# Urban Sanitation in Indian Cities: A Case Study of Patna

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**KEYWORDS**
*Urban Sanitation, Infrastructure basic services, community sanitation facility, Shit Flow Diagram (SFD)*

**ABSTRACT**
The rapid urban growth in Indian cities has exerted tremendous pressure on existing infrastructure, particularly in the area of sanitation. The influx of population into urban centres, along with inadequate facilities, often leads to challenges in managing and maintaining effective sanitation systems. This paper investigates the sanitation landscape of Indian cities through a comprehensive case study of Patna, focusing on the infrastructure's ability to meet the city's growing demands.
The paper contextualizes Patna within the framework of urbanization, discussing demographic character, population growth, housing conditions, and the persistent issues faced by urban poor communities and slum residents. A detailed profile of Patna's sanitation infrastructure is discussed, covering urban basic services such as sanitation facilities, sewerage system and water supply evaluating their reach, capacity, and efficiency.

To assess the existing sanitation status, the paper utilizes the Shit Flow Diagram (SFD) as a key analytical tool, providing a comprehensive overview of the city's sanitation value chain, from collection to disposal. The paper examines government and community-driven initiatives, including public and community toilets, and assesses the availability, accessibility, and conditions of these facilities.

The paper identifies significant sanitation challenges at multiple levels: city-wide systemic issues, institutional shortcomings, household-level inadequacies, and limitations faced by NGOs working in sanitation. Based on these observations and findings, paper proposes recommendations to enhance Patna's sanitation situation, focusing on sustainable infrastructure development, improved governance, and increased community engagement to address current gaps and improve sanitation outcomes in Indian urban areas..

## INTRODUCTION

For the well-being and healthy community, sanitation plays a vital role as it improves human health to support longer life spans leading to improved financial status. Sustainable Development Goal (SDG 6.2) emphasizes universal access to adequate and equitable sanitation and hygiene along with the irradiation of open defecation particularly focusing on the needs of vulnerable populations, including women and girls (United Nations) The poor status of sanitation inequalities impacts the health and socioeconomic aspect of the vulnerable group i.e. women and children are more because of their greater social vulnerabilities to sexual violence, and also the biology of the need for privacy safety, and cleanliness (Chaplin & Kalita, 2017). World Health Organization defines sanitation as a provision of services and facilities helping in the safe disposal of human waste to maintain hygienic conditions through services such as garbage collection and waste disposal (World Health Organization).

The National Urban Sanitation Policy emphasizes the sanitation value chain, where safe management of human excreta through confinement, treatment, disposal, and associated hygiene-related practices should be followed (National Urban Sanitation Policