrastructure development by India for effectively meeting the needs of its fast-growing urban population.

Cities and the Urban Local Governments would play a seminal role in realising its vision of Viksit Bharat by 2047. The Urban Local Governments therefore need to evolve from being mere administrative units into dynamic institutions of urban governance capable of managing complex infrastructure systems, engaging citizens, and driving sustainable development.

Realising the need to empower municipalities and strengthen Urban Local Governments (ULGs), the Govt. of India has taken several steps to unlock ₹7,00,000 -₹8,00,000 crore for urban growth from various initiatives – the Finance Commission Grants, the Urban Challenge Fund (UCF) and incentives for municipal bond issuance, besides additional inflows from Centrally Sponsored and State Specific Scheme Grants.

Sixteenth Finance Commission (2026–31)

The Sixteenth Finance Commission (FC) has recommended a massive boost to India's urban infrastructure spending by more than doubling the grant for Urban Local Governments (ULGs) to ₹3,56,257 crore for the 2026-31 period. This marks a significant jump of 230% from the ₹1,55,000 crore allocated by the Fifteenth Finance Commission. The Sixteenth Finance Commission has also substantially increased the proportion of untied grants compared to previous Finance Commissions, thereby providing greater fiscal flexibility to ULBs to address local priorities. The share of untied grants has been raised to 60% from the 27.4% recommended by the Fifteenth Finance Commission.

The Urban Challenge Fund (FY 2025–26 to FY 2030–31)

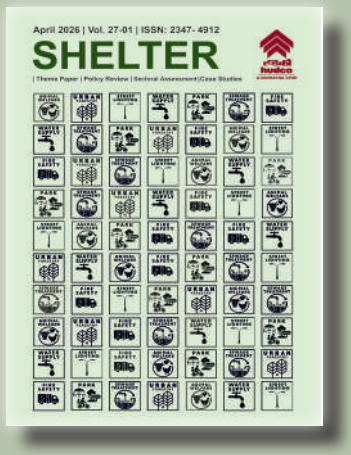
The Government of India has launched the Urban Challenge Fund (UCF) with an annual allocation of ₹1,00,000/- crore for improving urban infrastructure in the country in the Budget of FY 2025-26. This allocation would lead to a total investment of ₹ 4,00,000/- crore in the urban sector in the next five years, marking a paradigm shift in India's urban development approach from grant- based financing to market-linked, reform-driven and outcome-oriented infrastructure creation.

Municipal Bond incentives

Further, to develop the municipal bond market and introduce innovative financing structures, the Union Budget 2026 introduced a ₹100 crore incentive for municipal bond issuances exceeding ₹1,000 crore, aimed at boosting India's nascent bond market. This move encourages large city corporations to tap capital markets for infrastructure projects, complementing existing AMRUT (Atal Mission for Rejuvenation and Urban transformation) support for smaller issuances. The initiative seeks to foster fiscal discipline and enhance secondary market liquidity. While the Government of India has been forthcoming in its efforts of financially strengthening the ULGs, the onus now lies with the state governments to empower city governments both functionally and financially to realise the vision of Viksit Bharat by 2047.

The April issue of SHELTER explores the multifaceted challenges faced by ULBs, including gaps in the Union Budget, the role of Finance Commission recommendations in bridging fiscal disparities, the need for institutional reforms, and additional strategies for strengthening ULGs for realising the goal of Viksit Bharat by 2047. It also draws key learnings from relevant case studies. The theme paper by Soumyadip Chattopadhyay and Arjun Kumar provides a detailed analysis of the gaps in budgetary allocations and proposes measures to enhance both the quantum and effective utilisation of funds. Kulwant Singh's article examines the historical evolution of ULBs, evaluates their current performance, and highlights their potential to deliver essential urban services through institutional, financial, and technological reforms.

INSIDE



In the policy review paper, Sandeep Thakur from NIUA outlines the reforms recommended by various Finance Commissions to strengthen and rationalise municipal finance, while also identifying key areas requiring improvement to ultimately enhance urban service delivery. The paper by Sudhir Bhatnagar, Regional Chief of Jaipur Regional Office of HUDCO, provides an overview of the Urban Invest Window (UiWIN) conceptualised by HUDCO, including its objectives and HUDCO's role in its implementation. Ritesh Gupta's paper highlights structural deficiencies such as fragmented governance, limited municipal autonomy, restrictive regulatory frameworks, and inadequate land-use planning, and recommends resilience strategies derived from the experiences of emerging economies. The paper by Rinki Haldar and et al from UN-Habitat underscores the importance of evidence-based diagnostics for attracting bankable projects and advancing the goal of making cities garbage-free. The Scholars from the TERI School of Advanced Studies discuss the emerging significance of data centres and semiconductor facilities in shaping the future urban landscape. The paper by Ankit Jha et al from CEEW analyses the growing challenge of urban flooding and emphasises the crucial role of blue-green infrastructure in mitigating associated risks. The case study by Anisha Sultana and Avantika Upadhyay examines the institutional and financial lessons drawn from the Noida Development Authority model and its relevance for strengthening ULBs.

We are thankful for the overwhelming response that we received for this issue. We also sincerely hope that the readers would love this issue as much as we did in putting it together. We believe that the April issue would trigger a discourse on building the capacities and financial strengthening of Urban Local Governments which is an absolute imperative for realising the vision of Viksit Bharat by 2047.

THEME PAPER

POLICY REVIEW

SECTORAL ASSESSMENT

CASE STUDIES

IN THE BOX

Two-week Course for overseas professionals on "Leadership Skills for Women" (March 30 – April 10, 2026)

HUDCO's Human Settlement Management Institute (HSMI) organised the 61st Training Programme for women overseas professionals on "Leadership Skills for Women" sponsored by the Ministry of External Affairs (MEA), Government of India under its ITEC Programme during 30th March to 10th April, 2026. The programme was inaugurated by Shri Sanjay Kulshrestha, Chairman & Managing Director, HUDCO on 30th March, 2026, in the presence of Shri Tekkam Sridhar, Senior Executive Director, HUDCO and Ms. Varsha Punhani, Head, HUDCO's HSMI.

The training programme was attended by 21 delegates from 13 ITEC partner countries namely, Botswana, Ivory Coast, Colombia, Ghana, Kenya, Kyrgyzstan, Myanmar, Niger, Papua New Guinea, Paraguay, South Sudan, Tajikistan and Zambia. The programme was conducted on participatory lines with deliberations and insights from domain experts as well as the partcipants. In addition to the HSMI faculty, specialised technical inputs were delivered by distinguished experts from the government and private sectors, non-governmental organisations, and academia. Notable speakers who contributed to various sessions included Dr. Otojit Kshetrimayum, Labour Sociologist and Faculty Member, V.V. Giri National Labour Institute; Dr. Onkar Sharma, former Chief Labour Commissioner, Government of India; Ms. Manvi Dikshit Sharma, Advocate at Supreme Court of India and Dr. Charru Malhotra, Professor from Indian Institute of Public Administration; among others.

61st ITEC batch of overseas professionals with Shri Sanjay Kulshrestha, Chairman & Managing Director, HUDCO and Senior Officers of HUDCO and HUDCO's HSMI

Over the course of the two-week programme, participants were comprehensively exposed to both the technical and behavioural dimensions of planning, organising, leading, and coordinating in their professional roles. The programme highlighted policies and initiatives currently in practice in India aimed at promoting women's empowerment and inclusive participation in the workforce. The course aimed to equip women professionals with the requisite competencies to effectively overcome personal and professional challenges and to assume leadership roles within their respective organisations. Emphasis was placed on strengthening effective communication skills, strategic decision-making abilities, and managerial efficiency, while encouraging participatory learning through experience sharing and collaborative engagement. The technical sessions were further enriched by visits to sites of cultural and historical significance in Delhi, as well as to the Taj Mahal, a World Heritage Site in Agra.

Shri K Srinivas, Secretary, MoHUA delivering Valedictory Address of 61st ITEC Course

THE URBAN IMPERATIVE OF VIKSIT BHARAT@2047: PROMISES AND GAPS IN UNION BUDGET 2026–27

SOUMYADIP CHATTOPADHYAY
ARJUN KUMAR

The Backdrop

The UN World Urbanisation Prospects (WUP) 2025 projects an increase of 986 million in the global urban population by 2050, with over half concentrated in seven countries, including India, at the centre of this transition. According to the Census 2011, 31% of India's population lives in urban areas, which was estimated to rise to 35.2% by 2019. Although India is urbanising, the pace remains slower than in countries such as China and Brazil, partly due to the strict demographic, spatial, and economic criteria used to define urban settlements. Several reports suggest that India's actual level of urbanisation may be higher than official estimates. Moving beyond the conventional rural–urban binary, the WUP 2025 highlights the rapid transformation of peri-urban settlements and transitional spaces. It estimates that 40.3% of India's population lives in cities in 2025, while about 44% resides in towns and transitional areas.

India's urban system is highly top-heavy, with 70.2% of the urban population living in Class I cities (population above one lakh) and 42.3% residing in metropolitan cities (population above ten lakh). Notably, peripheral areas of metropolitan cities have grown faster than their core areas (Mathur et al., 2021). Between 2000 and 2020, 16 cities recorded higher growth in peripheral regions (GoI, 2026). Additionally, the rise of census towns, many with populations above 50,000 and often located beyond municipal boundaries or around large cities, has significantly altered India's urbanisation pattern. During the last intercensal period, rural-to-urban transformation accounted for about 36% of urban growth. With core growth slowing in large cities and peripheralisation increasing, alongside the expansion of medium and small cities and census towns, the challenges of managing urbanisation have intensified.

Cities are central to India's vision of achieving Viksit Bharat by 2047, as they function as engines of economic growth. Structural economic transformation offers opportunities but also raises challenges in realising the full potential of cities. Persistent issues include inadequate infrastructure, spatial inequality in access to basic services, and climate vulnerability, affecting both larger and smaller cities at varying scales. A World Bank study estimates that Indian cities require $840 billion in urban infrastructure investments over the next 15 years (until 2036), equivalent to 1.18% of GDP, with 55% of this investment needed to address deficits in basic urban services (Athar et al., 2022).

Urbanisation in India has also remained largely unplanned, reflecting a disconnect between spatial planning and socio-economic planning. Governance challenges persist, as cities often lack empowered administrative structures and financial autonomy for urban development, problems that are particularly acute in smaller cities, slums, informal settlements and rapidly transforming rural-urban regions. These dynamics necessitate differentiated strategies for

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megacities and for medium and small towns. The central challenge is to facilitate urban expansion—especially beyond major metros—so that cities can function as hubs of economic activity while addressing inequality, climate risks, and deficits in basic services.

Against this backdrop, the three Kartavyas proposed in Budget 2026—accelerating and sustaining economic growth, building capacity, and promoting an inclusive vision—carry significant implications for India's urban development trajectory. This paper therefore analyses budgetary allocations under Central Sector Schemes and Centrally Sponsored Schemes within the Ministry of Housing and Urban Affairs (MoHUA) over time, with particular attention to Budget 2026 announcements and their implications for governing, managing and facilitating urbanisation in India.

The Overall Trend in Urban Allocations

In the last couple of years, the government has intended to prioritise urban development, shifting focus from basic service improvement to long-term planning, infrastructure, and sustainability. In this year's budget, the Ministry of Housing and Urban Affairs (MoHUA) receives an allocation of ₹ 85,522 crores which is equivalent to about 50% increase over the revised estimates of budgetary allocations (revised estimate - RE) of ₹ 52,204 crores in 2025-26. However, the share of MoHUA's allocation in the total union budget has decreased from 1.9% (budget estimate - BE) in 2025-26 to 1.6% in 2026-27.

***Table 1 : Outlay in Budgets for* Cities**

Centre's Expenditure	Actual Estimate	Budget Estimate (Interim)	Budget Estimate	Revised Estimate	Actual Estimate	Budget Estimate	Revised Estimate	Budget Estimate
(in INR crores)	2023-24	2024-25	2024-25	2024-25	2024-25	2025-26	2025-26	2026-27
Net	68564	77523	82577	63669	53255	96777	57204	85522
Revenue component	42123		53948	32008	21632	59154	24226	50714
Capital component	26441		28628	31661	31623	37623	32978	34808
Smart Cities Mission	7704	2237	2237	1910	2036	.		
City Investment to Innovate, Integrate and Sustain (CITIIS)	278	163	163	89	90	.		
Total- Smart Cities Mission	7982	2400	2400	2000	2126	.		
CITIIS 2.0			225	225	94	250	50	300
National Urban Digital Mission (NUDM)			1150	108	-	1250	-	300
Urban Challenge Fund						10000	1000	10000
Atal Mission for Rejuvenation and Urban Transformation (AMRUT)	5590	8000	8000	6000	5647	10000	7500	8000
Total MRTS and Metro Projects*	23102	24931	24932	28816	28611	34807	29550	30996
Pradhan Mantri Awas Yojna Urban (PMAY-U) (Total)	21684	26170	30170	15170	5865	23294	7800	21625
PMAY-U 1. ISS- I for EWS/ LIG		0	3000	1000	35	2500	200	2000
PMAY-U 2. ISS-II for MIG		.	1000	500	15	1000	100	1000

Centre's Expenditure	Actual Estimate	Budget Estimate (Interim)	Budget Estimate	Revised Estimate	Actual Estimate	Budget Estimate	Revised Estimate	Budget Estimate
(in INR crores)	2023-24	2024-25	2024-25	2024-25	2024-25	2025-26	2025-26	2026-27
Scheme for Industrial Housing						2500	100	400
Swachh Bharat Mission Urban (SBM-U)	2392	5000	5000	2159	1893	5000	2000	2500
Deendayal Antyodaya Yojana-National Urban Livelihood (DAY-NULM)	501	0.02	300	30	29	-	-	-
Deendayal Jan Aajeevika Yojana-Shehari -DJAY(S)					62		200	537
Pradhan Mantri's Street Vendors's Atmanirbhar Nidhi (PM – SVANIDHI)	444	326	326	450	443	373	572	900
Identification of 4 Academic Institutions as Centre of Excellence in Urban Planning/ Design					1000			
Municipal Bonds								100
PM-eBus Sewa Scheme	1		1300	500	477	1310	300	500

*Note: ISS- interest subsidy scheme, EWS- economically weaker section; LIG- lower income group, MIG- middle income group;. *Includes grants to Metro and NCRTC. Source: www.indiabudget.gov.in*

Amongst urban schemes, centrally sponsored schemes account for 52% of MoHUA's budgetary allocation (BE) in 2026–27, while central sector schemes account for 43%. Notably, in FY 2025–26, centrally sponsored schemes witnessed a sharp decline of 65% in revised estimates compared to the budget estimates, whereas the decline for central sector schemes was 13%.

Harnessing the Potential of Agglomeration

Two of the most significant announcements in Budget 2026 are the direct focus on Tier II and Tier III cities with population above 5 lakh as engines of growth and the development of City Economic Regions (CERs) to unlock the potential of urban agglomerations. The budget proposes ₹5000 crore per CER over the next five years. Theoretically, CERs can enhance productivity through pooled labour markets that enable efficient matching between firms and workers, forward and backward linkages Amongst producers, suppliers, and consumers, and knowledge spillovers that spur innovation.

These dynamics reflect agglomeration economies, where equilibrium between labour supply and labour demand supports diverse, geographically proximate economic activities and transforms urban externalities into drivers of innovation and growth. However, such concentration also imposes costs in the form of overcrowding and increased pressure on transportation and other basic urban amenities. Realising a successful city economy, therefore, requires a coordinated policy push and large-scale infrastructure investment to balance the benefits and costs of

agglomeration. In this context, CERs create opportunities for integrated urban planning by linking transport, housing, economic systems, and climate strategies, thereby enabling cities to harness their agglomeration potential.

The government's renewed emphasis on Tier II and Tier III cities also aligns with earlier budget initiatives such as the Urban Infrastructure Development Fund (UIDF) announced in 2023–24 with an initial outlay of ₹10,000 crore and the proposed ₹1 lakh crore Urban Challenge Fund (UCF) in 2025–26. The UCF aims to transform cities into growth hubs through integrated infrastructure, transport, and spatial planning along economic corridors; promote creative redevelopment through transit-oriented development, brownfield regeneration, reorganisation of urban spaces, and unlocking of urban land values; and improve water and sanitation services with a focus on wastewater reuse, flood mitigation, and climate-resilient infrastructure. The fund is designed to partly finance bankable projects on a competitive basis for creative urban redevelopment and improvements in water and sanitation.

By linking central assistance under the UCF to reform conditionalities, the initiative seeks to improve operational efficiency in land-use and mobility planning, digitalisation of urban service delivery, and asset management systems. These measures are expected to strengthen project viability, facilitate greater private sector participation in urban development programs, and enhance the creditworthiness of cities necessary to leverage market finance. Following Cabinet approval of the UCF in February 2026 with central assistance of ₹1 lakh crore over the next five years, all cities with populations of 10 lakh or more, state capitals, and major industrial cities with at least one lakh population will be eligible to access funds and emerge as new growth hubs.

Centrality of MRTS in Urban Transport

Amongst the central sector schemes, Metro Rail and Mass Rapid Transit System (MRTS) receive ₹30,996 crore, accounting for about 36% of total MoHUA allocations. This substantial allocation reflects the government's continued policy focus on strengthening and expanding metro networks, with about 1,036 km of metro rail currently operational across 24 cities and 17 additional metro rail projects approved in Tier II cities.

Metro-centered transport investments also complement the National Transit Oriented Development Policy (2017), which aims to promote compact multimodal integration and value-capture financing around metro stations. However, lack of last-mile connectivity continues to constrain metro ridership in many Indian cities. In practice, the economic potential of such capital-intensive metro investments remains underutilised due to the absence of planned linkages with jobs and housing.

Facilities for non-motorised transport and last-mile connectivity are therefore crucial for improving urban mobility. The MoHUA introduced the PM e-Bus Sewa scheme in 2024 to improve city bus operations through the deployment of 10,000 e-buses under a PPP model. However, budgetary allocation for PM e-Bus Sewa in 2026–27 has been reduced by about 77% compared to the previous year (Table 1), which is concerning given the severe inadequacy of bus services in Indian cities. This shortage is reflected in the concentration of 61% of buses in nine megacities (GoI, 2026). The persistent deficit in bus services, particularly in Tier II and Tier III cities, increases dependence on private transport, leading to greater congestion and reduced urban productivity.

Unmet Housing Needs and Affordability Issues

Access to affordable housing has crucial implications for urban inequality, yet it remains out of reach for millions of urban residents. Using the global methodology based on lack of access to improved water supply, sanitation, and sufficient living area, the urban formal housing shortage in India is estimated at 5–7 crore units (GoI, 2025). Under PMAY (U) 2.0, affordable housing is defined as a dwelling unit with a carpet area of up to 60 sqm in metropolitan cities and 90 sqm in non-metropolitan areas, with a total value not exceeding ₹45 lakh. The cost of a 30 sqm housing unit is about ₹25 lakh, with land costs accounting for 35% to 63% of total cost depending on whether the unit is located in semi-urban or metropolitan areas (GoI, 2025).

Recent trends indicate a shrinking supply of affordable housing. The Knight Frank–NAREDCO report (2025) notes that the share of affordable housing units (costing less than ₹50 lakh) declined from 52.4% in 2018 to 17% by 2025 in India's top eight cities. Similarly, GoI (2025) reports a fall in the share of affordable housing from 40% in 2019 to 16% in 2024 in the total housing supply. In practice,

rising property prices and speculative practices have pushed many households, particularly those in lower-income groups, into informal living arrangements.

Against this backdrop, the reduction in budgetary allocation under Pradhan Mantri Awas Yojana–Urban (PMAY-U) and its 2.0 version—from ₹30,171 crore in 2024–25 to ₹21,625 crore in 2026–27—may further constrain the supply of affordable housing. As of 5 January 2026, about 12.22 million houses have been sanctioned based on municipal housing demand surveys, of which 11.46 million have been grounded for construction and 9.67 million completed. This progress remains far below the estimated urban housing shortage of 50–70 million units (GoI, 2025).

Among the four PMAY (U) verticals, the Affordable Housing in Partnership (AHP) and In-situ Slum Redevelopment (ISSR) components—potentially most effective for addressing affordability for the urban poor—account for about 14% of total sanctioned units, with the share declining to about 7% in 2025–26. Moreover, inadequate urban services and limited livelihood opportunities near project sites have led to low occupancy in housing units under AHP/ISSR.

Budgetary allocation for the Interest Subsidy Scheme (ISS) for Economically Weaker Sections (EWS), Lower Income Groups (LIG), and Middle-Income Groups (MIG) has declined from ₹3,500 crore in 2025–26 to ₹3,000 crore in 2026–27 (upon non utilisation from the last year). Low-income households also face difficulties in meeting eligibility norms to access the subsidy (Chattopadhyay and Kumar, 2025). Meanwhile, the Credit Risk Guarantee Fund Trust (CRGFT) continues to receive ₹500 crore, which may help ease eligibility constraints by providing guarantees to housing loans issued by public lending institutions. The Industrial Housing Scheme has been allocated ₹400 crore compared to ₹2,500 crore in 2025–26, possibly reflecting a lukewarm response from private developers.

Measures such as developing rental housing near workplaces and reserving 10–15% of housing stock for EWS/LIG households are crucial for expanding affordable housing supply at the city level. Consequently, lower allocations under schemes like ISS and industrial housing are likely to increase the burden on low-income groups seeking affordable housing.

Efficient land use policies are equally critical. In many Indian cities, land supply is constrained by restrictive Development Control Regulations (DCR), low Floor Space Index (FSI) or Floor Area Ratio (FAR), which encourage horizontal expansion while raising land values and the cost of providing basic services per housing unit. Unclear land titles further exacerbate land scarcity, especially in city core areas.

Therefore, financial provision for housing must be complemented by planning reforms, such as those proposed in the third draft master plan of the Chennai Metropolitan Development Authority, which emphasises rule-based provision of higher FSI in denser areas, mixed-use norms, and integrated transport development. Earlier reforms under Budget 2022–23, including the Unique Land Parcel Identification Number (ULPIN), the National Generic Document Registration System (NGDRS) for standardised deed registration, and improved intergovernmental coordination for time-bound land and construction approvals, also aim to improve land governance. Streamlining land digitalisation remains urgently necessary to ensure transparent land record management and efficient use of urban land resources.

Dip in Swachh Bharat Mission Urban (SBM-U) and Atal Mission for Rejuvenation and Urban Transformation (AMRUT) Allocations and City Livability

Access to water supply, sanitation, and scientific management of municipal solid waste directly influences public health, environmental sustainability, labour productivity, and overall urban quality of life. Two flagship urban programs—AMRUT 2.0 and SBM-U 2.0—aim to ensure water security, recycling and reuse of treated wastewater, rejuvenation of water bodies through a circular economy approach, garbage-free cities, and sustainable waste processing.

However, budgetary allocations for AMRUT and SBM (U) in 2026–27 are ₹8000 crore and ₹2500 crore respectively, representing cuts of about 25% and 60% compared to the previous year's budget. Such reductions could adversely affect the livability of Indian cities, as a large share of the urban population continues to face inadequate and poor-quality basic services. The budget also remains mute on the much-touted issue of worsening air pollution and quality issues in Indian cities and towns, and misses any major urban push to tackle the same.

According to the NSSO (2024), only 68% of urban households have access to piped water supply,

leaving the rest dependent on potentially unsafe drinking water sources. Waste management indicators also reveal significant gaps. In 2024, 884 cities received a 1-star rating under the Garbage-Free Cities framework, which evaluates parameters such as cleanliness of drains and water bodies, plastic waste management, and handling of construction and demolition waste. Only 275 cities achieved a 3-star rating, indicating at least 60% waste segregation and 70% processing of garbage.

The situation is particularly concerning in wastewater management. Although Indian cities generate about two-thirds of total wastewater as domestic used water, they treat only 28% and recycle or reuse just 8% of the treated wastewater. The Economic Survey 2025–26 estimates that ₹1.5–2.3 lakh crore in capital investments in water treatment technologies will be required by 2047 to achieve 100% sewage treatment. At the same time, circular water systems present substantial economic potential. Gupta et al. (2025) estimate a market value of ₹2.4–₹3.2 lakh crore for treated wastewater used for non-potable purposes, along with the potential to generate over 1 lakh jobs by 2047.

Squeezing of financial allocations would certainly undermine city's ability to provide clean water, adequate sanitation and lots of other amenities. This, in turn, would move the cities further away from global commitments related to SDGs and climate targets.

Moreover, as part of Smart Cities Mission, the Integrated Command and Control Centres (ICCCs) have been created to digitally monitor urban services, to decongest the dense city centers and to improve accessibility to basic education and health needs. Without any budgetary allocations for smart cities, the operational viability of the ICCCs looks uncertain. However, there is budgetary allocation of ₹300 crores in 2026-27 under the City Investments to Innovate, Integrate and Sustain 2.0 (CITIIS 2.0) scheme that intends to provide financial and technical support for up to 18 Smart Cities for projects promoting circular economy with focus on Integrated Waste Management and also for strengthening climate governance mechanisms at the state level on competitive basis.

Addressing Informality of Urban Workforce

The Economic Survey 2025-26 acknowledges informal labour as the foundational component of everyday urban life. Given the persistent deficit in formal employment generation, informal works offer immediate livelihood access and occupational flexibility to a vast segment of the urban workforce in India. Importantly, the Prime Minister's Street Vendors' Atmanirbhar Nidhi (PM SVANIDHI) scheme - although accounts for a small share of total MoHUA allocations – experiences about three-fold increase in budgetary support to ₹ 900 crore in 2026-27. This program by providing collateral free working capital loans has enhanced the livelihood opportunity of millions of urban street vendors.

Moreover, ₹536 crore has been allocated under the Deendayal Jan Aajeevika Yojana- (Shehari)-(DJAY(S)) in the current budget – an increase of about 2.6 times of revised estimates in 2025-26. These schemes would provide the much-needed credit support and recognition to a section of urban informal workers and could make them stakeholders towards building inclusive cities.

Conclusion and The Way Forward

A closer examination of budgetary allocation reveals two key insights. First, the reduction in funding for flagship urban schemes, combined with a growing emphasis on reform-linked incentives, signals a shift toward privatisation and innovative financing mechanisms for urban infrastructure. The Urban Challenge Fund (UCF) exemplifies this approach by capping the central government's contribution at 25% of the cost of bankable projects, while requiring at least 50% of project costs to be financed through bonds, bank loans, and PPPs. However, cities have yet to fully unlock the potential of own source revenue (OSR) and innovative financing. In most large Indian cities, OSR covers only 30–40% of total municipal expenditure, while in smaller cities it remains below 20%.

Weak financial health and limited creditworthiness further constrain municipal bond issuances. Among the 500 AMRUT cities, only 36 have secured investment-grade ratings of A– and above. To strengthen the municipal bond market, the Budget 2026 offers an incentive of ₹100 crore for a single bond issuance above ₹1000 crore, along with annual lump-sum grant-in-aid for Atal Mission for Rejuvenation and Urban Transformation (AMRUT) cities capped at ₹200 crore of bonds. Nevertheless, it is likely that larger cities with stronger financial and administrative capacity will benefit most from innovative financing and matching contributions, while smaller cities may struggle to plan and finance infrastructure projects.

Delay in implementation along with under utilisations gaps continue to affect urban schemes, leading to low fund utilisation and repeated deadline extensions. According to the World Bank (2025), under Smart Cities Mission (SCM) and AMRUT, cities were able to utilise only about one-fifth of the cumulative cost of approved projects. Weak implementation capacity of city governments remains a major constraint. The recommendation made in 2023 to establish a National Urban Regional Planning Authority (NURPA) as an apex advisory body to recruit urban planners and build planning capacity over five years has yet to be operationalised, reflecting a lack of commitment to strengthening urban management expertise.

Overall, the annual budget distributes resources across multiple urban development schemes, but cities' ability to effectively utilise these funds remains limited. While scaling up urban investment is necessary, the effectiveness of these allocations depends on cities' ability to mobilise matching contributions and fully utilise available funds.

This calls for a rethinking of urban governance practices.

- The fiscal empowerment of cities is essential, including granting city governments greater authority to set tax rates and expand the tax base. Strengthening own source revenue generation must become a priority. Encouragingly, the Sixteenth Finance Commission has recommended linking ULB performance grants to achieving either 1.05 times the previous year's Own Source Revenue (OSR) collection or a 5% annual compounded growth rate in OSR (whichever is lower).
- Urban governance remains fragmented, with multiple authorities managing urban development plans and programs, weakening accountability and coordination. Establishing an institutional framework with clear division of responsibilities and better synchronisation between planning and implementation across agencies is a critical reform.
- The professional capacity in cities is severely inadequate, particularly in terms of urban planners and financial analysts. Strengthening human resource capacity for urban service delivery institutions is essential. Creating a dedicated municipal cadre with periodic skill enhancement in planning, finance, engineering, and information technology would complement institutional reforms and improve urban planning and management efficiency. Prioritising capacity building of city governments is therefore crucial to address the evolving challenges of urbanisation in India and towards Viksit Bharat@ 2047.

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STRENGTHENING URBAN LOCAL GOVERNMENTS FOR URBAN BASIC SERVICES: THE PATH TO VIKSIT BHARAT @ 2047

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Abstract

India's ambition to achieve Viksit Bharat @ 2047 requires cities that are liveable, sustainable, and resilient. Urban Local Bodies (ULBs), constitutionally recognised through the 74th Constitutional Amendment Act of 1992, are expected to play a central role in delivering urban basic services such as water supply, sanitation, solid waste management, energy infrastructure, and urban transport. However, despite constitutional status, municipalities remain constrained by limited fiscal autonomy, fragmented institutional structures, and insufficient technical capacity. This paper examines the evolution of urban local governance in India, assesses the current performance of ULBs in delivering urban basic services, and analyses structural constraints. It also reviews national urban programmes such as the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Swachh Bharat Mission (SBM), Smart Cities Mission (SCM), and Swachh Survekshan in strengthening municipal governance. Drawing on international experiences and Indian best practices, the paper proposes institutional, financial, and technological reforms to empower ULBs to deliver universal urban basic services by 2047.

Introduction

India's vision of Viksit Bharat @ 2047—a developed nation by the centenary of its independence—depends fundamentally on the quality of its cities. By 2047, India's urban population is projected to exceed 800 million, making urban governance central to economic growth, environmental sustainability, and quality of life. Cities already contribute nearly 70% of India's GDP, yet their ability to provide reliable urban basic services—water supply, sanitation, solid waste management, energy access, and urban mobility—remains uneven.

At the heart of urban governance lie Urban Local Bodies (ULBs)—municipal corporations, municipal councils, and nagar panchayats—constituting the third tier of government. These institutions were constitutionally recognised through the 74th Constitutional Amendment Act (1992), which aimed to empower local governments with clear functions, financial authority, and democratic accountability.

Three decades later, however, many ULBs continue to struggle with limited financial autonomy, inadequate technical capacity, and fragmented governance structures. Despite these challenges, several cities have demonstrated that empowered and innovative local governments can deliver transformative improvements in urban services.

As India pursues the goal of becoming a developed nation by 2047, strengthening

ULBs—politically, financially, and technologically—will be indispensable for ensuring universal and sustainable urban basic services.

Evolution of Urban Local Governance in India

Urban local governance in India has a long history dating back to the colonial period. The first municipal corporations were established in Madras, Bombay, and Calcutta in 1687–88. Later reforms such as Lord Ripon's Resolution on Local Self-Government (1882) recognised the importance of decentralisation and citizen participation in municipal administration.

However, local governments remained largely subordinate to provincial and later state governments. Post-independence, several committees examined urban governance reforms, including the Balwantrai Mehta Committee (1957) and later the Ashok Mehta Committee (1978). These efforts emphasised decentralisation but focused mainly on rural governance.

The turning point came with the 74th Constitutional Amendment Act in 1992, which granted constitutional status to ULBs and mandated:

- Regular municipal elections
- Reservation for women and marginalised groups
- Formation of Ward Committees
- Establishment of State Finance Commissions
- Preparation of District and Metropolitan Plans
- Devolution of 18 functions listed in the Twelfth Schedule.

These functions include urban planning, water supply, public health, sanitation, solid waste management, roads, street lighting, and urban transport. Despite this constitutional framework, the actual transfer of powers and resources to municipalities has remained uneven across states.

This conceptual framework illustrates the central role of Urban Local Bodies in delivering essential urban services including water supply, sanitation, solid waste management, energy services, urban transport, and environmental management. The effectiveness of these services depends on three enabling pillars: **good governance and citizen participation, adequate financial resources, and strong technical capacity.**

Urban Basic Services: Why Local Governments Matter?

Urban basic services form the backbone of public health, environmental sustainability, and economic productivity. Effective delivery of these services depends on strong local governance for several reasons:

Proximity to Citizens: ULBs are closest to residents and best positioned to understand local needs and priorities.

Operational Responsibility: Most

Figure 1: Urban Local Governments as the Nucleus of Urban Basic Service Delivery

urban infrastructure services—water supply networks, waste collection, street lighting, and public transport—require efficient operational management at the city level.

Local Accountability: Elected municipal councils provide a democratic mechanism through which citizens can demand better services.

Integration of Urban Systems: Urban services are interconnected. Waste management affects water quality; transport influences air pollution and energy use. Integrated planning is most effective at the city level. Yet, the gap between responsibilities assigned to ULBs and their actual capacities remains significant.

Current Performance of Urban Local Bodies

India has more than 4,800 Urban Local Bodies, varying widely in size and capacity—from large metropolitan corporations to small town councils. Their performance in delivering basic services shows mixed results.

Water Supply: Although most urban households have access to improved water sources, a continuous water supply remains rare. Many cities provide water only for a few hours per day. Non-revenue water, including leakages and illegal connections, often exceeds 40% of the total water supplied to the city. However, some cities have made significant progress through reforms such as metering, public-private partnerships, and infrastructure upgrades.

Sanitation and Wastewater: Urban sanitation has improved significantly in recent years, particularly following national programmes promoting toilets and wastewater treatment. Nevertheless, challenges remain, for example, incomplete sewer networks, untreated wastewater discharge into rivers, limited faecal sludge management in smaller towns and so on. Cities that have adopted decentralised treatment systems and faecal sludge management models have shown promising results.

Solid Waste Management: India generates more than 160,000 tonnes of municipal solid waste per day. While door-to-door collection has expanded considerably, waste segregation, recycling, and scientific disposal remain inconsistent. Progress has been visible in cities adopting circular economy principles and integrating informal waste pickers.

Energy and Urban Infrastructure: ULBs manage critical energy-related services such as street lighting, public buildings, and increasingly electric mobility infrastructure. Many cities have transitioned to LED street lighting, reducing electricity consumption and operational costs.

Urban Transport: Urban mobility remains a major challenge due to congestion, pollution, and inadequate public transport. While large metropolitan areas have developed metro systems, smaller cities rely primarily on buses and intermediate transport. ULBs often lack authority over transport planning, which is frequently controlled by state-level agencies.

National Missions Strengthening Municipal Governance

In recent years, several national programmes have attempted to strengthen municipal service delivery.

Sanitation and Waste Management: The Swachh Bharat Mission (Urban) launched in 2014, significantly improved sanitation infrastructure and solid waste management systems. The programme's annual ranking exercise, Swachh Survekshan, created healthy competition among cities. Cities such as Indore, Surat, and Navi Mumbai have consistently ranked among the cleanest cities in the country.

Urban Infrastructure: The Atal Mission for Rejuvenation and Urban Transformation focuses on improving urban infrastructure, including water supply, sewerage networks, and green spaces.

Smart Governance: The Smart Cities Mission promotes the use of digital technologies for urban management through initiatives such as integrated command and control centres.

These programmes have contributed to improving urban infrastructure while also highlighting the need for stronger municipal institutions.

Key Constraints Facing Urban Local Governments

Despite constitutional recognition, several structural challenges limit the effectiveness of ULBs.

Incomplete Devolution of Powers: Although the Twelfth Schedule lists municipal functions, many states have not fully transferred these responsibilities to local governments. Critical sectors such as water supply, transport, and housing are often managed by state-level parastatal agencies. This fragmentation weakens accountability and reduces municipal autonomy.

Weak Financial Capacity: Financial constraints are perhaps the most significant barrier. Municipal revenues in India account for less than 1% of GDP, significantly lower than in many developed countries. Key issues include - limited property tax collection; dependence on state transfers; restricted access to capital markets; poor financial management systems. As a result, municipalities struggle to invest in infrastructure or maintain existing assets.

Limited Technical Capacity: Many municipalities lack qualified engineers, planners, environmental specialists, and financial experts. Staffing shortages are particularly severe in smaller towns. Urban infrastructure today requires expertise in areas such as climate resilience, circular economy systems, digital governance, and data analytics—skills that many ULBs currently lack.

Fragmented Institutional Structure: Urban governance often involves multiple agencies responsible for different services-development authorities, water boards, transport corporations, and state utilities. This fragmentation leads to coordination failures and delays in project implementation.

Weak Citizen Engagement: Although ward committees and participatory planning mechanisms are mandated, they are not consistently operational in many cities. Citizen participation is essential for ensuring accountability and improving service delivery.

Inspiring Examples from Indian Cities

Despite these challenges, several municipalities in India demonstrate that strong local leadership and innovation can produce significant improvements.

Indore - Transforming Solid Waste Management: Indore's municipal corporation has become a national leader in waste management through: 100% door-to-door waste collection, mandatory waste segregation, integration of informal waste workers and waste processing and recycling facilities. These efforts have transformed the city's cleanliness and made it a consistent top performer in national sanitation rankings.

Pune - Integrating Waste Pickers: Pune pioneered the integration of waste pickers through a cooperative model that allows informal workers to manage door-to-door collection and recycling. This approach improved waste segregation while providing livelihoods to thousands of workers.

Surat - Water and Public Health Improvements: After facing severe public health crises in the 1990s, Surat implemented sweeping municipal reforms that strengthened sanitation systems, improved drainage, and modernised urban management. Today the city is widely regarded as one of India's cleanest and most efficiently managed urban centres.

Panaji - Decentralised Waste Processing: Panaji has adopted decentralised waste processing units that minimise landfill dependence and encourage community-level participation.

International Lessons for Strengthening Local Governments

Several countries offer valuable lessons in empowering municipalities.

Brazil: Brazil's constitution grants strong autonomy to municipalities, enabling them to manage local infrastructure and collect taxes. Participatory budgeting in cities like Porto Alegre has significantly improved citizen engagement and transparency.

Germany: German municipalities operate within a highly decentralised governance framework. Local governments have strong fiscal powers, including the ability to collect local taxes and borrow for infrastructure projects. This financial autonomy enables them to maintain high-quality urban services.

Singapore: Although a city-state, Singapore demonstrates the importance of integrated urban planning and professional municipal management. Strong institutional coordination and data-driven governance ensure efficient service delivery.

South Korea: South Korean cities have adopted advanced digital governance systems, enabling real-time monitoring of urban services such as waste management, traffic flow, and energy consumption.

Strengthening Urban Local Bodies for Viksit Bharat

To realise the vision of developed and liveable cities by 2047, India must undertake a comprehensive strengthening of ULBs across three key dimensions: political empowerment, financial sustainability, and technological modernisation.

Political Empowerment: Effective urban governance requires stronger political authority at the city level. Key reforms include: full implementation of the 74th Constitutional Amendment across states, clear transfer of municipal functions from

parastatal agencies, strengthening mayoral leadership with defined executive powers, operationalising ward committees and area sabhas, empowering metropolitan planning committees for integrated regional planning, etc. These steps would enhance accountability and ensure that decisions affecting urban services are made at the city level.

Financial Strengthening: Municipal financial systems must be significantly strengthened. Priority measures include:

Property Tax Reform - Property tax is the most important local revenue source. Reforms should include GIS-based property mapping, rational valuation systems and improved compliance mechanisms.

Diversification of Revenue Sources - Cities should explore additional revenue streams such as, user charges for services, land value capture instruments, development impact fees and congestion charges in large metropolitan areas

Access to Municipal Finance - Municipalities should be encouraged to access capital markets through municipal bonds, credit enhancement mechanisms and pooled financing facilities for smaller cities.

State and central government grants should incentivise performance improvements in service delivery.

Technological Modernisation: Smart governance and digital technologies can significantly improve urban service management. Key initiatives include: digital platforms for municipal service delivery, real-time monitoring of water networks and waste systems, data-driven urban planning tools, smart energy systems and electric mobility infrastructure, etc. Building municipal data platforms can also support climate resilience planning.

Capacity Building and Professionalisation: India needs a new generation of urban professionals working within municipalities. Priority actions include: establishing municipal cadres for urban management, continuous training programs for municipal officials, partnerships with academic institutions and technical organisations, encouraging knowledge exchange among cities, etc. Programs supporting peer learning between cities have proven highly effective disseminating best practices.

Promoting Circular Economy Approaches: Urban basic services must increasingly adopt circular economy principles to address resource scarcity and environmental challenges. Examples include: waste-to-energy and composting systems, wastewater reuse for industry and agriculture, resource recovery from faecal sludge, construction waste recycling, urban renewable energy initiatives, etc.

Figure 2: Circular Urban Resource Cycle for Sustainable Cities

This systems diagram demonstrates how cities can transition from a linear service model to a **circular urban resource economy**. Wastewater reuse, recycling of solid waste, renewable energy generation, and sustainable transport systems interact to create resource-efficient and climate-resilient urban systems. Urban Local Bodies act as the coordinating institutions enabling these circular flows. Local governments play a critical role in enabling these systems through regulatory frameworks and infrastructure investments.

Aligning Urban Services with Climate Goals: Climate change adds urgency to strengthening municipal governance. Cities are major contributors to greenhouse gas emissions but also key actors in climate mitigation and adaptation. ULBs can lead climate action through energy-efficient infrastructure, sustainable urban transport systems, nature-based solutions for flood management, climate-resilient water and sanitation systems. Integrating climate considerations into municipal planning will be essential for resilient urban development.

The Road to 2047

India's journey toward becoming a developed nation will largely be written in its cities. Providing universal access to safe water, sanitation, waste management, energy, and sustainable transport will determine the liveability and competitiveness of urban areas. Urban Local Bodies must therefore evolve from being administrative units into dynamic institutions of urban governance capable of managing complex infrastructure systems, engaging citizens, and driving sustainable development.

Achieving this transformation will require: i) Genuine decentralisation of powers ii) Robust municipal finances iii) Professionalisation of municipal administration iv) Adoption of digital and green technologies and v) Active citizen participation. With these reforms, Indian municipalities can become engines of innovation and sustainability.

Conclusion

The vision of Viksit Bharat @ 2047 cannot be realised without strong and empowered urban local governments. Cities are where economic growth, environmental challenges, and social aspirations converge. Urban Local Bodies hold the key to delivering the basic services that define urban quality of life—safe water, effective sanitation, clean streets, reliable energy, and efficient mobility. India already has the constitutional framework and policy foundations for decentralised urban governance. The task ahead is to translate these principles into practice by empowering municipalities politically, strengthening them financially, and equipping them technologically. If India succeeds in building capable and accountable city governments, its cities will not only meet the needs of their citizens but also emerge as global models of sustainable urban development by 2047.

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PERFORMANCE AND TIED GRANTS VERSUS UN-TIED GRANTS- A CRITICAL APPRAISAL

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Abstract

Over the last three decades, several policy measures and reform initiatives have been introduced to strengthen and rationalise municipal finances. Despite these efforts, the reliance on fiscal transfers and support from the State and Central governments remains significantly high. The Central Finance Commissions are expected to suggest measures to augment the Consolidated Fund of the States so as to enable them to supplement the financial resources of municipalities. The 13th Finance Commission had introduced the concept of Basic and Performance Grant. The Basic Grant was accessed unconditionally, whereas the Performance Grant was conditional and available to States and municipalities upon fulfilment of nine conditions. The 14th Finance Commission also emphasised strengthening basic urban services and retained the Basic–Performance Grant structure. It has been observed that during the award periods of the 13th and 14th Finance Commissions, both states and municipalities encountered considerable challenges in complying with performance-linked conditions. Subsequently, during the award cycle of the 15th Finance Commission, municipalities faced a dual set of constraints: first, difficulties in meeting performance-based conditionalities; and second, compliance requirements attached to tied grants. These issues are underscored in the recently released report of the 16th Finance Commission, which highlighted that during the 15th Finance Commission period, the actual release declined significantly compared to the recommended allocation. This reduction is primarily attributable to the stricter and reform-linked conditionalities introduced under the 15th Finance Commission. The recommendations of the 16th Finance Commission envisage a higher flow of fiscal transfers to Urban Local Bodies(ULBs), while also simplifying the conditionality framework compared to the regime of the 15th Finance Commission. Since the gap between service level performance and benchmarks remains very large, it is important to see the impact of release of funds to ULBs in next five years with respect to the achievement of service level benchmarks.

India initiated wide-ranging economic and structural reforms in 1991, followed by the enactment of the 74th Constitutional Amendment Act in 1993, with the expectation that municipalities would progressively attain financial self-reliance. Over the last three decades, several policy measures and reform initiatives have been introduced to strengthen and rationalise municipal finances. Despite these efforts, achieving fiscal sustainability at the municipal level remains an enduring challenge. ULBs continue to face acute resource constraints, with their revenue base insufficient to meet growing expenditure obligations. Consequently, their reliance on fiscal transfers and

support from the State and Central governments remains significantly high.

Inter-governmental fiscal transfers from the State / Central Governments form a crucial share of municipal revenues. Article 243Y of the Constitution, introduced through the 74th Constitutional Amendment Act, and Article 280(3)(c) mandate the periodic constitution of the State Finance Commissions (SFCs) and the Central Finance Commission (CFC) every five years. The SFCs are entrusted with recommending the principles governing the distribution of the net proceeds of taxes, duties, tolls, and fees between the State governments and municipalities. Similarly, the CFCs are expected to suggest measures to augment the Consolidated Fund of the States so as to enable them to supplement the financial resources of municipalities.

During the period of 2010-11 to 2014-15, the 13th Finance Commission aimed at strengthening urban governance in India and also promoting effective decentralisation and put in place a very strong performance incentive mechanism for municipalities. Making a departure from the earlier Finance Commissions, the 13th Finance Commission had introduced the concept of Basic and Performance Grant. The Basic Grant was accessed by all the states unconditionally whereas the Performance Grant was conditional and available to states and municipalities upon fulfilment of nine conditions. Several states managed to gain immense benefits of the Performance Grants, not only as a vital source of funds, but also as an avenue to usher in reform measures. Conversely, a large number of the performance grant conditions were linked to state-level compliance requirements. In instances where a state failed to fulfil these stipulated conditions, municipalities consequently became ineligible to receive Finance Commission grants, thereby adversely affecting their financial position.

During the award period 2015–16 to 2019–20, the 14th Finance Commission placed emphasis on strengthening basic urban services and retained the Basic–Performance Grant structure in an 80:20 ratio. The Basic Grant was released to all states without conditions, whereas the Performance Grant was contingent upon the fulfilment of three mandatory criteria. To ensure a more objective assessment of urban local bodies (ULBs), these criteria were further operationalised through a Performance Grant (PG) Scheme designed by the Ministry of Housing and Urban Affairs. However, the performance grants for the last two years 2018-19 and 2019-20 were not released. As a result, the overall disbursal rate of the performance grant remained significantly low which was only about 34 per cent.

During the award period of 2021-22 to 2025-26, the 15th Finance Commission has discontinued with the concept of Basic and Performance Grant. In order to access ULBs grant, it's conditional on achieving of four mandatory conditions such as (i) deadline of March 2024 set for states to strengthen SFCs and table action taken reports in state legislatures, (ii) publishing of Audited Accounts, (iii) fixation of minimum floor rates for Property Tax Floor, and (iv) improvement in Property Tax collections in tandem with the growth rate of Gross State Domestic Product (GSDP).

It was argued that expecting property tax revenues to grow at a rate commensurate with GSDP poses a significant challenge, particularly for small and medium-sized municipalities. The potential for expansion in property tax collections is inherently more limited than GSDP growth, which is influenced by a broad range of macroeconomic and state-level factors. In contrast, growth in property tax revenue largely depends on improvements in assessment coverage, collection efficiency, and periodic revision of tax rates—revisions that typically do not occur more frequently than once in three years. Moreover, prevailing property tax rates often bear little relation to actual market values, resulting in modest revenue yields. Beyond the persistent issue of underassessment, weaknesses in tax administration and collection mechanisms further constrain the effectiveness of property tax as a robust source of municipal revenue.

The 15th Finance Commission also recommended tied and untied grants where the untied grants could be spent on any activity, barring staff salaries; the tied grants were specified for limited activities. As per the first Report of the 15th Finance Commission which was applicable for only one year, i.e., 2020–21, 31.6% of the total ULB grants were classified as tied grants for million-plus cities specifically for improving ambient air quality, and for enhancing water supply, conservation and management, as well as solid waste management. The remaining 68.4% of total ULB grants were earmarked for cities and towns with populations below one million. Of this, 50% were untied and the other 50%

were tied grants, equally divided for (a) improving drinking water infrastructure, including rainwater harvesting and recycling, and (b) strengthening solid waste management systems. Overall, 65.8% of the total ULB grants recommended for 2020–21 were tied in nature.

By the second Report of the 15th Finance Commission for the period 2021-26, continued with the same devolution formula for local body grants, similar to 2020-21. 31.6% of the total ULB grants, were classified as tied grants for million-plus cities specifically for improving ambient air quality, and for meeting service level benchmarks on drinking water supply, rainwater harvesting and water recycling, solid waste management and sanitation. The remaining 68.4% of total ULB grants were earmarked for cities and towns with populations below one million. Of this, 50% were untied and the other 50% were tied grants, equally divided for (a) sanitation (including solid waste management), and (b) drinking water, rainwater harvesting and recycling. Overall, 72.6% of the total ULB grants recommended for 2020–21 were tied in nature.

It has been observed that during the award periods of the 13th and 14th Finance Commissions, both States and municipalities encountered considerable challenges in complying with performance-linked conditions. In the subsequent award cycle of the 15th Finance Commission (2021–26), municipalities faced a dual set of constraints: first, difficulties in meeting performance-based conditionalities; and second, compliance requirements attached to tied grants. These issues are underscored in the recently released report of the 16th Finance Commission, which highlighted the recommended allocations versus actual releases. The data indicate that during the 13th and 14th Finance Commission periods, the release of grants amounted to 82.1% and 85.2% of the recommended amounts, respectively. However, in contrast, during the 15th Finance Commission period, the actual release declined markedly to only 62.6% of the recommended allocation. This reduction is primarily attributable to the stricter and reform-linked conditionalities introduced under the 15th Finance Commission.

Unlike the 14th Finance Commission, nearly 72.6% of 15th Finance Commission grants were tied to specific sectors such as water supply and sanitation and ambient air quality, with releases contingent upon verified performance and compliance. Mandatory conditions, including the timely conduct of local body elections, implementation of property tax reforms, submission of audited accounts, and public financial disclosures, have posed tough challenges, especially for small and medium ULBs with limited technical capacity, outdated valuation systems, and weak enforcement mechanisms. Additionally, delays in submission of utilisation certificates and administrative disruptions, including election cycles, have further slowed subsequent releases.

Recently, the 16th Finance Commission has submitted its report and attempted to address these concerns by rationalising performance-linked conditionalities and significantly reducing the proportion of tied grants. As discussed earlier, the 15th Finance Commission departed from the earlier framework of Basic and Performance Grants and instead

Table 1: Grants to ULBs recommended by previous Finance Commissions versus Actual Releases

Finance Commission	Recommended	Released	Released (%)
FC-10	1,000	834	83.4
FC-11	2,000	1,752	87.6
FC-12	5,000	4,470	89.4
FC-13	23,111	18,980	82.1
FC-14	87,144	74,259	85.2
FC-15 (upto July 2025)	1,21,055	75,718	62.6

Source: 16th Finance Commission Report

linked access to ULB grants with the fulfilment of four mandatory conditions. These included: (i) strengthening of State Finance Commissions and aplacing Action Taken Reports before State legislatures by March 2024; (ii) publication of audited municipal accounts; (iii) fixation of minimum floor rates for property tax; and (iv) improvement in property tax collections in line with the growth rate of Gross State Domestic Product (GSDP). In contrast, the 16th Finance Commission has reintroduced the earlier framework followed by the 14th Finance Commission, under which grants are structured into Basic and Performance components in the ratio of 80:20. This approach aims to simplify the conditionality framework while continuing to incentivise improvements in municipal governance and financial performance. The 16th Finance Commission has substantially increased the proportion of untied grants compared to previous Finance Commissions, thereby providing greater fiscal flexibility to ULBs to address local priorities. The share of untied grants has been raised from 27.4% under the 15th Finance Commission to 60%, while the proportion of tied grants has been correspondingly reduced from 72.6% to 40%. The tied grants are now restricted to key service areas such as sanitation, solid waste management, and water management. Additionally, the component relating to the improvement of ambient air quality in million-plus cities, which had been introduced by the 15th Finance Commission, has been completely discontinued.

Table 2: Grants to ULBs recommended by the 15 Finance Commission

100%. Performance Linked (Four Mandatory - Conditions)	Grant for ULBs	Rs. 1,21,055 Cr
	Million Plus Tied	Rs. 38, 196 Cr
	Million Untied	Nil
	Non-million Tied	Rs. 49,716 Cr
	Non-million Untied	Rs. 33 143 Cr
	ULB-Tied grant	Rs. 87,912 Cr (72.6%)
	ULB-untied grant	Rs. 33,143 Cr (27.4%)
	ULB-Tied & untied grant	Rs. 1,21,055 Cr
	Urban Health Wellness Centre	Rs. 24,028 Cr
	Urban health PHC	Rs. 2,095 Cr
	Grants for incubation of new cities	Rs. 8,000 Cr
	Grants for shared municipal services	Rs. 450 Cr
	Grand Total ULBs Grant	Rs. 1,55,628 Cr

Source: Report of the 15th Finance Commission

ULB grant	Rs. 2,90,157 Cr	
Basic Untied	Rs. 1,16,062.5 Cr (80%)	**Rs. 2,90,157 Cr**
Basic tied	Rs. 1,16,062.5 Cr	
Performance Untied	Rs. 58,032 Cr --------- (20%)	
ULB-Tied	**Rs. 1,16,052.5 Cr (40%)**	**Rs. 2,90,157 Cr**
ULB-Untied	**Rs. 174,094.5 Cr (60%)**	
ULB-Basic/Performance Grant	Rs. 290, 157 Cr	
Special Infrastructure Component	Rs. 56, 100 Cr	
Urbanisation Premium	Rs. 10,000 Cr	
Grand Total ULBs Grant	**Rs. 3,56,257 Cr**	

Source: Report of the Sixteenth Finance Commission

In addition to it, the 16th Finance Commission has recommended for 20% performance grant (untied). This performance grant has been divided into two equal parts, first component is related to ULBs performance and the second component is related to the State's performance. While the first component is linked to achievement of minimum 5% increase in own source revenue over the previous years by ULBs, the State government becomes eligible to avail the untied grant under the second component only on the transfer of matching grant of minimum 20% of the Union Finance Commission's basic grant to ULBs.

The recommendations of the 16th Finance Commission envisage a higher flow of fiscal transfers to ULBs, while also simplifying the conditionality framework compared to the regime of the 15th Finance Commission. The rationalisation of performance-linked conditions and the reintroduction of the Basic and Performance Grant framework—similar to that adopted by the 14th Finance Commission - is expected to enhance flexibility and improve the utilisation of grants. A higher proportion of untied funds, coupled with relatively simpler compliance requirements, may enable municipalities to better align expenditure with local priorities and service delivery needs.

However, the ability of ULBs to effectively absorb and utilise the higher level of financial resources will depend on addressing several structural and institutional constraints. One of the primary challenges relates to limited administrative and technical capacity within municipalities. Many ULBs, particularly small and medium-sized ones, face shortages of qualified personnel in areas such as urban planning, engineering, financial management, and project execution. This often results in delays in project preparation, procurement, and implementation, thereby constraining the effective utilisation of available funds.

ULBs may also face difficulties in meeting certain entry-level governance conditions, such as timely preparation and publication of audited accounts and adherence to institutional reforms recommended by higher levels of government. In addition, the limited pipeline of technically prepared projects may restrict the capacity of municipalities to utilise increased financial allocations effectively.

Finally, the effectiveness of higher transfers will also depend on the broader state and municipal institutional framework. Delays in fund transfers, limited fiscal autonomy, and fragmented urban governance where multiple agencies share responsibilities for urban infrastructure and services often constrain the operational effectiveness of municipalities.

It is important to see the impact of these large funds coming to ULBs in next five years with respect to the achievement of service level benchmarks. The Government of India introduced Service Level Benchmarks (SLB) in 2008 to measure the quality of urban services in four core sectors namely, water supply, sewerage, solid waste management, and storm water drainage (please refer Table 4) . Each sector has specific performance indicators such as water coverage, per-capita supply, metering, cost recovery, and complaint redressal (please see Annexure 1). The purpose was to create standard performance metrics and enable comparison across cities. However, several structural weaknesses limit the effectiveness of Service Level Benchmarks (SLBs) which makes most of the cities operate far below these levels, so the gap appears permanently large. For example, the benchmarks seem more idealistic rather than achievable targets such as 24×7 water supply, 100% sewerage coverage and 100% cost recovery.

Moreover, the SLB data is usually provided by the service provider itself i.e. either by municipalities or parastatal bodies which can lead to inconsistent data methodology, inaccurate or over-reporting of service level performance. Sometimes, the SLB reports remain administrative paperwork only.

It has been observed that the gap between service level performance benchmarks and the actual delivery of services remains very large. For example, water supply distribution in reality is only for 2 to 6 hours a day against the benchmark of 24 hours' round the clock water

supply. The water metering is also reportedly very low compared to the benchmark of 100% metering, waste processing is less than 70% on an average against benchmark of 100%, and lastly, sewerage coverage is much lower against benchmark of 100%. Audits have also found that many ULBs still do not meet the SLB norms for water supply or sanitation services. Moreover, even where funds are available, many ULBs struggle with (a) low absorption capacity, (b) project implementation delays and (c) procurement inefficiencies. As a result, service delivery outcomes remain poor despite increasing transfers. Thus infrastructure investment has not always translated into service-level improvement.

The SLB framework assumes that all cities should aspire to the same service standards, irrespective of their size, geography, or institutional capacity. Many experts now argue that benchmarking should be tiered by city size and context. Some of the options could be (a) realistic benchmarks as per city size, independent third-party verification of data, and linking grants to measurable outcomes. Recently, the 16th Finance Commission has also recommended that the practice of publishing Service Level Benchmarks should be continued and extended to all ULBs along with introduction of a third-party assessment or audit mechanism in the system to enhance the reliability of the self-reported figures.

In conclusion, while the recommendations of the 16th Finance Commission provide an important opportunity to strengthen municipal finances and improve urban service delivery, the actual impact will depend on parallel reforms aimed at enhancing municipal capacity, strengthening financial management systems, improving property tax administration, and deepening fiscal decentralisation. Without addressing these underlying structural challenges, the ability of ULBs to fully absorb and effectively utilise higher levels of fiscal transfers may remain limited especially for improving service level standards.

Annexure 1: Service Level Benchmarks

S. No.	Indicator	Benchmark
	WATER SUPPLY	
1	Coverage of Water Supply connections	100%
2	Per Capita Supply of Water	135 lpcd
3	Extent of Non-revenue Water	15%
4	Extent of Metering	100%
5	Continuity of Water supplied	24 Hours
6	Efficiency in redressal of customer complaints	80%
7	Quality of Water Supplied	100%
8	Cost Recovery	100%
9	Efficiency in Collection of Water Charges	90%
	SEWERAGE	
1	Coverage of Toilets	100%
2	Coverage of Sewerage Network	100%
3	Collection efficiency of Sewerage Network	100%
4	Adequacy of Sewage Treatment Capacity	100%
5	Quality of Sewage Treatment	100%
6	Extent of Reuse and Recycling of Sewage	20%

S. No.	Indicator	Benchmark
7	Extent of cost recovery in waste water management	100%
8	Efficiency in redressal of customer complaints	80%
9	Efficiency in Collection of Sewage Water Charges	90%
SOLID WASTE MANAGEMENT		
1	Household Level Coverage	100%
2	Efficiency in Collection of Solid Waste	100%
3	Extent of Segregation of MSW	100%
4	Extent of MSW Recovered	80%
5	Extent of Scientific Disposal of MSW	100%
6	Extent of Cost Recovery	100%
7	Efficiency in Collection of SWM Charges	90%
8	Efficiency in Redressal of Customer Complaints	80%
STORM WATER DRAINAGE		
1	Coverage	100%
2	Incidence of water logging	0 numbers

Source: Handbook of Service Level Benchmarking, Ministry of Urban Development, GOI.

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2. Government of India (2014), Fourteenth Finance Commission (2015-2020), Finance Commission, India.
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Ghaziabad's Landmark Step Toward Circular Water Economy

Ghaziabad is now home to one of India's most advanced water recycling and reuse facility, marking a significant milestone in sustainable urban water management. Developed under the Hybrid Annuity Model, this state-of-the-art tertiary treatment and reverse osmosis plant is capable of converting wastewater into high-quality reclaimed water suitable for large-scale industrial applications.

Supported by India's first Municipal Green Bond, this pioneering initiative of the Ghaziabad Nagar Nigam stands as an exemplary demonstration of the circular economy in practice. By transforming treated wastewater into reliable non-potable water for industries, the facility substantially reduces dependence on freshwater and alleviates stress on groundwater reserves.

In addition to enhancing regional water security, the project plays a vital role in advancing sustainability objectives and promoting climate-responsible urban development. It represents a forward-looking model for cities striving to build resilient and resource-efficient water systems.

Source: https://www.wabag.com/project/municipal-wastewater-reuse-industries-ghaziabad/

UiWIN: ENABLING COMPREHENSIVE URBAN DEVELOPMENT THROUGH INTEGRATED PLANNING AND FINANCING

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Background

India is undergoing a profound structural transformation driven by rapid urbanisation. Cities today function as engines of economic growth, centres of innovation, and hubs of employment generation. Over the last two decades, urban population growth has outpaced rural growth, placing unprecedented pressure on urban infrastructure systems. While urbanisation has created new economic opportunities, it has also exposed systemic gaps in infrastructure provision, service delivery, and institutional capacity. The challenge before India is not merely to accommodate urban growth, but to manage it in a planned, sustainable, and financially resilient manner.

To address these challenges, successive policy initiatives have encouraged cities to prepare City Development Plans (CDPs) and Master Plans. These documents provide a long-term vision for urban growth, identify sectoral deficiencies, and outline investment priorities. However, despite the availability of such plans, implementation on the ground has remained limited, particularly in small and medium-sized cities. This disconnect between planning and execution highlights the need for a structured institutional mechanism that can translate urban plans into bankable and implementable projects.

Introduction: Urbanisation and Infrastructure Gap

India's urbanisation trajectory has significantly altered the scale and nature of infrastructure demand. Many cities are now expanding beyond their planned carrying capacity, resulting in congestion, service shortfalls, environmental stress, and declining quality of life. Estimates indicate that urban infrastructure investment requirements far exceed current expenditure levels, leading to a persistent and widening infrastructure financing gap.

This gap is most pronounced at the level of Urban Local Bodies (ULBs), which are primarily responsible for urban service delivery. Despite constitutional empowerment, ULBs often lack the financial strength, technical expertise, and institutional systems required to execute large-scale infrastructure projects. As a result, urban development tends to be fragmented, reactive, and scheme-driven rather than aligned with long-term city visions.

Objectives of the Urban Invest Window (UiWIN)

The Urban Invest Window (UiWIN) has been conceptualised by HUDCO as a strategic intervention to address the structural weaknesses in urban infrastructure development. The primary objectives of UiWIN are:

- To facilitate planned and comprehensive urban development aligned with CDPs and Master Plans
- To bridge the gap between project planning and execution
- To strengthen the financial and institutional capacity of ULBs
- To enable access to diversified and long-term sources of urban infrastructure finance
- To promote development of bankable, self-sustaining urban projects

UiWIN is envisioned as a one-stop institutional framework providing end-to-end support to ULBs across the project lifecycle.

development needs. When these plans form the basis for project identification and investment prioritisation, cities can ensure balanced spatial growth, efficient service delivery, and long-term economic sustainability.

A key element of this vision is the focus on identifying bankable and self-revenue-generating projects. Such projects create a primary and stable source of income for ULBs, strengthening their financial position. Once core revenue-generating infrastructure is established, secondary economic activities—such as private investment, employment generation, and allied services—naturally emerge, creating a multiplier effect on urban growth.

from weak own-source revenues, low user charge recovery, poor creditworthiness, and limited utilisation of capital market instruments such as municipal bonds.

Technical challenges further exacerbate the situation, as many ULBs lack the expertise required for preparing detailed project reports (DPRs), conducting feasibility studies, structuring PPP projects, and managing assets efficiently. The absence of updated asset registers and GIS-based land inventories limits the ability of cities to monetise assets and plan investments strategically.

Capacity Constraints of Urban Local Bodies

The capacity constraints of ULBs

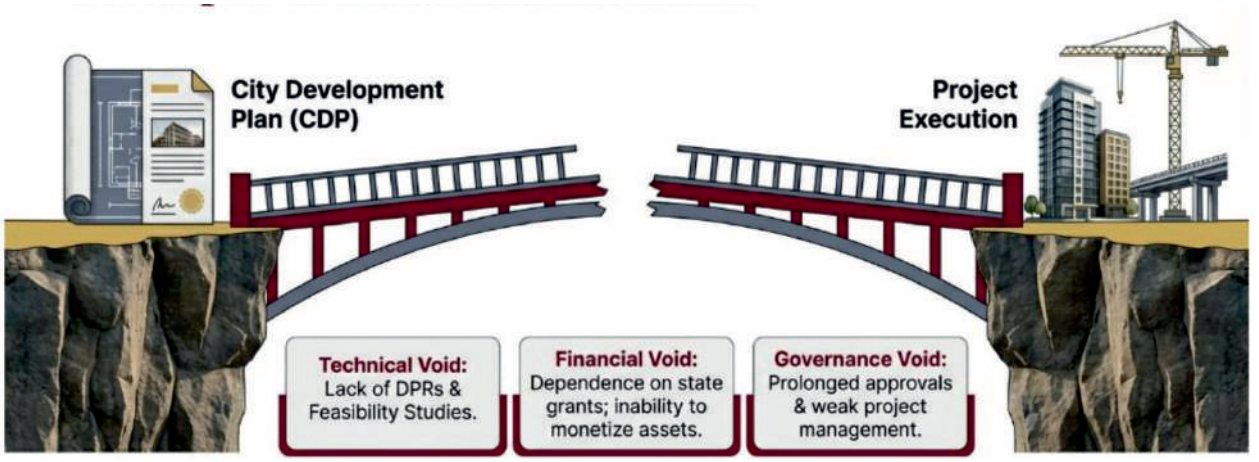

Figure 1: The 'Missing Middle' between city development plans and execution

Vision: CDP Led and Financially Sustainable Cities

The core vision of UIWIN is to enable cities to grow in a structured and sustainable manner, guided by CDPs and supported by sound financial and institutional mechanisms. CDPs provide a comprehensive assessment of existing urban problems, infrastructure gaps, and future

Key Challenges in Urban Infrastructure Development

Urban infrastructure development in India is constrained by a combination of governance, financial, and technical challenges. Governance challenges include prolonged approval processes, multi-layered decision-making, and inadequate focus on operation and maintenance of existing assets. Financial challenges arise

lie at the heart of the urban infrastructure gap. Most ULBs operate with limited human resources and insufficient exposure to modern project management, financial modelling, and asset management practices. Dependence on grants reduces incentives for financial discipline and long-term planning, while limited access to credit restricts capital investment.

Without institutional handholding, smaller ULBs find it particularly difficult to convert CDP proposals into bankable projects. This results in underutilisation of planning documents and missed opportunities for sustainable urban development.

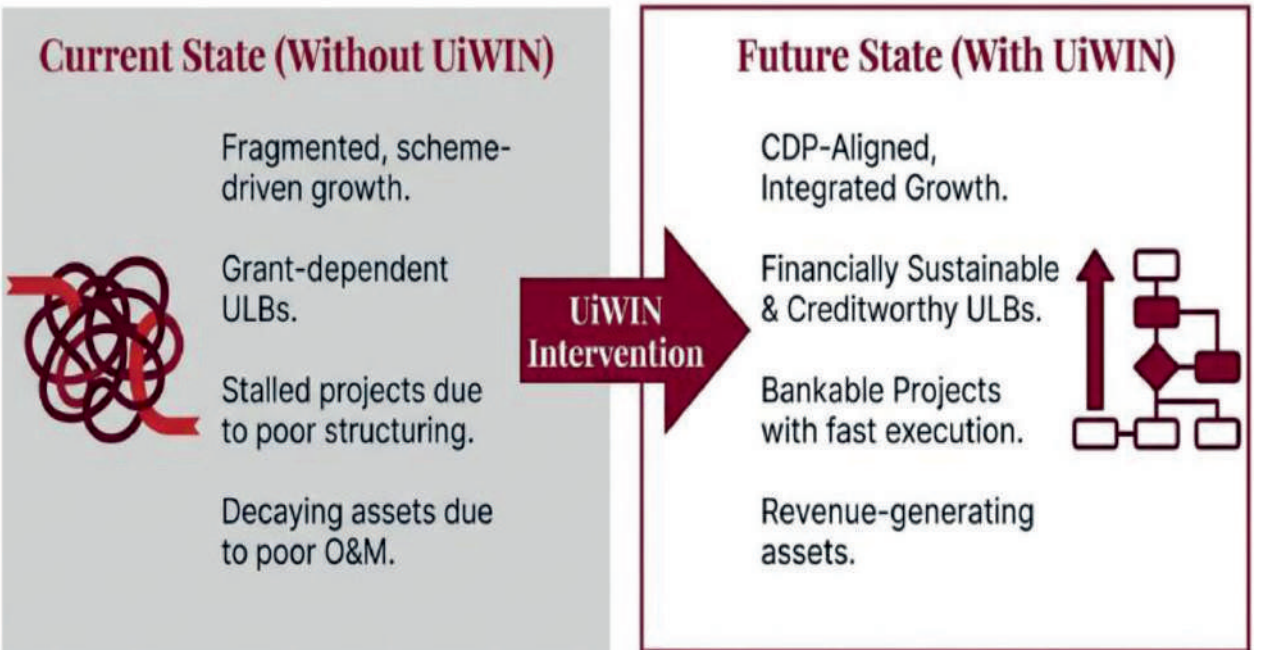

Figure 2: The expected impacts of UiWIN intervention

UiWIN as a Comprehensive Solution

UiWIN addresses these challenges through an integrated framework that combines planning support, financing facilitation, capacity building, and execution assistance. Its key components include:

- ***CDP Aligned Project Identification:*** Supporting ULBs in prioritising projects based on infrastructure gaps and development priorities identified in CDPs
- ***Financial Structuring and Access to Capital:*** Assistance in credit rating, municipal bonds, pooled financing, multilateral and bilateral funding, and PPP structuring
- ***Technical and Institutional Capacity Building:*** Support for DPR preparation, feasibility studies, financial modelling, and debt management frameworks
- ***Asset Management and O&M Support:*** Creation and digitisation of asset registers, asset mapping, and development of operation and maintenance tools

HUDCO's regional offices are repurposed as UIWIN State Offices to provide doorstep support and ensure last-mile delivery, particularly for smaller cities.

Role of HUDCO in Implementing UiWIN: An Institutional Advantage

The effective implementation of UiWIN is anchored in HUDCO's unique institutional strength as India's premier techno-financial institution in housing and urban infrastructure. With over five decades of experience, HUDCO provides an integrated suite of services encompassing financing, consultancy, technical advisory, and capacity building across the entire landscape of housing and urban infrastructure projects and operational depth to support CDP-led and financially sustainable urban development.

HUDCO's key strengths enabling UiWIN include:

- Five decades of techno-financial expertise in housing and urban infrastructure.
- Public Financial Institution mandate, providing financing, consultancy, technical advisory, and capacity building support.
- Strong multi-sectoral engagement and long-standing partnerships with State Governments, ULBs, and SPVs.

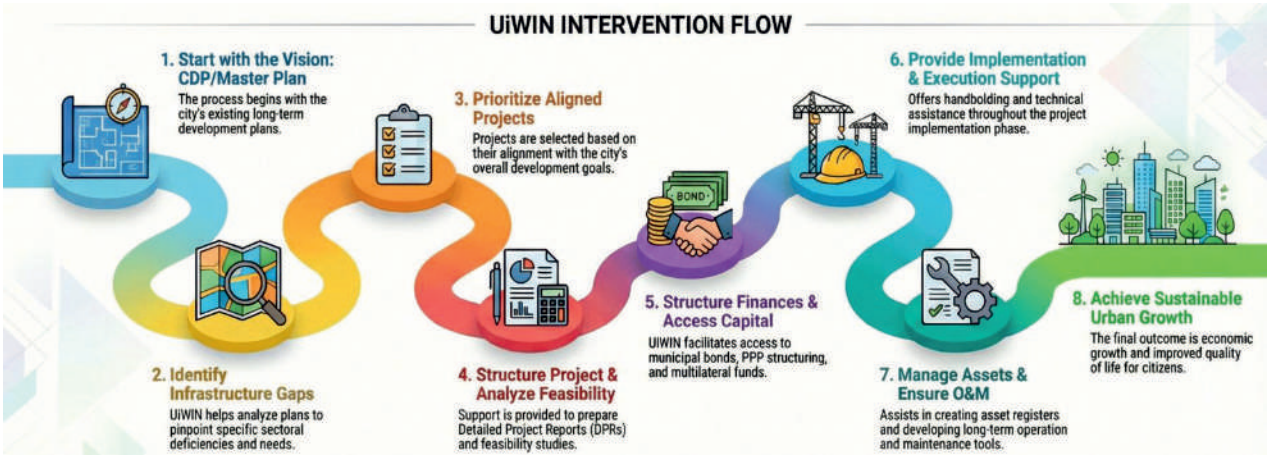

Figure 3: UiWIN Intervention flow

- Strategic alignment with flagship GoI programmes such as PMAY 2.0, AMRUT, Smart Cities Mission, SBM, JJM, and UCF.
- Navratna CPSE status, listed entity with 75% GoI ownership and NBFC–IFC registration with RBI.
- Consistently profit-making organisation, guided by the principle of "Profitability with Social Justice."
- Pan-India presence through regional offices in every state, enabling local execution, on-ground handholding, and effective last-mile delivery under UiWIN.

Conclusion: UiWIN and the Path to Viksit Bharat

As India enters the most critical decade of urban transformation, the realisation of the vision of Viksit Bharat will depend on the ability of cities to plan strategically, mobilise sustainable finance, and execute infrastructure projects efficiently. UiWIN represents a decisive institutional intervention that bridges the gap between planning and implementation by empowering ULBs with comprehensive, CDP-driven, and financially sustainable development support.

Anchored in HUDCO's institutional strength, technical expertise, and pan-India presence, UiWIN provides a scalable and replicable model for integrated urban infrastructure development. By strengthening ULB capacity, improving project bankability, and enabling access to long-term finance, UiWIN contributes to the creation of resilient, inclusive, and economically productive cities—laying a strong foundation for India's urban future and the broader national goal of Viksit Bharat.

Bengaluru's GIS-Enabled Property Assessment System

The Bruhat Bengaluru Mahanagara Palike (BBMP), in collaboration with the Indian Space Research Organisation (ISRO), has introduced a GIS-based online platform for property tax management. The Geospatial Enabled Property Tax Information System (GEPTIS) provides comprehensive mapping of all properties within the BBMP jurisdiction, enabling real-time monitoring of property tax collection across the city. This system enhances transparency, supports timely tax collection, and significantly improves administrative efficiency in assessing expected revenues, identifying defaulters, analysing property usage patterns, and detecting properties that have not yet been brought under the tax net.

Citizens can access detailed property information through a simple, one-time registration process. The platform also allows users to submit feedback to the Revenue Department regarding updates, corrections, or discrepancies in property records, thereby promoting accuracy and participatory governance.

Source: https://gisresources.com/bengaluru-city-geospatial-enabled-property-tax-information-system/

INSTITUTIONAL REFORMS FOR RESILIENT URBAN INFRASTRUCTURE IN EMERGING ECONOMIES

RITESH GUPTA

Abstract

Rapid urbanisation across emerging economies has intensified pressure on urban infrastructure systems, exposing deep structural weaknesses in governance, finance and institutional coordination. Despite increased public expenditure and international funding support, infrastructure systems in many cities remain vulnerable to climate shocks, service disruptions and fiscal instability. This paper argues that the core challenge of urban infrastructure resilience is fundamentally institutional rather than purely technical or financial. It examines structural deficiencies such as fragmented governance arrangements, limited municipal autonomy, weak regulatory frameworks and inadequate coordination between land use and infrastructure planning. Drawing upon comparative experiences from emerging economies, including India and selected global case illustrations, the study evaluates reform strategies such as metropolitan governance integration, fiscal decentralisation, municipal bond markets, public private partnership restructuring and digital asset management systems. The paper contributes to the fields of urban planning and infrastructure governance by proposing a multidimensional institutional reform framework that integrates governance capacity, financial sustainability, climate responsiveness and citizen participation. It concludes that long-term infrastructure resilience depends on systemic institutional transformation capable of aligning policy, planning and finance in rapidly urbanising contexts.

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Introduction

The twenty-first century has been described as the "urban century," with emerging economies experiencing unprecedented rates of urban growth. Cities across Asia, Africa and Latin America are expanding rapidly, both demographically and spatially. This transformation has generated economic opportunities but also placed enormous strain on urban infrastructure systems including transportation networks, water supply systems, sanitation facilities, housing stock and energy distribution grids.

While infrastructure investment levels have increased substantially in recent decades, persistent service delivery gaps remain evident. Urban flooding, traffic congestion, water scarcity, infrastructure collapse during extreme weather events and informal settlement proliferation reflect systemic vulnerabilities. These challenges are often attributed to financial constraints or technological deficits. However, growing evidence suggests that institutional weaknesses - rather than engineering limitations - constitute the primary barrier to resilient urban infrastructure.

Resilience in urban infrastructure refers to the capacity of systems to anticipate, absorb, adapt to and recover from shocks while maintaining essential services. In emerging economies, where climate risks intersect with high population densities and fiscal limitations, resilience is no longer optional; it is foundational to sustainable development. This paper examines how institutional reforms can enhance the resilience of urban infrastructure systems. It argues that governance integration, regulatory strengthening, fiscal decentralisation and institutional capacity-building are central to long-term infrastructure sustainability.

Urban Infrastructure and the Concept of Resilience

Urban infrastructure encompasses physical networks such as roads, metro systems, bridges, drainage systems, power grids and housing, alongside the institutional frameworks that govern their planning, financing, regulation and maintenance. Traditionally, infrastructure planning focused on expansion and capital investment. However, contemporary urban theory emphasises resilience - an adaptive capacity that enables systems to function effectively under stress.

Resilience has evolved from an engineering-centric understanding, where the objective was rapid restoration after disruption, to a broader socio-institutional perspective. Institutional resilience emphasises governance flexibility, regulatory adaptability, financial sustainability and participatory decision-making. In other words, infrastructure systems are only as resilient as the institutions that manage them.

Emerging economies face particular vulnerabilities due to rapid urbanisation, climate exposure, limited fiscal autonomy and fragmented governance structures. Infrastructure failures in these contexts frequently reveal systemic institutional weaknesses rather than design flaws. Therefore, strengthening institutions is critical to enhancing infrastructure resilience.

Institutional Challenges in Emerging Economies

Urban infrastructure systems in emerging economies face deep institutional challenges that go beyond financial or technical limitations. Rapid urbanisation, climate risks and growing service demands have exposed structural weaknesses in governance, regulation and administrative capacity. These challenges often reduce coordination, weaken accountability and limit long-term planning effectiveness. The following framework summarises the key institutional barriers that hinder resilient infrastructure development.

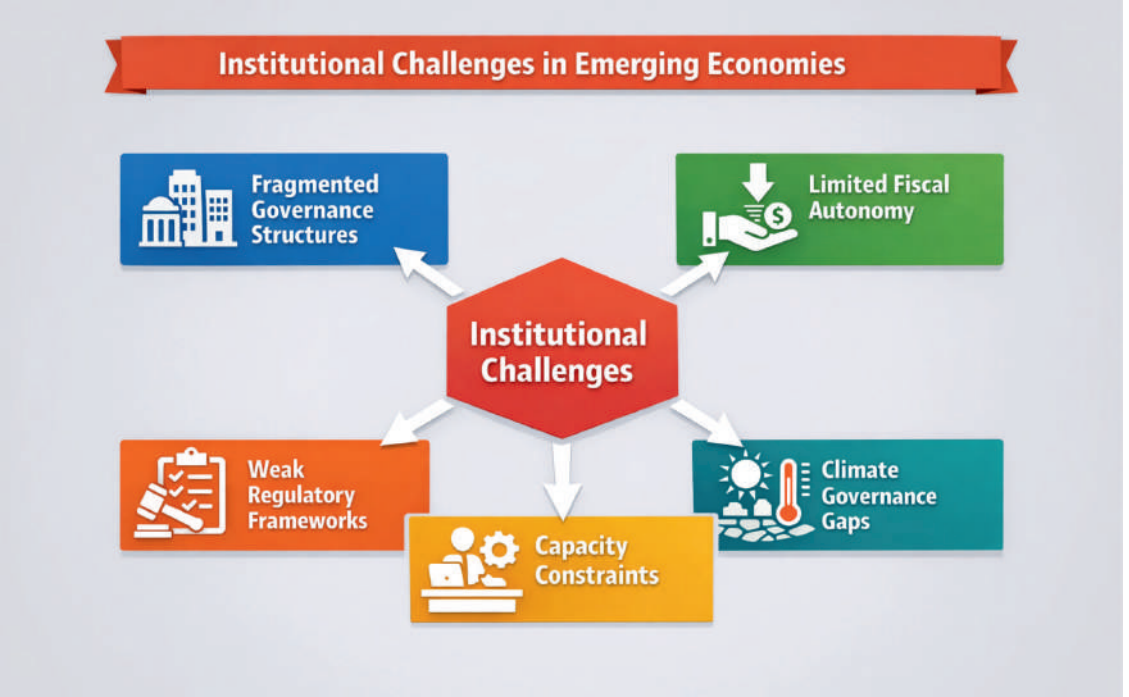

Figure 1: Overview of institutional challenges experienced by emerging economies

Fragmented Governance Structures: Urban governance in many emerging economies is characterised by institutional fragmentation. Multiple agencies often share overlapping responsibilities for transportation, housing, land use planning, water supply and environmental regulation. This fragmentation leads to coordination failures, duplication of efforts and inefficient resource allocation.

For instance, transport infrastructure may be planned by one authority, land use by another and environmental approvals by a third, with minimal institutional coordination. The absence of integrated metropolitan governance structures weakens strategic planning and reduces accountability.

Limited Fiscal Autonomy: Municipal governments frequently lack adequate financial independence. Heavy reliance on intergovernmental transfers constrains long-term planning and reduces local accountability. Limited authority to raise revenue through property taxes, user charges or bond markets undermines fiscal sustainability. Without predictable revenue streams, cities struggle to maintain infrastructure assets, leading to deterioration and increased vulnerability during shocks.

Weak Regulatory Frameworks: Independent regulatory bodies play a vital role in ensuring service quality, tariff rationalisation and transparency. In many emerging economies, however, regulatory oversight remains weak or politically influenced. This undermines investor confidence and discourages private sector participation.

Capacity Constraints: Urban local bodies often lack technical expertise in project appraisal, risk assessment, contract management and digital asset monitoring. Institutional capacity deficits limit effective implementation of infrastructure projects and hinder long-term resilience planning.

Climate Governance Gaps: Climate risks such as flooding, heatwaves and extreme rainfall events disproportionately affect cities of emerging economy. However, climate risk assessment is rarely institutionalised within urban planning frameworks. Infrastructure development often proceeds without systematic climate integration, increasing long-term vulnerability.

Governance Reforms for Infrastructure Resilience

Strengthening urban infrastructure resilience requires more than financial investment; it demands structural reforms in governance systems. Emerging economies must redesign institutional arrangements to improve coordination, enhance accountability and build long-term administrative capacity. Governance reforms play a critical role in aligning planning, finance and service delivery with resilience objectives. The following framework highlights the key reform pillars that enable cities to build stronger, more integrated and sustainable infrastructure systems.

Figure 2: A roadmap for infrastructure resilience through governance reforms

Metropolitan Governance Integration: Integrated metropolitan governance structures facilitate coordination across sectors and jurisdictions. Establishing unified metropolitan transport authorities or planning commissions reduces institutional silos and enhances strategic alignment between land use and infrastructure planning.

Metropolitan-level governance is particularly essential in large urban agglomerations where infrastructure networks extend beyond municipal boundaries.

Decentralisation with Accountability: Fiscal and administrative decentralisation must be accompanied by strong accountability mechanisms. Empowering urban local bodies with revenue authority while establishing performance benchmarks improves both efficiency and transparency.

Performance-based grants tied to service delivery outcomes can incentivise institutional reform and enhance resilience.

Institutional Coordination Mechanisms: Formal coordination platforms among transport departments, housing authorities, water boards and environmental agencies reduce duplication and enhance integrated planning. Inter-agency data sharing and joint infrastructure committees can institutionalise collaboration.

Professionalisation of Urban Administration: Training programs, performance evaluation systems and recruitment of specialised professionals improve institutional capacity. Professional management models reduce political interference and enhance long-term planning.

Financial and Regulatory Reforms

Building resilient urban infrastructure requires strong financial foundations and credible regulatory systems. Without sustainable revenue sources, transparent risk-sharing mechanisms and independent oversight, infrastructure investments often become fiscally strained and operationally inefficient. Financial and regulatory reforms help cities diversify funding, improve investor confidence and ensure long-term accountability in service delivery. The following framework highlights the key financial and regulatory pillars that strengthen institutional stability and support resilient infrastructure development.

Figure 3: Essential financial and regulatory reforms for building resilient urban infrastructure

Municipal Bond Markets: Access to capital markets enables cities to finance infrastructure independently. Municipal bonds improve fiscal discipline, enhance transparency and strengthen creditworthiness. Successful examples demonstrate that structured financial reforms can attract private investment while maintaining public accountability.

Public–Private Partnership (PPP) Restructuring: While PPP models have been widely adopted, poorly designed risk-sharing frameworks have often resulted in financial distress. Institutional reform must ensure transparent contracts, balanced risk allocation and regulatory oversight.

Value Capture Financing: Infrastructure investments often increase surrounding land values. Mechanisms such as betterment levies, development charges and transit-oriented development capture can generate sustainable revenue streams.

Independent Regulatory Authorities: Establishing independent regulators for utilities ensures tariff rationalisation, service quality standards and investor confidence. Regulatory independence reduces political distortions and strengthens institutional credibility.

Data Transparency and Institutional Accountability

Data transparency is a key foundation of resilient urban infrastructure. When governments openly share information about project costs, timelines, service performance, tariffs and financial health, it builds trust among citizens, investors and other stakeholders. Transparency reduces the chances of corruption, cost overruns and unnecessary delays because decisions and expenditures are visible and can be questioned. In areas such as municipal bonds and public–private partnerships, clear and reliable data strengthens a city's credibility and improves investor confidence. In simple terms, open information leads to better accountability and stronger financial discipline.

Digital tools make transparency more effective. Geographic Information System-GIS platforms, online dashboards, open procurement systems and real-time monitoring improve coordination across agencies and allow citizens to stay informed. However, technology alone is not enough. Transparency must be supported by clear rules, regular reporting and independent audits to ensure consistency and reliability. When transparency becomes a permanent part of governance, infrastructure systems become more dependable, responsive and sustainable over the long term.

Case Illustrations

Delhi Metro Rail Corporation (India): Delhi Metro model demonstrates the importance of institutional autonomy and professional management. Operational independence, strong project governance and financial discipline have contributed to reliability and resilience. The integration of land value capture and non-fare revenue mechanisms has strengthened financial sustainability.

Singapore's Integrated Urban Governance: Singapore's urban governance model illustrates how integrated planning and strong institutional coordination enhance resilience. Centralised yet accountable institutions align land use, housing and transport planning, ensuring long-term sustainability.

These cases underscore that institutional design significantly influences infrastructure outcomes.

A Multi-Dimensional Institutional Reform Framework

Based on the analysis, this paper proposes a multi-dimensional reform framework comprising:

1. ***Governance Resilience*** – Integrated metropolitan planning and coordination.
2. ***Financial Resilience*** – Diversified revenue sources and capital market access.
3. ***Regulatory Resilience*** – Independent oversight and transparent tariff systems.
4. ***Climate Resilience*** – Institutionalised risk assessment mechanisms.
5. ***Social Resilience*** – Participatory planning and equitable service provision.

These dimensions are interdependent. Strengthening one without addressing others limits overall resilience.

Policy Implications for Emerging Economies

Policymakers must prioritise institutional restructuring alongside infrastructure investment. Reform strategies should include:

- Establishing metropolitan-level governance authorities.

- Expanding municipal revenue powers.
- Strengthening regulatory independence.
- Embedding climate risk assessment into planning norms.
- Institutionalising citizen participation.
- Enhancing professional capacity within urban local bodies.

Institutional reform requires political commitment and long-term vision. Short-term project-based approaches are insufficient.

Conclusion

Urban infrastructure resilience in emerging economies is fundamentally an institutional challenge. While capital investment and technological innovation remain important, they cannot substitute for governance integration, fiscal autonomy and regulatory strength. Infrastructure systems reflect the capacity of institutions that design, finance and manage them.

As urban populations continue to grow and climate risks intensify, institutional reforms must move to the centre of urban policy discourse. Resilient cities are built not merely through concrete and steel but through accountable, adaptive and financially sustainable institutions. Emerging economies must therefore prioritise systemic institutional transformation to secure sustainable urban futures.

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STRENGTHENING URBAN LOCAL BODIES FOR A CIRCULAR WASTE ECONOMY: DATA-DRIVEN PATHWAYS TO VIKSIT BHARAT @2047

RINKY HALDAR
SFEETI PADELE

Abstract

India's Viksit Bharat @2047 vision demands that cities become engines of sustainable growth, and promote equitable service delivery, and climate resilience. Municipal Solid Waste (MSW) management is a visible, high-stakes proxy that can provide insights into the quality of governance in an Urban Local Body (ULB). India generates approximately 170,000 tonnes per day of Municipal Solid Waste (MSW); as of 2021-22, only 54% is scientifically processed/treated and 22% remains unaccounted for as either treated or disposed at landfills, according to data compiled under the Solid Waste Management (SWM) Rules, 2016 (CPCB, 2022). This paper argues that the fastest, most replicable pathway for ULBs to transition from a linear "collect-transport-dump" model to a circular, climate-aligned system is data-driven governance anchored in SDG 11.6.1 monitoring and UN-Habitat's Waste Wise Cities Tool (WaCT).

Using evidence from pilot applications in Thiruvananthapuram and Mangaluru, supplemented by the Waste Flow Diagram (WFD) methodology for plastic leakage quantification, the paper demonstrates how evidence-based diagnostics can translate directly into bankable investment projects, stronger contracts, formalised informal recycling value chains, and sustained outcomes. The paper further maps how these approaches align with SBM-Urban 2.0 Garbage Free Cities protocols, and the 15th Finance Commission grant frameworks. Policy recommendations focus on institutionalising Waste Wise Citite Jool (WaCT)as a mandatory diagnostic, mainstreaming outcome-based finance, and building the minimum viable capability stack in ULBs to sustain circular economy transitions through 2047.

Introduction

India's aspiration to become a developed nation under the vision of *Viksit Bharat @2047* represents a transformative national agenda that emphasises sustainable infrastructure, environmental resilience, economic productivity, and institutional strengthening. India's urban population has expanded nearly fourfold since 1970, reaching about 460 million by 2018, and is projected to grow to nearly 50% of the national population by 2050[10] , adding over 400 million new urban residents[11]. This rapid urban transition will significantly intensify pressures on municipal infrastructure systems and urban governance institutions.

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[10]United Nations' 2018 Revision of World Urbanization Prospects

[11] Reforms in Urban Planning Capacity in India. September 2021. NITI Aayog.

Among these challenges, municipal solid waste management has emerged as a critical test of Urban Local Bodies administrative, financial, and technical capacity. India currently generates approximately 170,000 tonnes of municipal solid waste per day, of which only about 54% is scientifically processed, while nearly 22%[12] remains unaccounted for due to leakages across the waste management chain, often ending up in open dumps, drainage systems, and water bodies. The waste sector is projected to grow alongside India's rapid urbanisation, making evidence-based ULB governance a non-negotiable foundation for the Viksit Bharat vision. Plastic waste, particularly low-value plastics, constitutes a significant portion of municipal waste streams and unmanaged waste. India generates an estimated 9.3 - 9.4 million tonnes of plastic waste annually (about 25,000 - 26,000 tonnes per day), of which only around 60% is recycled, leaving a large portion uncollected, improperly managed, or leaking into the environment as pollution[13]. As urban consumption and material throughput continue to increase, the performance of municipal waste systems will become an increasingly important determinant of urban liveability, climate resilience, and economic productivity.

National policy frameworks have recognised this urgency. The Solid Waste Management Rules, 2016, and the Swachh Bharat Mission Urban 2.0 have placed strong emphasis on 100% door-to-door segregated collection, scientific processing, legacy dumpsite remediation, digital monitoring, and achievement of "Garbage Free Cities" ratings in 3,583 ULBs[14] . SBM-U 2.0 explicitly shifts the focus from infrastructure creation alone to measurable service outcomes, institutional strengthening, and performance monitoring. This marks a transition from waste disposal as a municipal obligation to waste governance as a performance-driven urban management function. However, achieving these outcomes requires strengthening the governance capacities of ULBs beyond conventional service delivery models.

Plastic waste, particularly low-value and multi-layer plastics, exemplifies the structural gap between collection coverage and effective resource recovery. While collection efficiency in many cities has improved, recovery and environmentally sound processing remain uneven, highlighting the need for better data, system diagnostics, and investment prioritisation. In this context, evidence-based planning tools and indicators such as SDG Indicator 11.6.1, which measures the proportion of municipal solid waste collected and managed in controlled facilities, provide a standardised performance framework. Complementary methodologies such as UN-Habitat's Waste Wise Cities Tool and Waste Flow Diagrams support cities in diagnosing waste flows, identifying leakages, and prioritising targeted interventions that align with national missions such as SBM-U 2.0. Urban Local Bodies, as constitutionally mandated institutions under the 74th Constitutional Amendment Act, 1992, are central to this transition. Their role must evolve from operators of collection and transport systems to institutional enablers capable of managing material flows, enforcing standards, integrating informal recycling networks, structuring outcome-based contracts, and mobilising finance for circular infrastructure. Strengthening this institutional capacity is fundamental to achieving sustainable urban transformation.

This paper argues that the most effective pathway toward achieving the waste-related objectives of Viksit Bharat @2047 lies in strengthening ULB capacity through integrated, data-driven governance that aligns national policy frameworks with standardised performance measurement tools and circular economy interventions. Drawing on national waste statistics, policy analysis, and case evidence from UN-Habitat-supported initiatives, the paper demonstrates how ULBs can move from assessment to action through a structured delivery

[12] Central Pollution Control Board (CPCB), Status of Municipal Solid Waste Management in India 2023–24

[13] Plastic Waste Management issues, solutions & case studies https://sbmurban.org/storage/app/media/pdf/SBM%20Plastic%20Waste%20Book.pdf

[14] https://sbmurban.org/gfc-result-dashboard- 2024-25

chain that links diagnostics, prioritisation, investment design, and outcome monitoring. The paper is organised as follows: Section 2 situates municipal waste management within the broader urban sustainability nexus; Section 3 presents case evidence illustrating institutional capacity strengthening and circular economy integration; Section 4 aligns these lessons with the Viksit Bharat @2047 roadmap; and Section 5 outlines a phased pathway for achieving garbage-free, circular cities led by empowered Urban Local Bodies.

The Urban Sustainability Nexus - Why MSW Governance is a 'Viksit Bharat' Lever

The urban sustainability nexus describes the tight coupling between (i) public health and liveability, (ii) municipal finance and economic productivity, and (iii) environmental quality and climate resilience. Municipal solid waste sits at the intersection of all three dimensions: failures in waste systems manifest immediately as blocked drains and urban flooding, vector-borne disease outbreaks, hazardous open burning and air pollution, degraded land and property values, and spiraling municipal budgets, while successes in waste governance unlock circular economy opportunities, green jobs, and climate co-benefits[15] . For a nation pursuing developed-economy status by 2047, allowing the 22% gap in solid waste management to persist would directly contradict the infrastructure, health, and productivity imperatives of the Viksit Bharat vision.

India's MSW Performance: A Governance and Investment Gap: CPCB's Annual Report on implementation of the Solid Waste Management Rules, 2016 (for the financial year 2021–22) provides the most authoritative nationally comparable system-level snapshot available:

- Total MSW generated: 170,339 TPD
- Total MSW collected: 156,449 TPD (collection efficiency ~92% by mass)
- Total MSW processed/ treated: 91,511 TPD (54% of generation)
- Total MSW sanitary-landfilled: 41,455 TPD (24% of generation)
- Management gap (unaccounted): 37,373 TPD (22% of generation)
- National average per capita generation: 123.45 g/capita/ day (rising trend)

These figures reveal that while India has made significant progress, treatment rose from 36% in 2017–18 to 54% in 2021–22, the remaining gap represents a public health and environmental liability of nearly 37,000 TPD of unmanaged waste daily[16]. State-level analysis reveals sharp disparities in municipal solid waste processing across India. Lakshadweep (100% treatment), Chhattisgarh (98%), and Gujarat (about 86%) are among the high-performing regions in terms of waste processing. In contrast, several states lag significantly behind, including Arunachal Pradesh (around 4%), Puducherry (about 15%), and West Bengal (less than 10% processing). These disparities highlight that the challenge extends beyond infrastructure gaps and reflects deeper institutional and governance constraints within Urban Local Bodies (ULBs). Many low-performing cities have received capital investments for waste infrastructure but continue to struggle with operational management, technical capacity, and sustained processing of municipal waste streams.

From Linear Disposal to Circular Economy: The Institutional Shift for ULBs: A circular waste economy requires ULBs to manage material flows and value chains, not just vehicles and landfills. This institutional shift has three key dimensions:

Measurement and data governance: ULBs must generate reliable, comparable data on waste generation, collection, and facility performance as the foundation for evidence-based decisions and investor confidence.

Contractual and regulatory capability: ULBs must design, procure, and monitor performance-linked contracts for collection, processing, and disposal, aligning financial flows with measurable outcomes (collection coverage, recovery rates, controlled facility operations).

Stakeholder integration: The

[15] https://unhabitat.org/waste-wise-cities

[16] https://cpcb.nic.in/uploads/MSW/MSW_AnnualReport_2021-22.pdf

informal recycling sector handles a significant share of India's dry-waste recovery but operates outside formal governance systems. Integrating waste pickers, intermediate traders, and recyclers into formal value chains improves livelihoods, increases recovery rates, and reduces management costs for ULBs (UN-Habitat, WaCT).

The Measurement Backbone: SDG 11.6.1, WaCT, and WFD: Without standardised, credible measurement, ULB planning remains 'DPR-driven' rather than outcome-driven. SDG Indicator 11.6.1, 'Proportion of MSW collected and managed in controlled facilities out of total MSW generated, by cities', provides a globally comparable, ladder-based framework that differentiates collection coverage from controlled management performance (UN Statistics Division / UN-Habitat, 2025). UN-Habitat's Waste Wise Cities Tool (WaCT) operationalises this through a seven-step data collection and computation workflow, designed specifically because most cities in low- and middle-income contexts lack validated local waste data. The Waste Flow Diagram (WFD), a complementary rapid-assessment methodology developed by GIZ[17] , the University of Leeds, Eawag-Sandec, and Wasteaware, enables ULBs to map material flows and quantify plastic leakage from the formal system to the environment, enabling targeted interventions (GIZ et al., 2020). Together, WaCT and WFD create an evidence foundation that converts a ULB's waste challenge into a structured, investable problem statement.

The National Policy Anchor: SBM-U 2.0 as the Governance Shell: Swachh Bharat Mission - Urban 2.0 (2021–2026) provides the operational architecture within which ULBs must now work: 100% door-to-door collection of segregated waste; 100% scientific processing of all fractions; dumpsite remediation; outcome-based fund releases; mandatory digital monitoring (ICT-enabled governance); and standardised Garbage Free City (GFC) Star Rating protocols with independent third-party certification (MoHUA, 2021). SBM-U 2.0's City Solid Waste Action Plans (CSWAP) and capacity-building e-learning platforms create a ready governance 'shell' into which WaCT/WFD diagnostics can be plugged, linking evidence, investment, implementation, and accountability in a single operational cycle.

SBM-U 2.0 is explicitly structured around outcomes: 100% door-to-door collection of segregated waste, 100% scientific processing, legacy dumpsite remediation, and digital monitoring, supported by city action plans (CSWAP), standardised protocols (e.g., Garbage Free City star rating), capacity building, and mandatory digital enablement for projects in O&M. This gives ULBs a ready governance "shell" into which WaCT/WFD evidence can[18]

Case Analysis

Achieving the vision of Viksit Bharat by 2047 requires systemic transformation of urban infrastructure and governance, particularly in municipal solid waste management. ULBs as constitutionally mandated institutions are central to this transition. Moving beyond conventional collection and disposal systems toward circular resource management requires stronger institutional capacity, data-driven planning, and adoption of innovative recovery solutions. The experience of initiatives such as the Waste Wise Cities programme and piloting of frontier technologies that enable upcycling and circular use of low-value plastics, illustrate how ULBs can evolve into institutional enablers of circular economy transitions by strengthening governance systems, technical capacity, and stakeholder coordination, thereby supporting the shift from waste management to resource recovery.

Waste Wise Cities Initiative: Waste Wise Cities Tool (WaCT) as a Governance Methodology: The Waste Wise Cities Tool, developed by UN-Habitat, provides an important institutional instrument to strengthen evidence-based waste governance at the city level. Designed to operationalise SDG Indicator 11.6.1, the tool enables Urban Local Bodies to systematically quantify waste

[17] https://www.giz.de/expertise/downloads/giz-waste-flow-diagram-user-manual.pdf

[18] https://sbmurban.org/storage/app/media/pdf/swachh-bharat-2.pdf

generation, assess collection and recovery performance, and determine the share of waste managed in environmentally controlled facilities. In doing so, it supports municipalities in moving beyond routine reporting toward outcome-oriented performance measurement. Structured as a seven-step methodology (see Figure 1), WaCT integrates household waste estimation, recovery chain assessment, and facility control verification. This allows ULBs to identify institutional and infrastructure gaps across segregation, processing, disposal standards, and regulatory enforcement. When complemented by Waste Flow Diagram (WFD) analysis, the framework further helps cities map material flows, trace plastic leakage pathways, and identify high-priority intervention points.

By translating fragmented waste data into a structured diagnostic and planning framework, the tool assists ULBs in converting waste management challenges into clearly defined governance reforms and investable action areas. An assessment of the SWM status is provided and followed by a set of recommendations for each city. A summarised evaluation of the policy, legal, infrastructural and equipment gaps is presented in the form of colour indicators.

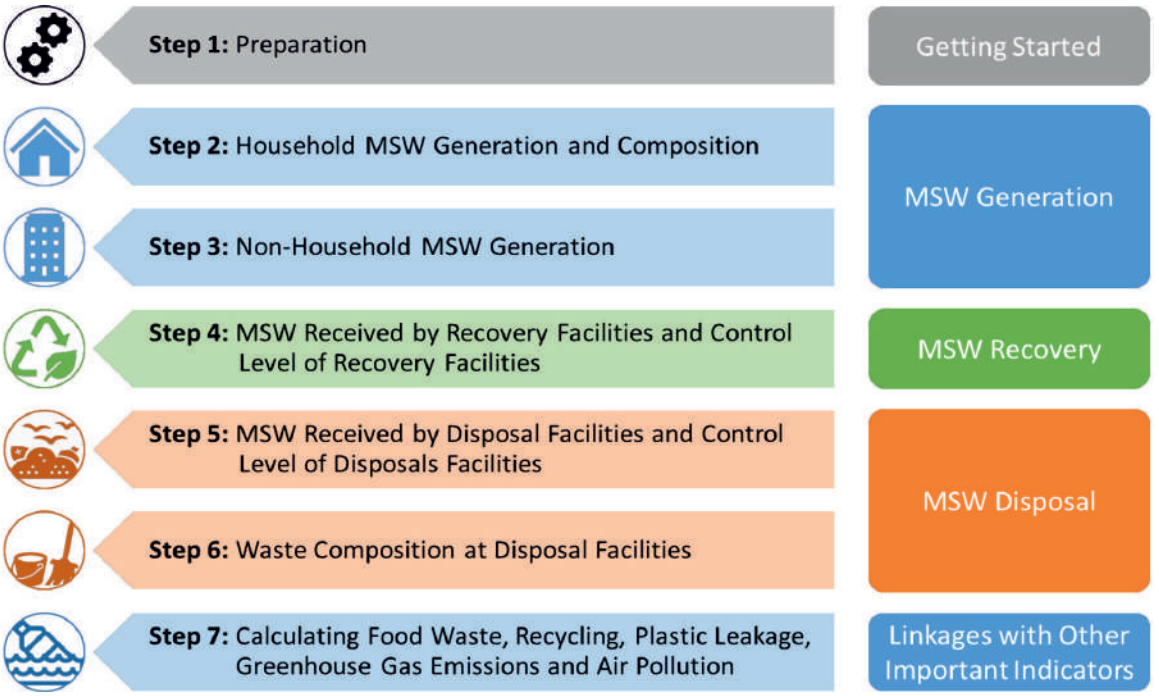

Figure 1: WaCT seven steps approach, Source- UN-Habitat (WaCT)

Table 1: Definitions used to classify and summarise the gaps identified at city level, Source- UN-Habitat

Large gap		No infrastructure or equipment is in place. There is no policy or legal initiative to support investments in infrastructure. Major gaps are identified and should be immediately addressed.
Medium gap		Some infrastructure or equipment is in place, but their use or condition is assessed to be poor or very poor. There are some policy or legal initiatives in place to support further investments but these not realistic or lacking proper enforcement mechanisms. Important gaps are identified which require immediate action.
Low gap		The infrastructure or equipment is in place and having an important contribution to the overall SWM system. There are policy or legal initiatives to support further improvements in the system. Some gaps exist and should be addressed.

Responsibility, and local SWM planning. Interventions are ranked on a scale of 1 to 3, where 1 denotes highest priority and 3 denotes lower priority, based on urgency, institutional feasibility, and public health and environmental implications. Identified gaps are categorised using a colour-coded classification system as shown in Table . The prioritisation is made considering the complexity of the intervention, the capacity of the government to implement it and the urgency of the problem taking into account public health and environmental impacts.

In 2021, under the Alliance to End Plastic Waste initiative, WaCT was applied in four pilot cities: Thiruvananthapuram and Mangaluru in India, and Addis Ababa and Bahir Dar in Ethiopia. The findings from these pilots provide empirical insights into how structured diagnostics can inform institutional strengthening and targeted waste system reforms.

India Pilot Application: Evidence from Mangaluru: The application of the WaCT in Mangaluru provides a data-backed illustration of how structured diagnostics can reshape municipal waste governance. The assessment in 2021 enhanced the city's baseline understanding of waste generation, recovery, and disposal pathways, revealing significant discrepancies between reported figures and measured system performance.

The study provided a detailed insight on the waste channelisation from resource recovery facilities till the disposal site. Mangaluru's per capita waste generation was found to be 0.64 kg, with the food waste generation about 0.23 kg per capita. Mangaluru had a good waste collection service, collecting more than 90% of the generated waste and in total, 30% of the generated waste in the city was reaching the recovery facilities through formal and informal systems. Plastic waste generation was 17% of the total waste. The survey of the recovery facilities observed that around half of them had basic control in their operations, which means they handled the waste processing in a cleaner way avoiding leakages. The study looked in detail at the city's plastic recycling and management systems and estimated that each person in the city annually contributed to 4.5 kg of plastics into the water systems.

Image 1: Household waste generation and composition analysis in Mangaluru, Source- UN-Habitat

The study estimated the waste generation in Mangaluru to be 391 TPD, whereas before WaCT implementation, the city estimated it generated 320-350 TPD of MSW. The recovery of waste in Mangaluru was found to be 110 TPD, which was new information as in background literature only 20 TPD was reported by the city. In the city's earlier reporting, the quantity of waste disposed

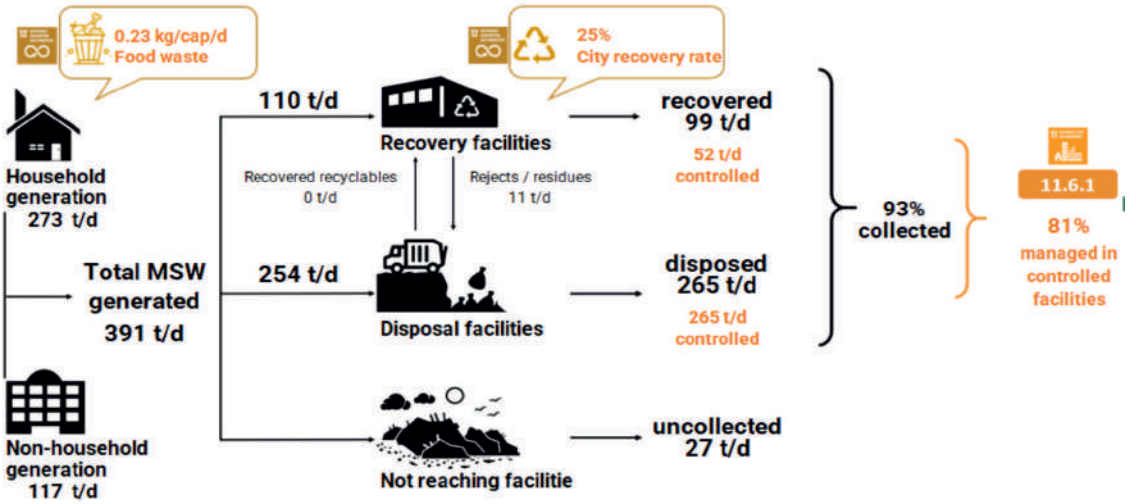

Figure 2: WaCT flow chart results in the Mangaluru, Source- UN-Habitat

appeared significantly higher because it also included waste received from neighbouring districts (30–50 TPD). The WaCT assessment clarified this discrepancy and estimated that approximately 265 TPD of waste disposed in the landfill originated from Mangaluru itself.

The assessment found that approximately 2% of generated plastic waste remained uncollected, with the primary leakage points occurring at the landfill site and within collection and transfer systems. Plastic leakage into the city's water systems was estimated at 2,762 tonnes annually, equivalent to 4.5 kg per person per year, or roughly 151 PET bottles per person annually. The total quantity of unmanaged plastic waste was estimated at 6,744 tonnes per year. This level of leakage is significantly higher than India's estimated national average of 0.09 kg/ person/year[10], partly reflecting the city's coastal geography and higher likelihood of plastics entering marine systems. At the national level, approximately 600,000 tonnes of plastic waste are estimated to be mismanaged annually[11] , with Mangaluru accounting for roughly 1.1% of this total.

In Mangaluru, high plastic leakages were observed at the disposal site as well as during the collection and channelisation of waste across recovery centres. The high influencers for leakages were waste transfer, waste containment in collection vehicles, weather conditions as the city received heavy rainfall and low level of control at the dumpsite. The major gaps identified in the city which would require an immediate action included:

- Awareness and capacity building with a focus on waste minimisation, segregation and zero waste systems
- Decentralised resource recovery by boosting recycling interventions and bringing efficiency and coordination in resource recovery
- Improvement of disposal site operations (Pachanady dumpsite)
- Financing and circular investments

[10] source: our world in data – Plastic waste estimated to the Ocean per capita

[11] source: our world in data – Mismanaged plastic waste

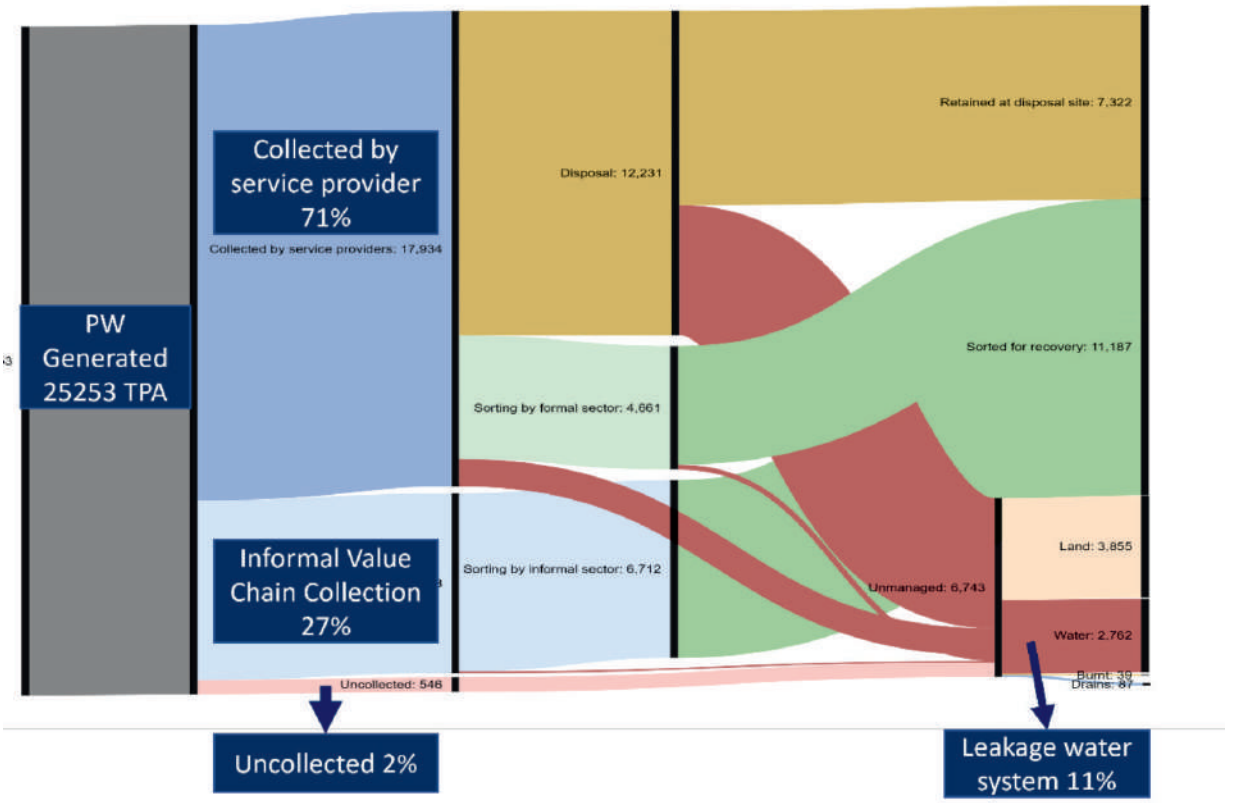

Figure 3: WFD results in Managaluru, India City (tonnes per year), Source- UN-Habitat

Table 2: Summary, classification and prioritisation of gaps in Mangaluru, Source- UN-Habitat

City/Country	Mangaluru, India		Prioritization (1-high, 3-low)
SWM stage	Policy / Legal	Infrastructure	
Separation at source			1
Waste collection coverage (incl. waste collection fees)			3
Waste transfer stations			2
Material recycling			1
Biological treatment (incl. waste to energy)			2
Waste disposal			1
Informal sector (incl. integration)			2
EPR			2
Local SWM plan/strategy			1

Priority	
High	1
Medium	2
Low	3

Gaps	
Large	
Medium	
Low	

The prioritisation was undertaken considering the complexity of the interventions, the capacity of the local government to implement them and the urgency of addressing associated public health and environmental risks, based on the WaCT results and the prevailing local conditions.

Frontier Technologies for Inclusive Circularity of Low-Value Plastics (NREF Initiative): The Frontier Technologies for Inclusive Circularity of Low-Value Plastics initiative, supported by the Norwegian Retailers' Environment Fund (NREF) and implemented by UN-Habitat in partnership with ULBs, represents a critical intervention to address structural gaps in plastic waste management systems, particularly the recovery and utilisation of low-value plastics. While ULBs in India have made significant progress in waste collection and segregation, low-value plastics such as multilayer plastics (MLPs), Low-Density Polyethylene (LDPE), and mixed plastics often remain unrecovered due to limited economic value, inadequate recycling infrastructure, and absence of viable local end-use markets. This results in substantial quantities of plastic waste being diverted to landfills, co-processing facilities, or leaking into the environment. This initiative addresses the gap by enabling circular economy pathways through the deployment of frontier upcycling technologies and strengthening institutional coordination between municipal authorities, private technology providers, and local stakeholders. The project demonstrates innovative technologies that convert low-value plastic waste into value-added construction materials, such as silica plastic composite blocks and resin-free plastic boards, described in detail in sections below.

Silica Plastic Waste Board: A key technological intervention under the initiative was the development of a sustainable alternative to bricks – the Sustainable Plastic-Waste Composite Blocks (SPWB). These composite blocks utilise a combination of dust/sand from construction and demolition waste and waste plastics, resulting in a cost-effective and environmentally friendly building material. The SPWB consists of approximately 75% dust/sand, derived from construction and

demolition waste, and 25% waste plastics, including low-value plastics (LVPs). The dust/sand serves as the primary component of the block, while the plastic functions as a bonding agent, eliminating the need for water or cement during production. The project combines foundry material handling technology with plastic extrusion technology to create this composite material.

Performance evaluations indicate that SPWB demonstrates significant advantages over conventional red clay bricks. The blocks are approximately 2.5 times stronger while weighing about 25%less, offering improved structural efficiency. By utilising construction and demolition waste along with low-value plastics, the technology simultaneously addresses two major waste streams and reduces pressure on landfills. The elimination of water and cement in production further lowers resource consumption and associated carbon emissions. With competitive production costs and comparable material performance, SPWB presents a technically viable and environmentally sustainable alternative within the construction sector.

Resin-free plastic panel boards: The initiative also demonstrates the production of resin-free plastic panel boards using shredded plastic waste, including LDPE, HDPE, and multilayer plastics. Through a meticulous process, the plastic waste is hot and cold pressed under a weight of 650 kg at temperatures between 160 and 170 degrees Celsius. This unique method does not rely on the use of resins, ensuring an eco-friendly approach to production. Depending on the desired board type, various plastic waste materials can be incorporated, including MLP, LDPE, LDPE + Aluminium, LDPE + HDPE, Post Industrial MLP, or post-consumer waste.

The resulting building boards exhibit good strength and versatility, making them suitable for various applications. By repurposing plastic waste, the technology offers a cost-effective and environmentally friendly alternative to traditional construction materials. These boards find utility in developing low-cost shelter solutions and various other construction projects. Moreover, the use of plastic waste materials reduces the environmental impact associated with plastic pollution and contributes to the principles of circular economy. It addresses the critical issue of plastic waste management, significantly reducing the strain on landfills and minimising environmental pollution. By upcycling plastic waste into valuable building boards, this technology contributes to a cleaner and more sustainable future.

Pilot Application: Evidence from Bhubaneswar, Odisha: The Bhubaneswar pilot demonstrates how frontier upcycling technologies can be embedded within an existing decentralised municipal waste management system. The city generates approximately 189 TPD of plastic waste, accounting for nearly 25% of its total waste stream, within an overall waste generation of about 757 TPD. The city operates 34 Material Composting Centres (MCCs) and 19 Material Recovery Facilities (MRFs) and has made progress in segregation and collection. However, a substantial share of recyclable plastics, particularly low-value MLPs and LDPE, is transported outside the state due to limited local recycling capacity and weak end-use markets. The NREF-supported intervention addresses this gap by aiming to establish local upcycling pathways through SPWB and resin-free plastic board technologies. The project aims to divert approximately 20 TPD of plastic waste, increasing recovery to 50 TPD by the third year, while leveraging Bhubaneswar's socially inclusive waste management model involving Swachh Sathis and self-help groups.

Policy, Finance, and Institutional Framework for ULB Strengthening in MSW Governance

The evidence from Mangaluru and Bhubaneswar demonstrates the transformative potential of data-driven tools when deployed within a supportive policy environment. Yet, tools alone are insufficient; their impact is multiplied when integrated into the full waste management value chain, from waste generation and segregation at source, through collection, transfer, and processing, to final disposal and resource recovery. This is precisely where UN-Habitat's Waste Wise Cities Tool

(WaCT) and Waste Flow Diagram (WFD) methodology find their deepest institutional relevance. These diagnostic instruments are not standalone assessments; they are designed to align with and strengthen the policy architecture that the Government of India has systematically built at the national level, from the SWM Rules 2016 to SBM-U 2.0, the 15th Finance Commission framework, and the Plastic Waste Management Rules. In this section, we demonstrate how WaCT and WFD can be integrated throughout each stage of the waste management value chain, how this integration aligns with national policy mandates, and what institutional and financial capabilities ULBs must develop to sustain these circular economy transitions.

National Policy Architecture Supporting ULB Transformation: India's policy framework for municipal solid waste management has evolved into a multi-layered and increasingly outcome-oriented architecture. However, national policy mandates and funding windows, by themselves, do not ensure better urban waste outcomes. They need to be complemented by a replicable and institutionalised delivery chain within urban local bodies (ULBs) that can translate regulatory obligations, fiscal transfers, and digital monitoring requirements into measurable circular-economy performance on the ground.

- At the regulatory level, the **Solid Waste Management Rules, 2016** provide the foundational legal framework. They require source segregation, door-to-door collection, and scientific processing, while also mandating authorisation for processing and disposal facilities above specified thresholds. In practical terms, these rules establish the minimum compliance baseline for any city aspiring to meet the standards of a developed India.
- At the programme level, Swachh **Bharat Mission–Urban 2.0 (SBM-U 2.0)** gives ULBs the principal operational platform for implementation. Through City Solid Waste Action Plans (CSWAPs), Garbage Free City (GFC) star ratings, mandatory digital monitoring, outcome-linked fund release, and structured capacity-building support, the mission provides the governance architecture through which cities can institutionalise planning, implementation, and performance tracking (MoHUA, 2021).
- The **Fifteenth Finance Commission** further strengthens this architecture by providing a major fiscal window for urban reform. With a substantial share of grants tied to national priorities including sanitation and solid waste management, and with an additional challenge fund for larger cities, these transfers create a direct opportunity for ULBs to invest in waste infrastructure and service improvements linked to measurable outcomes (Department of Expenditure, 2021).
- The **Plastic Waste Management Amendment Rules, 2022** add an important market and financing dimension through Extended Producer Responsibility (EPR). By placing recovery obligations on producers and importers and enabling plastic credit mechanisms, these rules allow ULBs to participate as collection and aggregation partners, thereby creating a potential non-budgetary revenue stream for plastic recovery systems (MoEFCC, 2022).
- **Finally, India's broader resource-efficiency and circular-economy policy framework**, reflected in the national policy discourse led by the Ministry of Environment, Forest and Climate Change, gives strategic legitimacy to the transition from waste management to materials management. This is especially important for integrating informal workers, improving resource productivity, and building value chains around recovery and reuse (MoEFCC, 2019).

Taken together, these instruments define the accountability, financing, and policy legitimacy within which ULB transformation must occur. Yet their effectiveness depends on whether cities can

convert them into an operational system of delivery. For that reason, the national policy must be matched by a replicable municipal delivery chain that is evidence-based, performance-linked, and institutionally embedded.

A Replicable and Institutionalised Delivery Chain for ULBs: A practical delivery chain is needed to translate diagnostics into sustained circular outcomes. In this regard, the Waste-Aware Cities Tool (WaCT) and the Waste Flow Diagram (WFD) provide a useful operational bridge between policy intent and municipal execution. Used together, they enable Indian cities to establish credible baselines, identify leakage points, structure investments, and monitor performance over time

Step 1: Establish a credible baseline (SDG 11.6.1 via WaCT): ULBs apply the seven-step WaCT protocol to compute total MSW generated, collected, and managed in controlled facilities, plus waste composition and facility control levels. This creates a validated, nationally comparable baseline that forms the foundation for investment proposals and grant applications (UN-Habitat (WaCT); UNSD/UN-Habitat, 2025).

Step 2: Map system leak points and plastic leakage Waste Flow Diagram (WFD): The WFD rapid assessment identifies where plastic escapes the formal system, at collection points, transfer stations, sorting facilities, or disposal sites, and determines the eventual fate (burnt, retained on land, entering drains/water systems). This enables investment prioritisation at the highest-impact intervention points rather than uniform infrastructure spending (GIZ et al., 2020).

Step 3: Convert gaps into structured project proposals: Each identified gap (collection coverage, transfer station upgrading, processing capacity, controlled disposal) is expressed as a City Solid Waste Action Plan (CSWAP) component under SBM-U 2.0, with output-outcome indicators, cost estimates, O&M models, and financing strategies (15th FC grants, SBM central share, EPR co-investment, PPP) (MoHUA, 2021).

Step 4: Build bankable, performance-linked contracts: Bankability requires guaranteed feedstock logic (segregation + collection enforcement), performance-linked payment structures for processing operators, end-market off-take arrangements (compost, RDF, recycled plastic), and measurable indicators for SDG 11.6.1 reporting and GFC star ratings.

Step 5: Monitor outcomes and enforce accountability: SBM-U 2.0's mandated ICT-enabled governance tools, route tracking, weighbridge digitisation, the Swachhata app for citizen grievance resolution, and third-party GFC assessments, provide the accountability architecture for sustaining performance after capital investment (MoHUA, 2021).

The Minimum Viable Capability Stack for ULBs: For this delivery chain to become institutional rather than project-driven, each ULB must develop a minimum capability stack, whether in-house or through well-managed contractual support.

- Data and analytics capability is needed to undertake annual SDG 11.6.1 reporting through WaCT and to maintain monthly operational dashboards covering collection efficiency, processing performance, and volumes reaching controlled facilities.
- Contract and performance management capability is essential for designing, monitoring, and enforcing service-level agreements across collection, transport, processing, and disposal functions, with a shift from input-based to outcome-oriented contracting.
- Regulatory compliance capability is required to track adherence to the Solid Waste Management Rules, assess whether facilities meet basic, improved, or full control standards, and monitor compliance under EPR-linked arrangements.
- Inclusion and livelihoods capability is critical for integrating informal waste workers into formal systems, including through registration, contracting, and integration into dry waste collection centres (DWCCs),

alongside occupational safety and social-protection measures consistent with Waste Wise Cities principles (UN-Habitat, WaCT).

- Digital governance capability is necessary to support route tracking, weighbridge digitisation, grievance closure, and operations monitoring, all of which are increasingly expected under SBM-U 2.0-funded systems (MoHUA, 2021).

Linking MSW Outcomes to ULB Financial Strengthening: In line with the broader agenda of strengthening ULB finances, circular municipal solid waste reform should be framed not only as an environmental obligation, but also as a fiscal and creditworthiness strategy.

Cost reduction through efficiency: Higher collection efficiency, source segregation, and processing reduce landfill costs, transport expenses, and remediation liabilities, directly improving ULB operating balances.

Revenue generation: Compost from organic waste, RDF for cement kilns, and plastic credits under EPR frameworks generate user-fee and off-take revenues that improve project financial viability and reduce dependence on central transfers.

De-risking investment: Transparent, standardised WaCT data, comparable across cities, improves lender confidence (HUDCO, development finance institutions) by demonstrating that project assumptions rest on validated, SDG-compliant baselines. This is a prerequisite for blended finance and bond issuance by ULBs.

15th Finance Commission leverage: The 60% tied grant component explicitly includes SWM as a national priority. ULBs with WaCT-validated baselines, CSWAP action plans, and GFC star-rating trajectories are better positioned to justify and absorb these grants than those without evidence-based programming (Department of Expenditure, 2021).

Way Forward: A Phased 2047 Roadmap for Circular, Garbage-Free Cities

To achieve Viksit Bharat @2047 in the MSW sector, this paper recommends a three-phase roadmap that builds institutional capacity progressively while delivering measurable outcomes at each stage. Anchored in SDG 11.6.1 baselines and aligned with national policy priorities, the roadmap sequences reform from foundational service delivery to advanced circularity

Phase I (2026–2030) - Universal service fundamentals and data integrity: The first phase focuses on establishing the basic conditions of an effective citywide waste system. Here, universal service fundamentals refer to reliable door-to-door collection of segregated waste, weighbridge-based accounting, routine data generation, and the elimination of open dumping and open burning hotspots.

Priority actions include: institutionalising annual WaCT assessments for SDG 11.6.1 reporting, ensuring stable citywide segregated collection and credible waste accounting, and identifying and eliminating open dumping and burning hotspots through rapid WFD-based leakage assessments. Key tools in this phase are WaCT, WFD, and SBM-U digital systems.

Phase II (2030–2040) - Circular recovery and controlled facilities: The second phase shifts from basic service provision to the expansion of recovery systems and the universalisation of controlled treatment and disposal facilities. The focus should be on operational performance, not merely infrastructure creation. Priority actions include: expanding MRFs, composting, bio-methanation, and RDF systems where appropriate, ensuring facilities meet basic, improved, and full control standards in practice, and using outcome-based contracts and monitoring systems, supported by SBM-U-style protocols, to sustain performance.

Phase III (2040–2047) - Near-zero leakage and materials management: The final phase moves cities from conventional waste management to materials management, with the aim of minimising leakage and maximising value recovery. Priority actions include: strengthening design incentives, segregation quality, and end-markets for recovered materials, reducing unmanaged waste and

plastic leakage into drains and water bodies through continuous WFD-style diagnostics and corrective action, and embedding waste governance within a standing municipal performance system linked to SDG reporting and national protocols. Overall, the proposed roadmap offers a practical pathway for cities to move from basic service coverage and data reliability to controlled systems and, ultimately, to a high-value circular urban economy by 2047.

Conclusion

Urban Local Bodies are the institutional bedrock on which India's Viksit Bharat @2047 vision must ultimately stand. In the domain of municipal solid waste, the transition from a linear, disposal-oriented system to a circular, resource-efficient economy is not primarily a capital challenge, it is a governance, data, and capacity challenge. UN-Habitat's Waste Wise Cities Tool (WaCT), anchored in SDG 11.6.1, and the complementary Waste Flow Diagram (WFD) methodology provide precisely the evidence architecture needed to convert this governance challenge into a structured, investable, and accountable development programme. Aligned with SBM-U 2.0's outcome-based governance architecture, the National Resource Efficiency Framework, and the 15th Finance Commission's tied-grant provisions, this approach offers a replicable, scalable, and nationally anchored pathway for ULBs of every size and capacity to progress toward garbage-free, circular, climate-resilient cities by 2047.

WaCT Framework

The Waste Wise Cities framework developed by UN-Habitat provides a concise conceptual anchor for strengthening municipal waste governance and guiding the capability stack required within Urban Local Bodies (ULBs). The framework is built around three operational principles:

- **Universal Collection:** Ensuring reliable waste collection services for all residents, including informal and underserved settlements.
- **Environmentally Controlled Treatment and Disposal:** Managing waste through regulated facilities that support segregation, recovery, recycling, and scientifically managed landfills.
- **Prevention of Waste Leakage:** Minimising the escape of waste into rivers, drains, land, and marine ecosystems through improved infrastructure and governance.

Together, these principles establish a practical benchmark for cities to assess service coverage, environmental performance, and institutional capacity in advancing circular and sustainable urban waste systems.

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URBAN SYMBIOTIC RESOURCE RELATIONSHIPS OF DATA CENTRES AND SEMICONDUCTOR FACILITIES FOR VIKSIT BHARAT 2047

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Introduction

The global economy is undergoing a rapid structural transformation driven by advances in Artificial Intelligence (AI), cloud computing, digital governance, fintech innovation, and the expansion of internet-based services. Semiconductors enable computation and data processing in electronic systems are essential components of processors, memory, and communication devices. Whereas the Data Centres (DCs) enable the storage, processing, and transmission of growing data volumes (Tripathi et al., 2026), together, they form the foundation of modern digital infrastructure, supporting advances in computing, AI, and telecommunications (Varas et al., 2021). This growing synergy necessitates increasing the establishment of DCs and Semiconductor Fabrication Facilities (SFF), in and around cities, consequently influencing both the tech industry and urban management aspects. Establishing DCs and SFFs in urban catchments is also driven by cities providing specialised workforce, financial incentives to anchor local tech ecosystem, and proximity to end users.

DCs are inherently energy intensive, requiring continuous power and sophisticated cooling systems. Global DC electricity consumption reached 415 TWh in 2024, accounting for 1.5% of global electricity demand, with an annual growth rate of ~12% since 2017. Projections indicate consumption may exceed 945 TWh by 2030 (International Energy Agency (2024). India mirrors this trajectory: electricity demand from the DC sector, is expected to reach ~13.56 GW by 2031–32 (The Economic Times (2026).), emerging as one of the fastest-growing DC markets globally, with capacity expanding from 375 MW in 2020 to ~1,500 MW by 2025 and projected to each 6.5 GW by 2030. Parallel to this, India's semiconductor sector is also accelerating rapidly, with the domestic chip market expected to reach USD 100–110 billion by 2030, supported by the ₹76,000 crore India Semiconductor Mission and the approval of six major units between 2023 and 2025 (GoI, 2026).

Energy, water, land, and materials have become limiting resources in dense urban–industrial systems, creating opportunities for cross-sector resource exchange where one system's waste becomes another's input (Figure 1). Aligning with national Resource Efficiency initiatives, this study locates DCs and SFFs within broader urban ecosystems to highlight interdependencies and enable their transition toward resilient, symbiotic infrastructure. In resource-constrained India, such integrated approaches are critical to advancing long-term development goals under Viksit Bharat 2047 (GoI., 2025; Tripathi et al., 2026).

Resource Intensity and Emerging Symbiotic Pathways in Data Centres and Semiconductor Fabs with their city ecosystem

The resource consumption pressures through DCs and SFFs on city-regions are high in Mumbai, Chennai, Hyderabad, Bengaluru, and the Delhi NCR, that collectively host nearly 90% of India's total data-centre capacity, with Mumbai alone accounting for 53% as of 2025 (CBRE, 2025). Notably, these same city areas are among India's water-stressed cities. However, this spatial concentration also creates opportunities for circular and symbiotic resource flows among water, energy, land, and infrastructure systems located within proximity. Such resource optimisation measures not only reduce waste generation but also reduce the burden of resource extraction for infrastructure.

Potential Symbiotic Resource Exchange from DCs: DCs are closely integrated with the urban ecosystem, relying on the city's infrastructure for uninterrupted, high-quality power, sufficient water for cooling, and effective drainage systems. In turn, DCs generate recoverable resources such as waste heat that can support district heating or cooling, and opportunities for sludge drying, and can utilise treated wastewater as an alternative cooling source (Figure 2).

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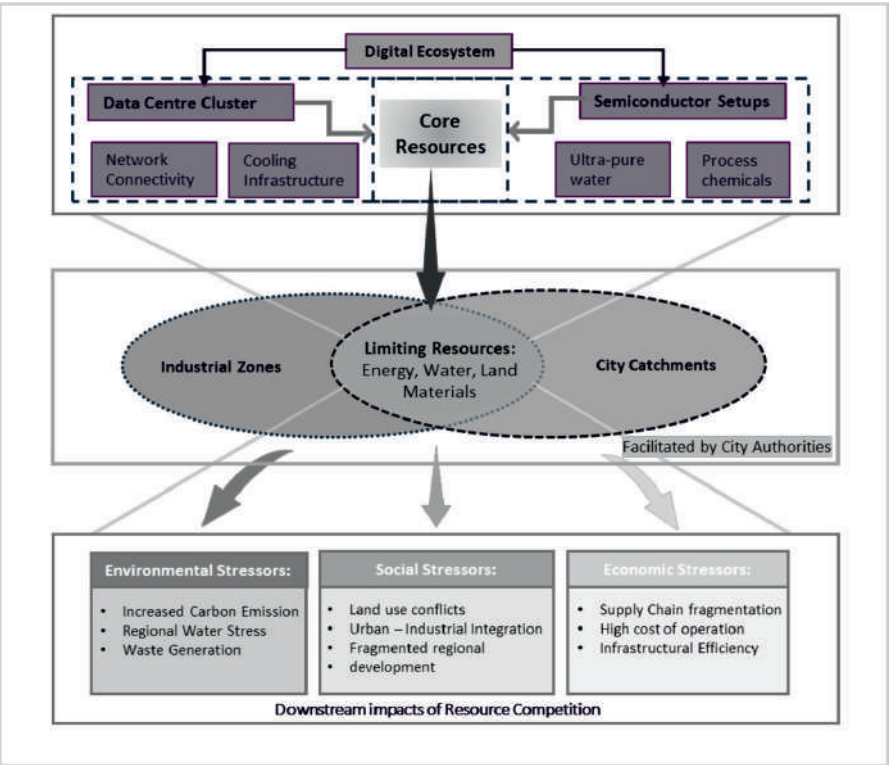

Figure 1: Shared Resource Constraints and Sustainability Trade-offs in the Digital Ecosystem

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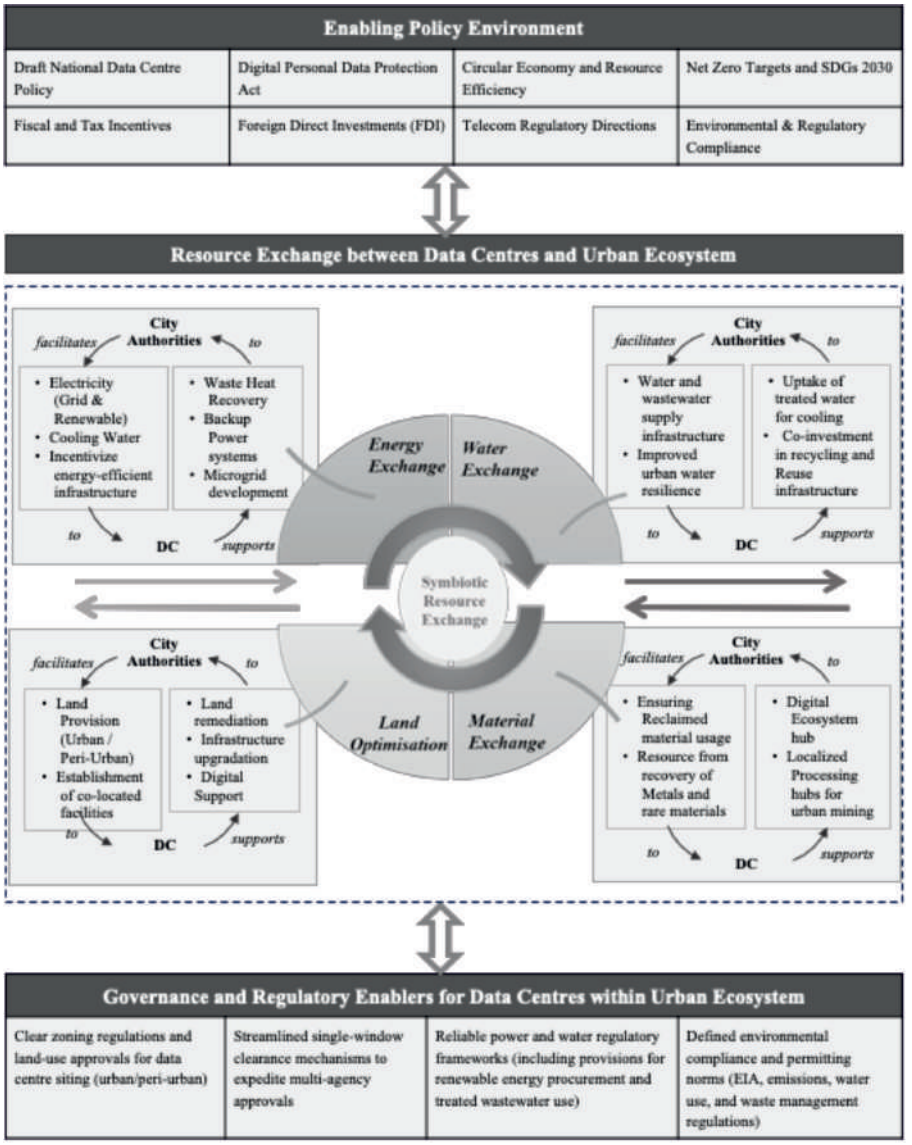

Figure 2: Potential Symbiotic Exchange of DCs with City Ecosystem

Energy Symbiotic Exchange with City Ecosystem:

DCs electricity demand in India is projected to increase from approximately 1% of national electricity consumption today to nearly 3% by 2030 (IEEFA, 2025), placing significant pressure on grid stability, renewable energy integration, and national carbon mitigation pathways. In metropolitan regions with inconsistent grid quality, DC operators often rely on diesel-based backup generators, heightening air pollution risks, carbon emissions, and local environmental impacts. The emergence of AI oriented DCs, which require high-density compute clusters and advanced cooling systems, further intensifies these challenges and has been explicitly highlighted in Budget 2026–27 infrastructure assessments (PIB, 2026). Addressing these challenges requires renewable-energy integration, reliable 24/7 power, and dual-supply systems to enhance resilience and circularity. At the same time, DCs can support urban energy symbiosis by supplying recoverable waste heat for district heating/cooling, industrial use, healthcare, and adsorption-based cooling.

Rising energy demand creates opportunities for collaborative, circular solutions, with Urban Local Bodies (ULBs) playing a key role through renewable Power Purchase Agreements, demand-response, and grid-stability partnerships to enhance resilience and decarbonisation (Tripathi et al., 2026). In countries such as Finland, Denmark, and the Netherlands, DC waste heat is reused for district heating and cooling, low-temperature industrial processes, and hot-water supply in cities.

Water Circularity Symbiotic Exchange:

Water scarcity has emerged as the primary constraint to digital expansion in India, given that most hubs are in water-stressed metropolitan areas. India's DCs currently consume ~150 billion litres of water annually, with demand projected to double by 2030, underscoring the urgency for water-efficient cooling and integrated resource planning (Mordor Intelligence, 2025). Modern DCs that handle high computational loads, generate more heat and require liquid cooling. Water is commonly used, with cooling towers dissipating heat and make-up water compensating for evaporation losses. Typically, cooling a 100-MW hyperscale facility can take ~2 million litres of water per day (Tripathi et al., 2026).

Considering water as a common and limited resource, ULBs hold significant potential to advance water circularity by supplying treated wastewater from municipal STPs for DC cooling, while DC waste heat can be utilised for sludge drying and other thermal processes. This approach is already reflected in practice, with Amazon Web Services using 100% reclaimed wastewater in a closed-loop system to cool over 20 data centres in Virginia and California, where water is continuously reused after reprocessing (DCD, 2023), drastically cutting the use of municipal fresh water. This exemplifies how one industry's waste stream can supply another's needs, yet despite this strong synergy, DC–ULB water symbiosis remains largely underutilised.

Materials and E-Waste Exchange:

DCs generate concentrated, high-value e-waste streams due to short server refresh cycles and large volumes of power equipment, positioning them as practical anchors for urban mining. Globally, 62 million tonnes of e-waste generated in 2022 contained ~US$91 billion in recoverable metals, with server and PCB components exhibiting gold concentrations multiple times higher than natural ores, alongside substantial copper, aluminium, and rare-earth content (Baldé et al., 2024; Patel, 2024).

A practical example is Microsoft's Circular Centre's e-waste management, where end-of-life servers, storage devices, batteries, and power equipment are systematically disassembled, refurbished, or routed for high-grade material recovery rather than bulk recycling or disposal. In India, National Resource Efficiency and Circular Economy initiatives also emphasise strengthening secondary materials markets, expanding modern recycling ecosystems, and supporting policies for the recycling of

electronic and electrical waste. By embedding circular-economy operations directly within major digital hubs, the digital ecosystem can function as localised aggregation and processing hubs for urban mining, reducing material leakage while supplying secondary metals back into manufacturing supply chains (Microsoft, 2025; Craske, 2026).

Land Optimisation:

DCs require large, contiguous, infrastructure-ready land parcels with access to high voltage substations and fibre networks. Land scarcity, zoning restrictions, and lengthy approval processes, primarily overseen by ULBs, pose significant development hurdles. Presently, India hosts ~271 DCs, ranking seventh globally, with a landscape concentrated in Mumbai, Chennai, Hyderabad, Pune, and Delhi NCR due to robust network connectivity, submarine cable access, and strong enterprise demand (IBEF., 2025). Although trends such as edge computing may enable more geographically distributed DC deployment, many existing DCs remain located in water stressed regions, raising long-term sustainability concerns.

Optimising land use for DCs requires careful site selection based on climate risks, connectivity, and scalability, alongside assessment of environmental and infrastructural suitability. Integrating these factors through spatial planning, co-location, and circular resource use is essential for sustainable scaling.

Resource Symbiotic Exchange of Semiconductor Fabrication Facilities (SFF)

As illustrated in Figure 3, SFF is characterised by substantial resource inflows, including high energy demand, ultrapure silicon wafers, large volumes of ultrapure water, and a wide array of specialised process chemicals used in wafer cleaning, oxide removal, photolithography, and etching (Wang et al., 2023). The process simultaneously generates significant hazardous waste streams, greenhouse gas emissions, and metal laden sludge, necessitating rigorous handling and integration into chemical recovery and recycling systems to reduce environmental burdens (Noman et al., 2024b). SFF's high water intensity further compounds these challenges: producing 1 L of ultrapure water typically requires 1.4–1.6 L of source water, raising acute water-security concerns in regions that host semiconductor clusters (World Economic Forum, 2024).

Wastewater management thus emerges as a critical environmental and operational constraint, given

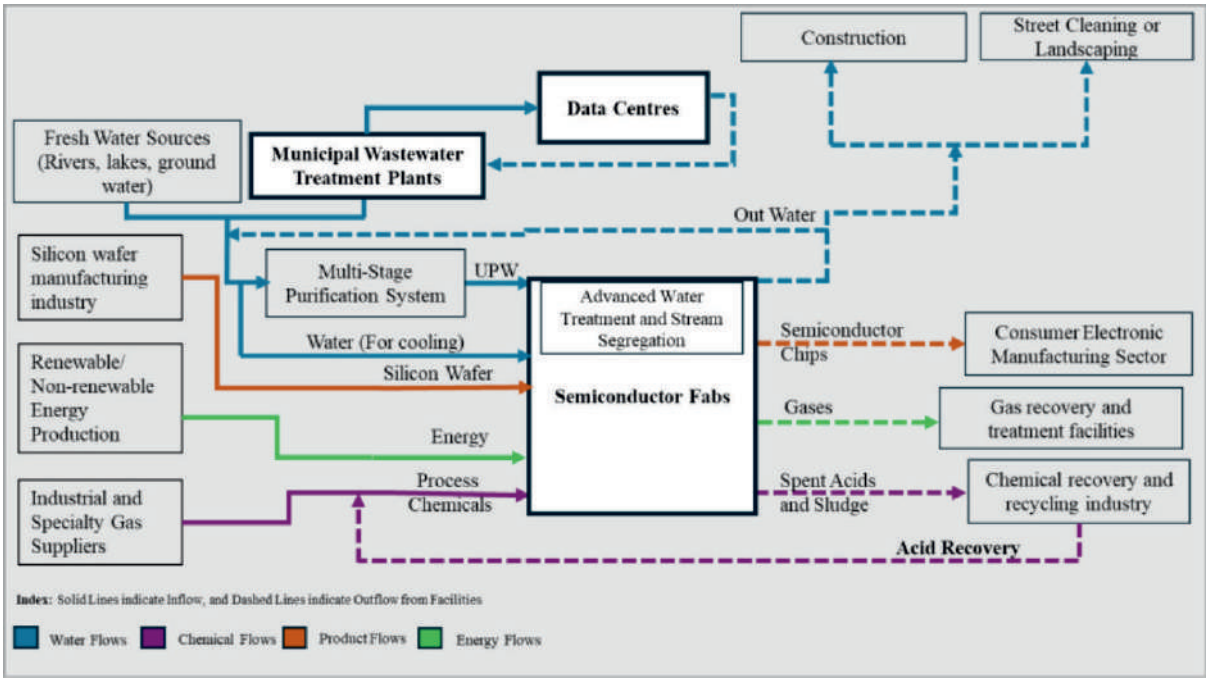

Figure 3 : Material flows and potential symbiotic exchange of SFF and DCs

the extensive use of ultrapure water and chemically diverse effluents generated during wafer fabrication. Improving resource efficiency requires coordinated strategies such as source segregation, advanced treatment, and closed-loop recycling. As depicted in Figure 3, the integration of advanced treatment systems with membrane-based filtration has enabled water-reuse rates of up to 81% (Semiconductor Industry Association, 2021) and, in some cases, has reduced freshwater withdrawals to near zero through comprehensive wastewater reclamation (Micron Technology, 2023; TSMC, 2023). Beyond internal recycling, urban–industrial water symbiosis provides an additional route to reduce freshwater dependence, especially in water-stressed manufacturing zones. Collaborations can significantly enhance water resilience, while simultaneously supporting advanced manufacturing, for instance, Intel's partnership with the City of Chandler, Arizona, where the municipality supplies high-quality recycled water for cooling and fabrication (WaterWorld, 2025). Similar circular-water strategies in India's semiconductor ecosystem could significantly cut freshwater extraction in stressed regions, improve resilience and deliver economic benefits. Simultaneously, SFFs require large, strategically located, seismically stable land parcels with reliable utilities and buffer zones, intensifying land pressures in industrial clusters (John VerWey, 2021). ULBs therefore need to align national and regional spatial frameworks to secure climate-resilient land with grid readiness and proximity to treated wastewater sources. This integrated approach is visible in planned hubs such as Dholera SIR in Gujarat, where land allocation is tied to bulk power and wastewater-reuse systems, and in data-centre and electronics policies in Telangana and Tamil Nadu that promote siting near STPs, renewable-energy hubs, and utility corridors (Government of Gujarat, 2026; Government of Telangana, 2024; Government of Tamil Nadu, 2021). These examples signal a shift from ad-hoc siting to planned, resource-aware land allocation, though implementation remains uneven across urban regions.

City Ecosystem as System-Level Resource Flow Enablers

ULBs play a central role in governing resource management for SFFs and DCs, facilitating integrated resource flows while enabling the digital ecosystem through approvals, land allotment, and provision of water, power, and environmental clearances (Dhoot, 2026). ULBs with their comprehensive oversight of existing and planned infrastructural development, are strategically positioned to enable symbiotic resource-sharing mechanisms. As illustrated in Table 1, several examples already demonstrate symbiotic interactions between select DC operators and ULBs in India.

Similarly, supported by national incentives such as India Semiconductor Mission, semiconductor manufacturing in India is also gathering momentum. Table 2 highlights how DC operators leverage public infrastructure to draw on urban resource inputs while generating co-benefits for city systems, enhancing social and community outcomes—collectively conceptualised as 'Urban Resource Integration and Co-benefits'. Overall, Tables 1 and 2 illustrate how the digital ecosystem contributes capital, technology, and skilled employment, strengthening regional economies while highlighting urban resource integration and co-benefits between ULBs and semiconductor facilities.

Table 1: Urban Resource Interactions and Co-benefits across Data Centre Infrastructure

Facility	ULB-Facilitated Policy Support	Urban Resource Integration and Co-benefits
STT GDC India Data Centre - Chennai 2 (Ambattur Campus) Capacity: 25.5MW (IT load) **Other Campuses:** Chennai • Mumbai • Pune • Noida • Delhi • Bengaluru • Hyderabad • Ahmedabad • Kolkata • Jaipur	***The Chennai Metropolitan Development Authority*** support (under **the *Tamil Nadu Data Centre Policy)*** ▪ Dual power from grid ▪ Up to 50% power supply augmentation (via TANGEDCO) ▪ 100% electricity tax waiver (for 5 years) ▪ Land cost subsidy and stamp duty exemption	▪ 60% energy from green power (including 250 kW onsite solar ▪ Rainwater harvesting & treated water reuse ▪ Advanced systems: hybrid cooling, RO reuse, high-TDS recycling, WUE monitoring ▪ Zero Liquid Discharge. **STT GDC (across campuses):** ▪ Upskilling rural youth in data centre operations ▪ Tribal farmer support (Lakhpati Kisan program benefitting1600+ households) ▪ ESG governance, policy advocacy & industry collaboration
Yotta Data Centres India - Navi Mumbai Campus Capacity: 52 MW (IT Load); 7000+ racks **Other Campuses:** Greater Noida • Delhi NCR • Gujarat	***Panvel Municipal Corporation*** support (under the ***Maharashtra IT/ITES Policy***) " ▪ Faster permissions through Single Window System (SWS) ▪ Partial IT Park space utilization ▪ Industrial land allocation	▪ Dual feed 110/33 kV substation (Khopoli & Chembur) ▪ Moving toward 100% renewable operations (solar/wind; future hydrogen) ▪ Lithium-ion UPS (NM1) for efficient, long-duration backup **Yotta (across campuses):** ▪ Community outreach (Eg: Yotta Riders Club's visits to orphanages) ▪ Donations to bridge the digital divide ▪ ESG Charter guiding environmental & social commitments
Nxtra by Airtel - Noida- Sec 62 (NCR 1) Capacity: 4.5 MW (IT load); 1250 racks **Other Campuses:** Noida • Pune • Chennai • Mumbai • Manesar • Bhubaneshwar • Bengaluru • Hyderabad	***New Okhla Industrial Development Authority*** support (under the ***Uttar Pradesh Data Centre Policy***): ▪ 100% exemption on stamp duty on first transaction of land and 50% exemption on second transaction ▪ 100% exemption on electricity duty (10 years) ▪ Dual Power Grid availability ▪ Open access availability ▪ Capital and land subsidy	Across campuses (FY25): ▪ PUE ↓ 10% (from the FY21 baseline ▪ 49% of energy from renewables ▪ 13,488 KL water recycled. ▪ Hazardous waste safely managed ▪ 1,411 tonnes waste recycled. **Nxtra (across campuses, FY25):** ▪ Employee engagement: 85/100 ▪ Gender diversity ↑ 2.3× ▪ CSR spend: ₹61 million ▪ Impact: 1.25 lakh beneficiaries across 27 schools
CtrlS Datacentre India – Kolkata Capacity: 16 MW IT Load; 1137 racks **Other Campuses:** Navi Mumbai • Chennai (Ambattur) • Hyderabad • Noida • Bengaluru	***New Town Kolkata Development Authority*** support (through the ***West Bengal Data Centre Policy)***: ▪ 100% stamp duty exemption ▪ Dual Power Grid availability ▪ fuel subsidy (for backup power) ▪ 24X7 uninterrupted and high-speed water supply	▪ Dual power sources (N+N active feeds) ▪ DG Backup 48hrs (N+N redundancy) ▪ UPS (N+N Redundancy). ▪ Green grid-linked cooling and infrastructure ▪ Renewable energy integration ▪ E-waste reduced through circular models ▪ Water recycling to address scarcity **CtrlS (across campuses):** ▪ Paperless operations → 500,000 trees saved

Facility	ULB-Facilitated Policy Support	Urban Resource Integration and Co-benefits
		▪ Carbon reduction – equivalent to 149,172 cars over 900 days)
AdaniConneX Hyperscale Data Centre – Hyderabad (under development) Potential Capacity: 600 MW (IT Load) **Other Campuses:** Chennai • Navi Mumbai • Noida • Pune	***Hyderabad Metropolitan Development Authority*** support (under the ***Telangana Data Centre Policy***): ▪ 50% building fee rebate ▪ Land subsidy & 25% lease subsidy (upto ₹5 lakh for 3 years) ▪ Dual-grid power ▪ Renewable open access ▪ Patent reimbursement (₹2–10 lakh) ▪ R&D grants	▪ Up to 100% renewable energy ▪ Treated water reuse & rainwater harvesting Reduced water–energy intensity (innovation-driven) ▪ Air-cooled chillers & water-efficient free-cooling (reclaimed water) **AdaniConneX (across campuses):** ▪ Community programmes such as Udan and SuPosan, implemented by the Adani Foundation ▪ Focus – community empowerment & social infrastructure strengthening.
NTT - Bengaluru 3 Capacity: 12MW (IT load); 2500 racks **Other Campuses:** Bengaluru • Mumbai • Delhi NCR • Chennai	***Bruhat Bengaluru Mahanagara Palike*** support (under ***the Karnataka Data Centre Policy***): ▪ Dual grid power supply ▪ Land and capital subsidy ▪ 100% exemption from electricity duty (for 5 years) ▪ 100% land conversion fee exemption ▪ 100% exemption from stamp duty (upto 10 acres)	▪ Express BESCOM feeders to a 66 kV substation ▪ 3–15 kVA power options ▪ Isolation-transformer PDUs ▪ N+N UPS battery backup ▪ N+2 redundancy (transformers & generators) **Across global campuses:** ▪ Biodiversity protection & pollinator habitats ▪ Recycling, refill stations & scrap upcycling ▪ Sustainable campaigns (fashion, reusable tableware) ▪ Tree planting & coastal cleanups ▪ E-waste: 1,678 kg collected ▪ Digital cleanup: 1.83 TB

Source: STT GDC India (2026); Sheth (2024); Nxtra by Airtel (2025); CtrlS DataCentres (2026); AdaniConneX (2026); NTT Data Centres (2026); NTT DATA (2025); Cushman & Wakefield (2025)

Table 2: Urban Resource Interactions and Co-benefits across Semiconductor Infrastructure

Facility	ULB-Facilitated Policy Support	Co-benefits
Tata Electronics (TEPL) in partnership with Powerchip Semiconductor Manufacturing Corp (PSMC) of Taiwan - Dholera, Gujarat **(Project Implementation Phase)** Capacity: 50,000 wafers/month	***Dholera Special Investment Region Development Authority***, under the ***Dholera SIR framework***, support (through the ***Gujarat Semiconductor Policy***) ▪ 40% capital subsidy ▪ ₹2/unit power and ₹12/m³ water subsidy ▪ Up to 75% land subsidy on first 200 acres (Dholera) ▪ Uninterrupted power and water supply	▪ Potential: 20,000 direct & indirect skilled jobs ▪ Strengthens supply chain ("Make in India, For the World") ▪ Strong connectivity: airport, roads, water & wastewater, underground power, smart ICT ▪ Investments in infrastructure: 100 MLD water pipeline & bulk network (Dholera SIR)
Micron Semiconductor ATMP Facility - Sanand Gujarat **(Project Implementation Phase)** Capacity: Sanand ATMP plant will assemble, test, package DRAM and		▪ Transitioning to carbon-free electricity ▪ Advanced water-saving tech → Zero Liquid Discharge ▪ Across global operations: ▪ Scope 1 emissions ↓ 16% (since 2020) ▪ Water conservation ↑ 66%

Facility	ULB-Facilitated Policy Support	Co-benefits
NAND memory; tens of millions shipped in 2026, scaling in 2027.	***Gujarat Government*** and ***Sanand Nagarpalika*** (through the ***India Semiconductor Mission*** and the ***Gujarat Semiconductor Policy)***	▪ 95% reuse & recycling; zero hazardous waste to landfill ▪ CSR: community support, equity, STEM access & careers
Kaynes Semicon Pvt Ltd – Sanand, Gujarat **(Early Development Stage)** Capacity: 6.33 million chips/day		▪ Across campuses, Kaynes focuses on: ▪ Biodiversity protection ▪ Energy & water conservation ▪ Waste Management ▪ ESG alignment & community engagement ▪ Continuous improvement & innovation
Tata Semiconductor Assembly & Test (TSAT) - Morigaon, Assam **(Project Implementation Phase)** Capacity: Designed to produce 40 million chips per day	***Morigaon Municipal Board*** (under the ***Assam Electronics (Semiconductor etc.) Policy)*** ▪ 40% Capex subsidy & 100% stamp duty waiver ▪ 50% power subsidy & ₹5/m³ water (up to 10 years) ▪ SGST refund & 20% payroll support.	▪ Transitioning towards renewable energy ▪ Jobs: 15,000 direct + 13,000 indirect ▪ Strengthens India's semiconductor supply chainCSR focus: • Health & education • Rainwater harvesting • Employability & natural resource conservation
HCLFoxconn JV (India Chip Private Limited) - Jewar, Uttar Pradesh **(Early Development Stage)** Capacity: 20,000 wafers/month; 36 million chips per month	***Yamuna Expressway Industrial Development Authority (under Uttar Pradesh Semiconductor Policy)*** ▪ 50% capital subsidy & 75% land subsidy on the first 200 acres and 30% on additional purchase (ATMP/OSAT) ▪ 100% stamp and electricity duty exemption ▪ 50% transmission charge waiver (25 years)	▪ Expected Requirement: 19,000 kVA power & 2,000 MLD water ▪ Boosts semiconductor self-reliance ▪ Generates significant employment
SiCSem Private Limited - Bhubaneshwar, Odisha **(Early Development Stage)** Production Capacity: 60000 (SiC) wafers annually (5,000 wafers/month) Packaging Capacity: 96 million units annually (8 million units/month)	***Odisha Govt.*** and ***Bhubaneswar Municipal Corporation*** (under ***Odisha Semicon Fabless Policy)*** ▪ 30% of the Overall Project Capex ▪ 100% exemption of stamp duty ▪ 100% exemption of electricity for 10 years ▪ SGST reimbursement ***IDCO (Industrial Infrastructure Development Corporation)*** provides land at subsidized IPR rates.	▪ Renewable energy integration ▪ Strengthens supply chains across key sectors: EVs, railways, data centres, renewables, smart grids, industrial automotive ▪ Expected to create over 1000 direct and several thousands of indirect jobs.

Sources: Tata Electronics (2024); Micron Technology (2024;2026); Kaynes Technology (2024); Press Information Bureau (2024a); Press Information Bureau (2024b); Times of India (2026); Odisha Government (2023)

Strategic Pathways for Advancing Digital Sectoral Symbiotic Exchanges

Circular resource management in the digital ecosystem offers environmental and economic benefits but depends on urban systems supplying water, energy, land, and waste services, positioning ULBs as key coordinators of infrastructure, regulation, and resource flows. As India's DC and SFF sectors expand, there is an opportunity to mitigate risks while creating opportunities for symbiotic, circular, and resilient urban-industrial ecosystems, enabled through systems-level planning, innovation, and institutional collaboration, as described in this section.

Embed Resource Exchange and Circular Economy Principles into National Digital Infrastructure Strategy:

This study underscores that water, land and materials form critical resource systems whose pressures are deeply amplified by DC and SFF operations. A national framework should therefore embed resource exchange diagnostics into the planning, siting, design, and operation of new facilities. This includes:

- Enhance resource efficiency by ensuring material recirculation plans and minimising linear resource flows.
- Encouraging state governments to harmonise land-use regulations, environmental permitting, and utility provisioning with national resilience objectives.
- Integrating technology solution roadmaps that combine closed-loop water systems and heat recovery mechanisms, particularly for SFFs where wastewater streams contain heavy metals, fluorides, acids, and alkalis, necessitating controlled discharge and continuous makeup water loops.

Institutionalising these requirements would support long term infrastructure resilience and reduce systemic exposure to water scarcity, energy volatility, and climate driven disruptions.

Advance Industrial Symbiosis for Material Exchange: DCs and SFFs produce high quality, recoverable resource streams that can serve as productive inputs for urban and industrial systems. To unlock this potential, the following symbiotic pathways should be prioritised:

Water Symbiosis:

- Establish long term agreements between ULBs and industry for the supply of treated sewage effluent for DC cooling and SFF processes.
- Co-invest in tertiary wastewater treatment systems where municipal infrastructure requires upgrading.
- Promote shared industrial water grids enabling reclaimed water exchange between DCs and municipal utilities.
- DCs can support in providing waste heat for sludge drying in STPs.
- Mandating closed loop water systems and Zero Liquid Discharge aligned recycling frameworks within SFFs, supported by advanced membrane technologies and oxidation processes, including cascading reuse within SFF utility loops to minimise freshwater intake.
- Use of intelligent automated water management systems using real-time monitoring and control through digital twins to optimise water reuse and discharge cycles.

Materials Symbiosis:

- Develop urban mining hubs in major DC and semiconductor clusters, enabling co-located recovery of copper, aluminium, gold, rare earths, and critical metals from e-waste.
- Integrate recovered materials like SFF equipment, process residues, and high-value scraps into domestic electronics manufacturing, reducing import dependency and strengthening circular supply chains.

Integrate Siting, Spatial Planning, and Urban Infrastructure Coordination:

- Integrate DC and semiconductor zones into regional spatial frameworks, ensuring alignment with water availability, climate risk maps, and renewable energy corridors, while accounting for fab-specific requirements such as vibration-free zones, buffer areas, and utility

redundancy. Prioritise siting in planned technology parks that offer pre-provisioned utilities, dual grid systems, and access to treated wastewater pipelines.

- Strengthen coordination across ULBs, development authorities, and utilities to eliminate fragmented approvals and reduce project delays, while linking DCs and SFFs with nearby industrial clusters and municipal systems to maximise resource exchange efficiency.

This will support climate resilient urban development while mitigating regional resource conflicts.

Foster Multi Level Governance, Data Transparency, and Long-Term Sectoral Coordination:

Achieving a sustainable digital industrial ecosystem requires coordinated governance across national ministries, state governments, ULBs, and industry actors. Priority actions include:

- Introducing mandatory disclosure of Power Usage Effectiveness (PUE), Water Usage Effectiveness (WUE), Carbon Usage Effectiveness (CUE), heat reuse levels, and water sourcing patterns to enhance sector wide transparency, alongside fab-specific metrics such as UPW recovery rates and process energy intensity.
- Establishing a national-state coordination platform to harmonise renewable procurement rules, wastewater reuse regulations, and circular economy compliance requirements.
- Designing long term training, certification, and capacity building programmes for ULBs and industry personnel on circular water management, e-waste handling, resource nexus planning, and heat recovery design.
- Promoting adoption of advanced intelligent automation systems, including site-level digital twins, to enable real-time optimisation of energy, water, and heat flows across facilities and grids, alongside deployment of advanced cooling technologies such as liquid cooling systems in line with ASHRAE guidelines, and energy management practices including demand response and grid-interactive operations.
- Building smarter factories, using smarter machines, promoting fab-level automation, integrating advanced real time analytics, and using energy-efficient cleanroom operations (e.g., VFD-based cooling systems) to reduce energy intensity while improving operational throughput.

Conclusion

India's pursuit of digital transformation under the vision of Viksit Bharat 2047 is increasingly anchored in the rapid expansion of DCs and SFFs, both of which represent a new, resource intensive typology of urban adjacent infrastructure. While these sectors are indispensable, their high demands for resources pose significant sustainability and governance challenges, particularly in water stressed and energy constrained city regions in India. This study underscores the need to go beyond facility level efficiency measures towards an integrated systems-based approach focused on industrial symbiosis and circular infrastructure within city catchments. It advocates that technological solutions such as advanced water recycling, waste heat recovery, intelligent automation, and digital twins are most effective when embedded within an ecosystem-scale framework, particularly through an emphasis on municipal wastewater treatment plants, SFFs, and DCs. In this context, ULBs emerge as a key institutional actor in enabling the transition through regulatory measures and facilitating resource flows between the facilities.

Upscaling the role and techno-managerial capacities of ULBs is critical for managing high-precision utilities and enabling rapid regulatory responses to large-scale digital and industrial transformations. This will assist in effective planning and operations of DCs and SFFs, shifting them from resource intensive enclaves to active contributors to urban sustainability. Embedding the industry within resilient, circular urban systems is essential to ensure that India's digital growth remains environmentally sustainable, economically inclusive and socially equitable.

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Indore's Journey from Waste to Green Energy

The Indore Municipal Corporation has positioned itself as a pioneer by establishing Asia's largest municipal waste-to-energy facility under the Galvanizing Organic Bio-Agro Resources Dhan (GOBARdhan) initiative. This state-of-the-art plant stands as a benchmark for converting municipal organic waste into valuable, sustainable resource.

The facility operates through a sophisticated integration of advanced technology and skilled human effort. Dedicated teams collect segregated organic waste from households and markets across the city, while specialised machinery processes this material, breaking it down and converting it into cleaner alternatives to conventional fossil fuels. Capable of handling a diverse range of organic inputs, such as kitchen waste, agricultural residues, and animal manure—the plant produces approximately 17,000 kilograms of environmentally friendly bio-CNG and 100 tonnes of high-quality compost daily.

This pioneering initiative substantially contributes to India's pursuit of a circular economy by maximising resource recovery, reducing waste generation, and aligning with the nation's climate commitments under the Paris Agreement.

Source:https://krishijagran.com/others/indore-s-gobardhan-plant-transforming-waste-into-wealth-through-bio-cng-and-compost-production, https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=152161&ModuleId=3&reg=3&lang=2

BEYOND GREY: THE CASE FOR REVALUING URBAN BLUE-GREEN ASSETS IN INDIAN CITIES

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Abstract

Indian cities are reeling under the stress of climate change-induced extreme weather events coinciding with rapid urbanisation to affect these "growth engines". Urban flooding has emerged as a critical challenge for both - metropolitan cores to rapidly expanding Tier 2 towns. While the traditional policy response has been to expand grey infrastructure like storm-water drains, culverts and pumping systems, these measures alone have been insufficient in preventing repeated flood episodes. This paper argues that a systematically under examined driver of flood vulnerability is the degradation of blue-green infrastructure like lakes, wetlands and vegetated landscapes that have historically functioned as natural flood buffers, absorbing excess rainfall, moderating peak runoff and supporting groundwater recharge. Their decline is not merely ecological but a governance and fiscal failure. In most Indian municipalities, water bodies are recorded at nominal values sometimes as low as one rupee, rendering them invisible within municipal budgeting and planning frameworks. The paper proposes a Green Asset Register (GAR) as the institutional vehicle for correction, operationalised through a Replacement Cost valuation methodology and an Asset Health Index (AHI) that tracks condition and drives maintenance allocation. Rather than substituting grey infrastructure, the paper advocates for a structured complementarity between the two, embedded within municipal finance and climate resilience planning.

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Introduction - Viksit Bharat@2047 and the Climate Stress Test of Indian Cities

Indian cities present a paradox - expanding rapidly, generating economic growth and employment and yet remaining physically fragile to climate shocks. Climate change is reshaping Indian cities - as it affects the economy, infrastructure, service delivery and people's capacity to cope and adapt. In recent years, the trends have become even more concerning as seasonal monsoons have transitioned from months of manageable rainfall into periods of acute hydrological stress for Indian cities. For example in July 2023, Delhi's Yamuna surged to a record 208.66 meters displacing over 25,000 residents. A year later, a 228 mm deluge - the highest in 88 years - brought the capital to a standstill (CWC, 2025). Mumbai experienced similar events in the years 2024 and 2025 - recording 300 mm of rainfall in just six hours, far exceeding its drainage capacity of 25 mm per hour (The Hindu, 2025). Bengaluru's 2022 floods submerged global IT hubs leading to millions in lost productivity while Chennai's Cyclone Michaung in 2023 inflicted heavy economic damages and forced a total shutdown of its international

airport. According to the India Meteorological Department (IMD), the frequency of short-duration high-intensity rainfall events across several Indian regions has increased over the past two decades, a trend consistent with broader climate projections for South Asia (IMD, 2021; IPCC, 2022). These events are the manifestation of a grim climate reality where urban deluges have turned from occasional to annual events.

Increased instances of urban flooding are not merely a sign of seasonal disruption but carry significant economic implications. India's urban centres are the economic engines of the country accounting for more than 60 percent of India's GDP (NITI Aayog, 2021). In the pursuit of the Viksit Bharat@2047 vision, cities are central to sustained economic growth but repetitive flooding episodes undermine this directly. They disrupt transport and supply chains, damage infrastructure, erode investor confidence and deepen urban inequalities. As climate variability intensifies, these risks will compound, requiring us to assess whether the existing urban flood management paradigm is adequate in an era of intensifying climate change?

The Concrete Ceiling: Why Grey Infrastructure Is Reaching Its Limits

Traditionally the response to mitigating urban floods has meant expanding grey infrastructure. Cities typically respond to waterlogging by widening storm-water drains, constructing new culverts or increasing pumping capacity. While these are necessary components of urban flood management and are often grounded in established hydraulic design principles, the effectiveness of these drainage systems depends fundamentally on the broader hydrological behaviour of the urban catchment. In conditions where natural water storage systems such as lakes, wetlands and floodplains are degraded, runoff volumes increase sharply and peak flows reach drainage networks more rapidly. Under these conditions, even well-designed drainage systems struggle to cope.

Take Delhi for example. The city's last drainage master plan was designed in 1976 for 50 mm of rain per day- far below today's rainfall events (Passi et al., 2024). Bengaluru, once called the 'City of Lakes' saw its built-up area expand more than tenfold between 1973 and 2020 (Ramachandra et al., 2021). As wetlands and tanks disappeared and lake systems became fragmented, the city lost much of its capacity to absorb rainfall. The floods of 2022 were not solely an engineering failure. They were the consequence of decades of hydrological transformation.

Reframing the Problem: Making the Case for a Hybrid Shield

The persistence of this problem raises a critical question. **Why have urban blue-green assets received so little attention within mainstream urban infrastructure planning?**

This paper argues that the answer lies partly in the institutional and financial frameworks that govern urban assets. Natural water bodies often occupy an ambiguous position within municipal systems- they are mapped in master plans but poorly integrated into asset management frameworks, maintenance budgets and financial reporting mechanisms. In several cases, lakes transferred from state departments to municipal authorities are recorded in balance sheets at nominal values because reliable historical cost data is unavailable. While administratively convenient, such practices inadvertently signal that these assets hold little financial significance. When an asset appears negligible in fiscal terms it becomes difficult to justify substantial operational expenditure for its maintenance. This results in a cycle of neglect as silt accumulates, water quality deteriorates and storage capacity declines. As water bodies lose their hydrological function, cities become increasingly dependent on engineered drainage solutions further reinforcing the dominance of grey infrastructure. It then proposes a framework anchored in the **Green Asset Register (GAR)**, functional valuation and the Asset Health Index (AHI) through which that invisibility can be corrected.

The Governance Gap: Why Natural Infrastructure Keeps Failing

Urban flooding debates in India tend to focus on the physical performance of drainage infrastructure - undersized, poorly maintained or designed to outdated rainfall assumptions. While valid, these explanations

overlook a deeper institutional dimension i.e. how municipal systems recognise, value and manage the natural assets that historically moderated urban water flows. Unlike roads, bridges or water treatment plants, lakes and wetlands are rarely integrated into asset management systems or infrastructure investment frameworks despite performing critical functions including flood storage, groundwater recharge and microclimate regulation. The result is a structural asymmetry where engineered assets receive routine budgeting, monitoring and maintenance while natural assets do not, eroding their hydrological function with each passing monsoon cycle. Two interrelated factors drive this misalignment 1) a systemic bias toward capital-intensive infrastructure investment and 2) accounting practices that render natural assets financially invisible within municipal balance sheets.

The Build-Neglect-Rebuild Trap

A recurring pattern in Indian urban infrastructure management is the "Build-Neglect-Rebuild" cycle where public systems prioritise the creation of new assets while long-term operation and maintenance remain chronically underfunded. NITI Aayog notes that O&M budgets frequently fall below 1–2 percent of asset value with operational expenditure largely dependent on municipal own-source revenues that remain severely constrained (NITI Aayog, 2021). The World Bank observes that weak revenue bases and limited cost recovery create a persistent maintenance gap even as national programmes like the Smart Cities Mission and AMRUT channel substantial capital into new projects while municipal governments generate less than one percent of national GDP in revenues (World Bank, 2022). Deferred maintenance accelerates deterioration, ultimately forcing reconstruction that can exceed the original capital investment (ORF, 2023).

For natural infrastructure, this cycle is particularly damaging. Governments periodically fund one-time lake rejuvenation projects but desilting, pollution management and catchment regulation require continuous management that is rarely institutionalised in municipal budgets. Many urban lakes consequently follow a predictable arc - restoration through a publicly funded project, gradual degradation through inadequate maintenance and eventual calls for renewed intervention. Lakes in Bengaluru, Hyderabad and Delhi have undergone multiple such cycles over two decades with limited long-term success reflecting a structural failure to treat natural water bodies as long-term infrastructure assets rather than one-time environmental projects.

The CapEx-OpEx Disconnect: How National Funding Architecture Locks Out Maintenance

The structural CapEx bias in India's urban financing architecture is not incidental - it is codified. Across Atal Mission for Rejuvenation and Urban Transformation (AMRUT 1.0) (₹50,000 crore), AMRUT 2.0 (₹2,99,000 crore) and the Smart Cities Mission (₹48,000 crore), central assistance flows exclusively toward capital creation with no dedicated O&M funding stream (Ministry of Urban Development, 2015). The World Bank (2022) found that 14 large Indian cities recovered less than half their water supply O&M costs, performing worse than comparable utilities in Brazil, China, South Africa and Vietnam and so the current design creates assets whose long-term upkeep remains unfunded (Athar et al., 2022).

For green infrastructure, this glitch operates at a deeper level. Engineered assets however underfunded at least appear in Fixed Asset Registers with depreciation schedules that signal deteriorating condition and eventual replacement costs. An urban lake performing equivalent hydrological functions like retaining runoff, recharging groundwater, attenuating flood peaks enters the same register as "land" valued at Re. 1, generating no depreciation signal, triggering no maintenance allocation and sending no fiscal warning as siltation steadily erodes its service capacity. The CapEx-OpEx glitch thus compounds a classification failure wherein central schemes fund the creation of grey infrastructure while the parallel green infrastructure that supplements it remains not merely underfunded but fiscally invisible.

The "Nominal Value" Trap: Analysis of the National Municipal Asset Valuation Methodology Manual

A critical institutional factor reinforcing the neglect of urban natural infrastructure lies in the valuation frameworks used in municipal accounting systems. India's National Municipal Accounts Manual (NMAM) developed to guide urban local bodies in preparing asset registers, allows certain public assets, particularly those that are difficult to monetise or transfer, to be recorded at nominal values such as Re. 1 (Ministry of Urban Development, 2004). This approach is administratively convenient because it enables municipalities to formally list assets whose market value cannot be easily determined.

When applied to ecological infrastructure such as lakes, wetlands and ponds it produces an unintended consequence - these assets become financially invisible within municipal balance sheets regardless of their hydrological significance (Venkatachalam, 2021). Financial visibility materially influences maintenance priorities, capital planning and borrowing capacity. Assets that appear insignificant in fiscal terms are therefore less likely to receive sustained operational funding, not because decision-makers are indifferent to their ecological value but because the finance system offers no mechanism to translate that value into a maintenance obligation.

The NMAM mandates that assets be identified, geo-tagged, categorised and recorded in a Fixed Asset Register (FAR) with infrastructure assets forming a major category (GASAB, 2013; AP MAVMM, 2018). In practice however, municipal governments frequently lack complete records of asset ownership, original construction costs or acquisition dates, and many listed assets cannot be physically verified (ICAI, 2025). Under these circumstances, assets default to a nominal Re. 1 valuation resolving the administrative gap but creating a state of financial dormancy in which assets remain on the books but carry no fiscal weight in budgeting or investment decisions.

Capacity constraints compound the problem. Persistent staff shortages, limited technical expertise and frequent administrative transfers weaken institutional continuity in asset management (ADB, 2013), meaning that once assigned a nominal value, assets rarely undergo revaluation and never receive dedicated maintenance allocations. The structural paradox this produces is significant as assets delivering measurable ecological and hydrological services are formally recognised in municipal accounts but functionally disconnected from the budgeting systems that determine whether those services are sustained. For natural infrastructure, this is not a bureaucratic inconvenience but a mechanism through which fiscal invisibility becomes physical deterioration.

The Cost of Invisibility: From Fiscal Neglect to Flood Exposure

Beyond their ecological value, lakes and wetlands function as distributed hydrological infrastructure that regulate stormwater flows, recharge aquifers and moderate local microclimates (IWMI, 2025). When these systems deteriorate or disappear cities lose a significant portion of their natural capacity to absorb climatic shocks. The consequences are not limited to environmental degradation but extend directly to rising flood exposure, declining water security and intensifying urban heat stress. In this sense, the financial marginalisation of natural infrastructure translates into a deeper form of institutional climate vulnerability. The following subsections examine three pathways through which this occurs: the loss of volumetric retention capacity, the misclassification of water bodies as developable land and the erosion of critical ecological co-benefits.

Lost Capacity: How Cities Are Draining Their Own Flood Buffers

In any urban watershed, incoming rainfall is distributed across four pathways: 1) interception by vegetation, 2) infiltration into soil, 3) storage in water bodies and surface runoff into drains. Drainage systems were never designed to handle 100 per cent of rainfall — they depend on the first three pathways absorbing the bulk of it before water reaches engineered infrastructure. Volumetric retention capacity is the total volume of stormwater a landscape can absorb, detain or

store before it becomes surface runoff that loads the drainage network. As cities urbanise, pervious surfaces are replaced by concrete, natural infiltration diminishes, and an ever-greater proportion of rainfall becomes immediate runoff. When water bodies are simultaneously degraded through encroachment, siltation and neglect, the drainage network faces volumes it was never designed to manage. Urban flooding in India is, at its core, the consequence of this compounding loss of a landscape that has shed its natural absorptive capacity faster than engineered systems have been able to compensate for it.

The Vacant Land Fallacy: How Misclassification Enables Encroachment

Fiscal invisibility contributes directly to administrative misclassification. When lakes and wetlands are not recognised as infrastructure assets, they are frequently treated as vacant or underutilised land within planning frameworks creating incentives for encroachment and redevelopment. Across Indian cities, lakebeds and wetlands have been converted into housing, transport infrastructure and commercial uses. The Pallikaranai Marsh in Chennai has shrunk by nearly 90 percent over several decades, consumed by the IT corridor, residential colonies and a municipal landfill (SANDRP, 2016). The World Resources Institute identifies wetland loss and floodplain encroachment as major drivers of rising urban flood exposure in rapidly growing metropolitan regions (Browder et al., 2019). Such transformations not only reduce water storage capacity but fragment catchment systems, severing the hydrological connectivity between water bodies that makes distributed natural storage effective.

Beyond Flooding: Water Security, Groundwater and Urban Heat

The degradation of urban lakes cascades beyond flood management. Lakes sustain groundwater availability by allowing rainfall to infiltrate gradually into aquifers during the monsoon (Caretta et al., 2022). In Bengaluru, as lake coverage has diminished, the city has become increasingly dependent on long-distance Cauvery transfers and intensive groundwater extraction (Ramachandra et al., 2021). Data from the Central Ground Water Board show that groundwater levels in parts of the metropolitan region have been declining by more than one metre annually.

Urban water bodies also contribute to microclimatic cooling through evaporative processes and associated vegetation. Satellite studies consistently show lower surface temperatures in neighbourhoods adjacent to lakes compared with dense built-up areas. As heatwaves intensify across South Asia, the World Meteorological Organization emphasises the growing importance of blue-green assets in urban climate adaptation (García Sánchez & Govindarajulu, 2023). The disappearance of lakes therefore represents more than an environmental loss. It reflects a structural weakening of the natural systems that support flood resilience, water security, and urban climate stability.

The Fix: Institutionalising the Green Asset Register

Creating a Dedicated Register for Natural Assets

The diagnosis points clearly to the institutional locus of reform - the municipal asset management and accounting framework. Natural blue-green assets are not absent from Indian cities; they are absent from the fiscal architecture that governs how cities allocate maintenance resources. The solution proposed operates at this institutional level, introducing three mutually reinforcing elements - a ***Green Asset Register (GAR)*** as a dedicated supplementary register for natural infrastructure; a ***Replacement Cost*** methodology to move from nominal to functional valuation; and an Asset ***Health Index*** to track asset condition over time.

A Green Asset Register (GAR) is a formal municipal record of natural infrastructure assets like lakes, wetlands, urban forests and permeable green cover that captures not just their existence but their functional contribution to urban water management. Unlike the current default, which records these assets as undifferentiated land at nominal value, a GAR entry records water spread area, estimated storage capacity, ecological condition, ownership and crucially a replacement cost estimate reflecting the engineered infrastructure that would be required to deliver the same service if the natural asset were lost.

The international precedent is instructive. In 2014, the Town of Gibsons in British Columbia became the first municipality in North America to formally define natural assets as a municipal asset class with binding obligations to maintain them alongside engineered infrastructure, proving the concept was operationally feasible at scale. The town's aquifer, foreshore and stormwater ponds whose engineered replacement would cost an estimated CA$ 3.5-4.0 million are formally registered and budgeted for (MNAI, 2024). Ontario subsequently embedded this approach into provincial regulation which now requires all municipalities in the province to include natural infrastructure in their asset management plans. No Indian ULB has taken an equivalent step - Bengaluru's 210 lakes remain distributed across five agencies, received by Bruhat Bengaluru Mahanagara Palike (BBMP) as land parcels under custodial care rather than as valued infrastructure assets. The institutional architecture for a GAR does not need to be invented. It needs to be formally adopted within the NMAM framework - taking an administrative decision to treat India's urban lakes as the infrastructure they already are (MoHUA, 2025). .

From Nominal Value to Functional Valuation

Recording a lake at Re. 1 does not just understate its value - it severs the link between what an asset is worth and what the municipality is willing to spend maintaining it. The Replacement Cost Method estimates what it would cost to engineer a substitute delivering the same service a natural asset currently provides. The method translates ecological value into infrastructure cost language, the language in which municipal budgets are written and defended. A municipal commissioner does not need to understand ecosystem services theory to recognise that spending ₹2 crore on periodic desilting is preferable to budgeting ₹200 crore for a concrete retention basin delivering equivalent flood storage.

Data also reinforces the scale of this accounting failure. IISc estimates Bengaluru's surviving lakes deliver an annual ecosystem service value of ₹364.5 crore with a capitalised Net Present Value exceeding ₹9,378 crore (Ramachandra et al., 2024). Yet these assets sit in BBMP's registers as land valued at Re. 1. A city that records a ₹9,378-crore asset as effectively worthless on paper guarantees it will never receive the maintenance required to prevent its collapse. Similarly, assessments by the National Remote Sensing Centre (NRSC), using satellite data, reveal that Hyderabad's lake area has shrunk by 61% between 1979 and 2023-from 40.35 square kilometres to approximately 16 square kilometres (Prakash, 2024.). Modern global valuations from the Ecosystem Services Valuation Database (ESVD) estimate that inland wetlands provide services worth roughly $48,600 per hectare per year through flood mitigation and hydrological regulation (Brander et al., 2024). By this measure, the degradation of over 2,400 hectares of functional lake area results in an annual economic hemorrhage of nearly ₹1,000 crore representing a total forfeiture of natural asset value running well into the tens of thousands of crores over the infrastructure's lifetime. The replacement cost estimates for Indian natural assets can be found in academic literature but what does not exist is a mechanism for embedding them within the accounting and budgetary systems through which ULBs actually allocate resources. A GAR operationalising the replacement cost method would transform these valuations from external knowledge into internal fiscal data. The replacement cost figure is not a supplementary calculation rather it is the GAR entry value that replaces Re. 1 on the municipal balance sheet, transforming the asset's fiscal identity from vacant land to quantified infrastructure.

The Asset Health Index

Under current NMAM classifications, land is a non-depreciable asset assumed not to wear out (Ministry of Urban Development, 2004). Urban water bodies, defaulting to the land category, inherit the assumption of infinite useful life with no accounting mechanism to recognise functional degradation through siltation, pollution or encroachment. National-level data from the CWC Compendium on Sedimentation (2024), based on 439 reservoir studies, shows an average annual loss in gross storage capacity of 0.44% per year due to siltation alone (CWC, 2024). A lake losing 0.44% of its storage capacity annually is

functionally depreciating but the municipal balance sheet records no change!

The Asset Health Index (AHI) is proposed to correct this. It is the GAR's built-in condition monitoring mechanism where the GAR creates the asset record, the AHI updates it annually, converting physical deterioration into a fiscal signal the system can act on. Specifically, it tracks a water body's service delivery relative to a defined baseline measuring not whether the asset physically exists but how much of its design-capacity function it still delivers. Three parameter groups contribute to the composite score: volumetric retention capacity (water spread area and storage volume relative to baseline); hydrological connectivity (inflow-outflow function and absence of encroachment on feeder channels); and ecological and water quality indicators assessed against a baseline established at GAR registration. The relative weighting of each parameter group is designed to be calibrated locally; a lake serving a flood-prone dense catchment would weight volumetric retention most heavily, while one in a water-scarce context might prioritise groundwater recharge indicators. Scores range from 0 (fully degraded) to 1.0 (full design capacity).

The Criticality Matrix

It also powers a Criticality Matrix that combines condition score with governance risk, population density in the catchment, historical flood incidence, and current O&M arrangements to generate a prioritised maintenance order. A lake with an AHI of 0.52 serving a dense residential ward is a Priority 1 asset requiring immediate intervention. The same score in a low-density peri-urban fringe is a Priority 3 asset managed through community stewardship. The matrix allows cash-constrained ULBs to direct limited maintenance budgets toward the assets where degradation poses the greatest flood risk to the greatest number of people.

Financing the Transition: Making Natural Infrastructure Fiscally Viable

Recognising natural assets within municipal accounting systems is a necessary first step but recognition alone does not guarantee maintenance. Sustained upkeep of blue-green assets requires dedicated, predictable funding streams, something most ULBs currently lack. The following mechanisms are designed to work within India's existing fiscal architecture, creating financing pathways that are actionable at the ULB level without requiring new legislation -

Grant conditionality - Making GAR establishment a pre-condition for accessing AMRUT 2.0 project funding and Finance Commission tied grants would create a powerful and immediate incentive for adoption. The mechanism is not novel. AMRUT 1.0 already requires Service Level Benchmarking as a funding condition. Extending this to require annual GAR updating and AHI-based maintenance allocations for Priority assets would institutionalise the register without requiring legislative change.

Table 1: AHI — Illustrative Scoring Framework

AHI Score	Condition	Interpretation	Recommended Action
0.8 – 1.0	Healthy	Asset performing at or near design capacity	Routine maintenance; annual monitoring
0.6 – 0.79	Moderate	Measurable degradation; service delivery is declining	Scheduled desilting; catchment review
0.4 – 0.59	Degraded	Significant capacity loss; flood risk elevated	Priority maintenance; budget allocation triggered
Below 0.4	Critical	Severe degradation; near-total function loss	Emergency restoration; encroachment enforcement

The AHI functions as the de facto depreciation schedule for natural assets driving maintenance budget allocations in the same way that conventional depreciation signals replacement needs for engineered infrastructure.

Shadow valuation for credit access - Only 95 out of 223 credit-rated Urban Local Bodies (ULBs) achieved the investment-grade ratings required to access the bond market, a barrier attributed to poor fiscal management and the non-availability of reliable accrual-based accounts. This credit gap is exacerbated by legacy accounting practices where fixed assets with unknown historical costs are recorded at a nominal value of Re. 1 systematically understating a municipality's asset base. Transitioning to accrual-based financial statements allows ULBs to establish the creditworthiness necessary to attract investment and raise resources from open markets (Murali et al., 2023). Under a shadow valuation approach, natural assets would retain their nominal Re. 1 in statutory accounts preserving NMAM compliance while a supplementary schedule annexed to the balance sheet records replacement cost values for each GAR-registered asset. For credit rating agencies, this provides a more complete picture of the municipality's asset base and the contingent liabilities it avoids through maintenance. For bond investors, it signals fiscal prudence and climate resilience material factors under SEBI's 2023 green bond framework. This is analogous to how the Town of Gibsons addressed the same constraint, disclosing natural asset values that accounting standards did not yet formally accommodate.

Land value capture escrows - Properties adjacent to healthy lakes command a premium of 15–25% over comparable properties without water body access, documented in Hyderabad and Bengaluru contexts. A modest betterment levy applied to property transactions within a defined radius of a restored water body would generate a dedicated, self-sustaining revenue stream for maintenance without drawing on the general municipal fund and creates a constituency of property owners with a direct financial interest in the lake's upkeep. Examples of São Paulo (Brazil), Medellín (Colombia), Singapore and the United Kingdom have been referenced widely.

CSR adoption linked to the Criticality Matrix - The Criticality Matrix provides a transparent, evidence-based instrument for pitching specific high-risk assets to corporate donors. A corporate entity adopting a Priority 1 lake under a CSR arrangement would commit to funding annual maintenance against a defined AHI improvement target over 3-5 years. The GAR provides the baseline, the AHI provides the performance metric, and the Criticality Matrix provides the risk narrative. Several Bengaluru-based technology companies have already engaged in informal lake adoption programmes; the GAR framework would formalise these arrangements and enable accountable impact reporting.

Conclusion: Resilient Cities as the Foundation of Viksit Bharat@2047

The growing flood vulnerability of Indian cities is not solely a consequence of intensifying rainfall or rapid urbanisation. It is also the product of institutional frameworks that render natural infrastructure fiscally invisible, administratively marginalised and chronically undermaintained. Urban blue-green assets are critical climate infrastructure. They are currently governed as if they were vacant land.

The reforms proposed in this paper do not require complete restructuring of urban governance. They require targeted changes to how municipal accounting systems classify, value and track the condition of natural assets changes that would drive maintenance allocation, capital planning and financing decisions toward the sustenance of these systems. The Green Asset Register, the Asset Health Index and the shadow valuation mechanism are each designed to work within existing institutional constraints while progressively shifting the fiscal treatment of natural infrastructure from invisibility to legibility. As global climate adaptation frameworks increasingly emphasise the significance of blue-green assets in building resilience, the question for Indian cities is not whether to integrate natural infrastructure into governance, it is how quickly the institutional capacity to do so can be built.

We propose the following recommendations directed primarily at urban local bodies as the frontline custodians of these assets with complementary actions for State Urban Development Departments.

Table 2: Recommended Actions for ULBs and State Urban Development Departments

S.no.	Recommendation	Primary Actor	Action Required
1	Establish Green Asset Registers	Urban Local Bodies	Inventory all blue-green assets, geo-tag and record in a GAR with baseline AHI scores and replacement cost estimates. Integrate GAR data into annual budget documentation.
2	Reform Asset Valuation Practice	ULBs / State Urban Depts	Move from nominal Re. 1 valuation to replacement cost methodology for all GAR-registered natural assets. Annex shadow valuation schedule to municipal financial statements.
3	Embed AHI in Resilience Planning	ULBs / State Govts	Require AHI scores and GAR data as mandatory inputs into city-level stormwater master plans and flood resilience plans. Link capital investment decisions to volumetric retention baselines.
4	Secure Sustainable Finance	ULBs / State Finance Commissions	Develop ring-fenced Blue-Green Maintenance Escrows funded through land value capture. Use GAR Criticality Matrix to pitch Priority 1 assets to CSR funders. Pursue shadow valuation recognition for credit rating purposes.

State Urban Development Departments should provide standardised GAR templates, AHI assessment protocols and technical capacity support to ULBs, particularly at Tier 2 scale.

India's urban flood crisis is, at its core, a governance crisis. The rainfall is intensifying but the deeper struggle is institutional - a municipal system that has spent decades building drainage infrastructure while allowing the natural assets that make that infrastructure viable to deteriorate unrecorded, unmaintained and undervalued. Lakes do not disappear overnight. They disappear gradually through accumulated planning decisions, encroachment approvals and deferred maintenance cycles, each made easier by accounting frameworks that assign them no fiscal weight.

The reforms proposed in this paper are modest in their ambition relative to the scale of the problem. They do not require new institutions, new legislation or significant new expenditure. They require municipal systems to see what is already there and to count it, value it and maintain it. A Green Asset Register is not a radical intervention. It is the minimum condition for informed governance. The Asset Health Index is the equivalent of knowing whether your drainage network is functioning before the monsoon arrives.

Indian cities will not become climate-resilient by building more concrete. They will become resilient when the natural systems underlying urban hydrology are treated with the same fiscal seriousness as the engineered systems built on top of them. The institutional tools to do this exist. The evidence to justify it is overwhelming. What remains is the administrative will to act.

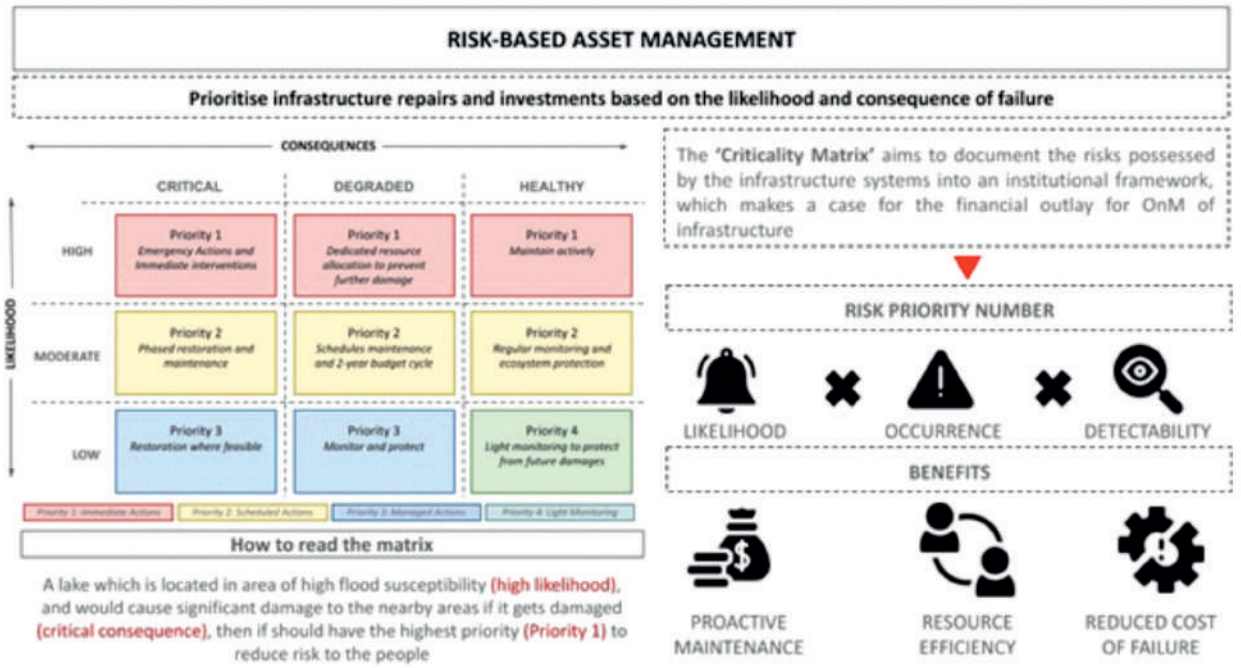

Figure 1: Risk-based Criticality Matrix
Source: Author's visualisation

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STRENGTHENING URBAN LOCAL BODIES FOR VIKSIT BHARAT@2047: INSTITUTIONAL AND FINANCIAL LESSONS FROM THE NOIDA DEVELOPMENT AUTHORITY MODEL

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Abstract

India's Viksit Bharat@2047 vision recognises Urban Local Bodies (ULBs) as key drivers of infrastructure-led and fiscally sustainable urban growth. Urban India contributes nearly 63% to the national GDP while providing home to 35.4% of the population. Yet, municipal revenues remain structurally weak at just 0.7 to 0.8% of GDP, with 45 to 50% of ULB income dependent on intergovernmental transfers

In this context, the New Okhla Industrial Development Authority (NOIDA), established under the Uttar Pradesh Industrial Area Development Act, offers a contrasting fiscal model anchored in land value capture. Between 2019 and 2023, land premiums accounted for 72–78% of its revenue, while capital expenditure remained high at 55–65%, significantly above the national municipal average of 25 to 30% (RBI, 2022; NOIDA Budget, 2020–23). This is reflected in the infrastructure delivery indicators - water supply of 450 MLD against a demand of 420 MLD, STP capacity of 410 MLD despite a national urban treatment gap of 30% (CPCB, 2023), and 85–90% solid waste processing, exceeding the national average reported under the Swachh Bharat Mission.

The paper argues that while NOIDA's fiscal autonomy enables rapid infrastructure expansion, long-term sustainability will depend on revenue diversification, institutional resilience, and greater social and environmental integration.

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Introduction

Urban governance in India has been fundamentally shaped by the 74th Constitutional Amendment Act, which formally empowered municipalities and municipal corporations with planning and service delivery responsibilities. Since then, rapid rural–urban migration and economic restructuring have accelerated the growth of cities. India's urban population is projected to nearly double to about 951 million by 2050 (UN DESA, 2018). Cities are central to economic transformation, expected to generate nearly 70% of new jobs by 2030 (McKinsey Global Institute, 2010). Yet, infrastructure provisioning has not kept pace with the rapid urbanization (as per World Bank 2022 report). Over half of the urban infrastructure required by 2050 is yet to be built.

Under the national vision of Viksit Bharat@2047, urban areas are positioned as engines of inclusive and sustainable growth, supported by stronger institutions and improved service delivery (Government of India, 2023). However, most Urban Local Bodies (ULBs) continue to operate with limited fiscal autonomy. Municipal revenues remain modest by international comparison, largely dependent on property taxes and intergovernmental transfers, with constrained capacity for capital investment (RBI, 2022; 15th Finance Commission, 2021). Bridging this gap requires innovative resource mobilisation, institutional reform, and long-term planning framework to finance resilient and equitable urbanisation.

Table 1: Key Urbanisation Indicators in India (2023)

Indicator	Value	Year
Urban Population (%)	35.4%	2023
Urban GDP Contribution (%)	63%	2023
Number of ULBs in India	4,800	2023

Source:(MoHUA), Govt. of India; WBUD Data (2023); Census of India (for ULB statistics)

Against this broader context, New Okhla Industrial Development Authority (NOIDA) in Uttar Pradesh presents a distinctive counter-model of urban governance and finance. Established under the Uttar Pradesh Industrial Area Development Act, NOIDA functions as a state development authority with statutory powers to acquire, develop, and dispose of land. This framework allows it to generate substantial revenue through land monetisation primarily via competitive auctions and long-term lease premiums unlike most municipalities that depend largely on property taxes and intergovernmental transfers (RBI, 2022; CAG, 2021).

Over the past decade, this land-based financing model has enabled NOIDA to fund major infrastructure investment, including expressways, link to Delhi Metro and the upcoming NOIDA International Airport at Jewar (Government of Uttar Pradesh, 2023). The budget documents of NOIDA indicate consistently high capital expenditure ratio compared to national municipal averages (NOIDA Budget Documents, 2020–23; RBI, 2022).

However, audit observations have also pointed to governance and regulatory concerns, including land allotment practices and financial risk exposure tied to real estate cycles (CAG, 2021). While NOIDA's model demonstrates fiscal dynamism, it simultaneously raises questions about transparency, equity, and long-term sustainability in land-led urban development.

Case Study Analysis: The NOIDA Model

Institutional Structure and Governance

The New Okhla Industrial Development Authority (NOIDA) is a statutory urban development authority constituted by the Government of Uttar Pradesh under the Uttar Pradesh Industrial Area Development Act. Unlike a conventional municipal corporation, it is not headed by an elected mayor or council. Instead, it is governed by a state-appointed Board and led by a Chief Executive Officer, typically a senior bureaucrat entrusted with wide executive powers over land acquisition, sector planning, plot allotment, and levy of development charges (Government of Uttar Pradesh, 1976; NOIDA Act provisions).

This centralised and bureaucratic structure provides NOIDA with significantly greater administrative autonomy and technical capacity than most Urban Local Bodies (ULBs). The Authority maintains dedicated planning, engineering, and land management departments, enabling relatively swift execution of infrastructure projects (Gupta & Tiwari, 2022). However, the absence of an elected council raises concerns regarding

Table 2: Key Indicators of Municipal Finance in India

Indicator	National Average	Year
Municipal Revenue as % of GDP	0.7–0.8%	2022
Property Tax Share (%)	15–20% of revenue	2022
State Transfer Dependency (%)	45–55%	2022
Average Capex Ratio (%)	25–30%	2022
Municipal Borrowing Level (₹)	3,000 Cr (national total bonds out-standing)	2023

Source: MoHUA, Govt. of India; RBI Reports on Municipal Finances (2022–2023)

democratic accountability, stakeholder representation and governance vulnerabilities. In 2021, development authorities in Uttar Pradesh, including NOIDA, were brought under the audit purview of the Comptroller and Auditor General of India. The CAG's performance audit (2005–18) reported irregular allotments, collusion between officials and developers, and outstanding developer dues amounting to approximately ₹18,633 crore by 2020.

Despite these concerns, the Authority's professional management has facilitated complex initiatives, including new structural audit frameworks and major corridor expansion projects (NOIDA Authority Releases, 2025). The model illustrates a clear trade-off of administrative decisiveness and infrastructure delivery on one hand, and accountability and equity concerns on the other.

Fiscal Model and Revenue Sources

NOIDA's most distinctive feature is its fiscal model based on land monetisation. The Authority treats its undeveloped land as its primary asset. It acquires large tracts often at subsidised compensation, develops roads, utilities, and then sells or leases parcels to developers. Over the past decade, NOIDA has become adept at generating cash through auctions and leases. In FY 2022-23, NOIDA set a revenue target of ₹4,880 crore from sale of properties, lease rents and user charges against which the actual collections realised was ₹6,456 crore. These receipts came almost entirely from development fees i.e plot premiums and lease rentals, with property tax revenue negligible in comparison. The Authority uses sophisticated e-auction platforms to sell group-housing, commercial and industrial plots to the highest bidders. By contrast, most ULBs depend mainly on property tax.

Accordingly, NOIDA's annual budget far exceeds that of a normal municipality of similar population. Table 3, illustrates this disparity. For FY 2025-26, NOIDA Authority's approved budget was ₹6,920 crore which is two and a half times more than the budget of Lucknow Municipal Corporation. By FY 2025-26, NOIDA's budget is projected to reach ₹8,732 crore, which in per-capita terms is astounding. While the population of Gautam Buddha Nagar (NOIDA+Greater Noida) is only 0.6 million residents, it accounts for over 10% of the GDP of UP. Some reports even compare its per-capita income (₹10.17 lakh) to that of Japan. The ability to mobilise funds through land sales is central to the Authority's prosperity.

Major revenue streams include:

(a) Land Sale Premiums – highest-value plots (residential, commercial, group housing) are auctioned;

(b) Lease Rentals – many areas are allotted as leaseholds (annual rents);

(c) Service Fees and Utilities – charges for water, sewerage, parking, etc.;

(d) Transfer Premiums – developers often pay extra for higher FAR or land-use changes.

In 2024-25, NOIDA increased its land prices by 6% for most plot categories, reflecting market conditions. These policies underscore its heavy reliance on land income.

In contrast, typical ULBs in India see only modest revenues. According to Reserve Bank of India (RBI), municipal own-tax revenues, mainly property tax remain small, and combined with grants form the bulk of most city budgets. Table 1 shows

Table 3: Finance Commission Grants to ULBs (Amount and Share)

Finance Commission	Grants to ULBs (₹ crore)	% of Grants (ULBs vs total)
13th FC (2010–15)	23,600	26%
15th FC (2021–26)	155,000	36%
16th FC (2026–31)	356,257	45%

Source: Finance Commission of India – Reports of the 13th, 15th, and 16th Finance Commissions; Ministry of Finance, Government of India Budget Documents (Urban Local Body Grants)

that the 13th and 15th Finance Commissions (FCs) allocated just 26% and 36% of grants to ULBs, whereas the 16th Finance Commission raised this share to 45%. Even with rising grants, most ULBs cannot match NOIDA's self-generated resources. This fiscal autonomy has allowed NOIDA to maintain high service levels. The Authority reported collection of 88% of all dues in FY 2023-24 (a record high), which in turn was utilised for capital investment as well as for social projects. In 2025, NOIDA earmarked ₹224 crore for its 29 surrounding villages (villagers have 15 seats on the Board of the Authority, which is reflective of its inclusive structure).

Infrastructure Provisioning

NOIDA Authority ploughs its revenues back into the implementation of large-scale infrastructure projects. A prime example is the NOIDA-Greater Noida Expressway and parallel projects. In 2024 it approved a six-lane Chilla–NOIDA elevated highway to relieve congestion and allocated ₹1,906 crore for major road expansion projects including ₹326 crore for street lighting and flyovers. Notably, a dedicated ₹1,359 crore was set aside for the NOIDA International Greenfield Airport (Jewar) project, illustrating how NOIDA leverages its own funds for improving connectivity. Phase-1 of Jewar Airport is nearly 95% complete and is expected to be fully operational by Dec 2026. This upcoming airport will dramatically boost NOIDA's economic profile, enabling setting up of new industries and real estate development.

Other amenities have also seen similar traction. The connectivity of NOIDA with other cities has improved with the introduction of Blue Line metro (Delhi Metro extension) and upcoming Aqua Line (NOIDA-Greater Noida Metro). In keeping with the dynamics of the region, the Authority has modernised waste-treatment plants and has ambitious plans for solar/water projects. Compared to many cash-strapped municipalities, NOIDA has managed to accelerate project delivery by creating its own infrastructure fund and by tying new development fees to project completion. The Authority has a virtuous cycle of land sales financing amenities, which in turn raise land values for further sales.

This model, however, has its own trade-offs. Housing and urban amenities for lower-income residents has been a matter of concern. NOIDA's rapid sale of serviced plots has sometimes outpaced its ability to ensure affordable housing. The CAG audit noted that although policies required 20–25% of Group Housing projects to include EWS/LIG units, earlier brochures (pre-2014) omitted these conditions. Such institutional lapses mean that recent development undertaken by the Authority caters mostly to high-end buyers, while unfinished "stalled" projects from the 2008–11 period, leave middle-class buyers high and dry. These oversights underscore the need to pursue monetisation with adequate regulatory checks.

Comparative Analysis: NOIDA vs. Other Urban Local Bodies

To contextualise NOIDA's achievements, there is a need to compare important functional and revenue collection parameters with other ULBs. Table 4 provides a budgetary comparison of NOIDA and Lucknow Municipal Corporation. NOIDA's projected budget (₹8,732 crore) is nearly four times that of Lucknow's projected budget (₹2,278 crore) for FY 2025-26, despite NOIDA's population being one-third of Lucknow. While Lucknow relies on property tax and state grants, the main source of revenue for NOIDA is land sales.

Greater Noida Industrial Development Authority (GNIDA) is no different. It incurred a revenue loss of ₹19,500 crore (up to 2017-18) due to defaults and faulty allotments. As per CAG, much of Greater Noida's estimated revenue was unrealised or undercharged. GNIDA's case underscores that having an authority is not sufficient; it must

Table 4: Annual Budgets: NOIDA vs Lucknow

City (Fiscal Year)	Budget (₹ crore)
NOIDA (FY2023-24)	6,503
NOIDA (FY2025-26)	8,732
Lucknow (FY2026-27)	2,278

Source: New Okhla Industrial Development Authority Budget Documents (FY 2023–24 & FY 2025–26); Lucknow Municipal Corporation Budget Document (FY 2026–27).

also have disciplined financial controls. In contrast, NOIDA has managed to avoid significant defaults other than legacy dues. Both authorities illustrate the risk of aggressive development strategies without the backing of strict enforcement payment conditions.

Compared to typical Municipal Corporations (MCs), NOIDA's scale is unparalleled. RBI data show that in 2019-20, MCs' own revenues averaged only 0.2–0.3% of GDP. Most MCs spend around one-third of their budgets on capital works. By contrast, NOIDA channels a larger share into development e.g. ₹2,410 cr of ₹8,732 cr in FY25-26, 28% is earmarked for new projects. Typical MCs often under-invest due to revenue constraints and bureaucratic delays. RBI observed that even amongst the 10 largest ULBs, only 66% of budgeted capital spending was realised (2017–20).

In Table 5, these differences have been illustrated. It shows that while Municipal Corporations (MCs) across the country spent 30–42% of their budgets on Capital Expenditure (2017–20), NOIDA routinely commits a comparable or larger share every year. Importantly, NOIDA's Capital Expenditure is fully backed by confirmed own revenues, whereas many MCs rely heavily on uncertain grants.

The governance models in Developmental Authorities and Urban Local Bodies differ sharply. Municipal Corporations have elected councils, though often with limited executive power and must follow state-appointed guidelines for their budgets and plans. NOIDA Authority, by contrast, is a corporatised agency free of municipal election cycles. This agility helps in rapid decision-making as reflected in record revenue collections of 88% in FY24 but at the potential cost of democratic oversight. In practice, NOIDA mitigates this by public consultations on master plans including those with village representatives, but the authority-vs-municipality divide remains a key institutional difference.

Lessons and Reforms

NOIDA's model suggests that land monetisation can dramatically boost urban resources. The policy makers could consider similar instruments like improved development charge regimes, betterment levies and more use of Transfer-of-Development Right (TDR) tools to boost their own revenue collection. Ahluwalia and Mohanty advocate such tools to formalise land-value capture. NOIDA sells plots but does not systematically levy additional charges for infrastructure beyond basic premiums. Cities could implement "value-based" pricing, where higher FAR or re-zoning triggers surcharges. Public-private partnerships (PPPs) in infrastructure could also be expanded. NOIDA's lease model is a form of PPP for facilitating urban development. Enabling ULBs to access private capital as the World Bank suggests, requires creditworthiness. NOIDA's healthy cash flows makes it a good candidate for issuing infrastructure bonds.

However, regulatory and equitable governance need to accompany monetisation. The CAG findings underline the need for transparent e-auction rules and strict enforcement of dues. Strengthening urban audit and citizen oversight bodies can deter collusion. State Finance Commissions and Central Finance Commissions (CFCs) should incentivise ULBs to adopt reforms like GIS-based property registries and online payment systems, which NOIDA already uses to enhance its collections.

Another key dimension is climate resilience. Rapid land development often reduces green cover and increases flood risk. NOIDA must ensure its expansion especially around Jewar follows environmental norms e.g. rainwater harvesting, flood zoning. Policy options include mandating green buildings, afforestation fees on new developments, and investing auction proceeds in urban flood controls or public parks. The World Bank, 2025 notes that timely green investment can avert billions in climate losses; NOIDA's infrastructure fund need to integrate a dedicated climate-adaptation component to mitigate against climate risks.

Bridging the institutional gap requires empowering ULBs nationwide. NOIDA's success is due in part because of the structure of the Authority and state support. While not all cities can become development authorities, states can delegate more fiscal powers to municipalities as the 74th Constitutional Amendment Act intended. The 16th Finance Commission's enhanced grants are a step, but these need to be complemented with structural reforms. These reforms include giving ULBs greater share in city-land auctions, enabling them to issue municipal bonds, and building professional staff cadres. Central and state governments could create urban "model

Table 5: Capital Expenditure as % of Total Expenditure

Year (Municipal Corps)	Capital Expenditure Share (%)
2017–18 (All MCs avg.)	30%
2019–20 (All MCs avg.)	42%

Source: Reserve Bank of India, Report on Municipal Finances; Ministry of Housing and Urban Affairs, Urban Local Body Finance Data (Municipal Corporations).

projects" or special-purpose vehicles to replicate high-quality infrastructure delivery in other cities, akin to NOIDA.

Conclusion

NOIDA's experience illustrates both the promise and pitfalls of market-based urban development in India. The monetisation of land can mobilise enough finance to fund world-class infrastructure projects, roads, airports, metro and thereby generate prosperity in Gautam Buddha Nagar region comparable to Japan. This model resonates with the vision of Viksit Bharat by 2047. It demonstrates how a city authority can create jobs and modern amenities, echoing the projected "70% GDP from cities" narrative.

However, NOIDA model also shows that institutional capacity and equity cannot be overlooked. Strong urban governance frameworks is central to ensuring the translation of revenue gains into broad-based services and not just gated enclaves. NOIDA's governance gaps, collusion of developers and uncompleted projects serve as a caution for other ULBs contemplating replication of the NOIDA model. The replication of NOIDA model in other cities need to be supplemented with transparent processes and social safeguards.

ULBs could play a critical role in India's urban transformation. By channelising land monetisation revenue and private investment into infrastructure, the funds required for infrastructure development can be easily mobilised. However, success will depend on embedding these models within a holistic policy environment that includes legal reforms, capacity building, and climate resilience measures. In conclusion, NOIDA's unique fiscal-institutional blueprint offers valuable lessons. It should neither be idolised nor discarded, but studied and adapted carefully as part of India's long-term strategy for achieving the vision of "Viksit Bharat by 2047".

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आवास के अतिरिक्त इन्फ्रास्ट्रक्चर का वित्तपोषण

हडको, एक एनबीएफसी-आईएफसी, जो आवासीय वित्तपोषण के अतिरिक्त अपने क्षितिज का विस्तार करते हुए, सुदृढ़ इन्फ्रास्ट्रक्चर परियोजनाओं को वित्तीय सहायता देने की प्रतिबद्धता के साथ विकसित भारत के उद्देश्य को प्राप्त करने के लिए परामर्श एवं क्षमता निर्माण सेवाओं के माध्यम से योगदान दे रहा है।

प्रमुख ताकत

- पैन इंडिया उपस्थिति और सरकारों के साथ सुदृढ़ संबंध
- न्यूनतम एनपीए और परिसंपत्ति की बेहतरीन गुणवत्त
- सर्वश्रेष्ठ क्रेडिट रेटिंग: घरेलू-एएए, अंतर्राष्ट्रीय-संप्रभ
- फ्लैगशिप मिशनों के प्रभावी कार्यान्वियन को पूरक बनान
- मजबूत वित्तीय अनुपात और लाभप्रदत
- क्षमता निर्माण और परामर्शी सेवाओं के माध्यम से मूल्य संवर्धन

उपलब्धिया

- नवरत्न का दर्जा प्राप्त
- एचएफसी से एनबीएफसी - आईएफसी में परिवर्तन
- एमएमआरडीए तथा अमरावती स्टेट कैपिटल डेवलपमेंट जैसे प्रतिष्ठित परियोजनाओं हेतु फंडिंग
- धारा 54 ईसी और जीरो कूपन बॉन्ड्स के अंतर्गत पूंजीगत लाभ कर छूट बॉन्ड जारी करने की अनुमति
- अब तक की सर्वाधिक स्वीकृतियां, संवितरण और धन जुटाव
- अंतर्राष्ट्रीय उधार के माध्यम से वैश्विक उपस्थिति में वृद्धि

हाउसिंग एंड अर्बन डेवलपमेंट कॉर्पोरेशन लिमिटेड
आवासन और शहरी कार्य मंत्रालय, भारत सरकार के अंतर्गत एक एनबीएफसी-आईएफसी
सीआईएन: एल74899डीएल1970जीओआई005276 जीएसटीआईएन: 07AAACH0632Q1ZDएफ
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हुडको
hudco
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Urban Invest Window (UiWIN)

UiWIN - One stop Solution for Creation of
Sustainable Urban Infrstructure for Viksit Bharat

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UiWIN
URBAN INVEST WINDOW

Core Functional Verticals - UiWIN

Readiness

- Asset Identification Inventory & Digitalisation of Asset Register
- Maximizing Asset Value and Performance
- Resource Identification, Debt Management Framework
- Plan Borrowing limits, Debt Servicing Capacity
- Account Standardisation

Project Formulation

- Project Identification, Conceptualization and Implementation
- Preparation of DPRs, Techno-Economic Viability Studies etc.
- Project Structuring
- PPP Framework

Financial Closure

- Assistance in Credit Rating
- Strengthening Own Resources
- Access to Multilateral, Bilateral & FDI
- Private Funds (PPP) & Debt
- Municipal Bond Issuance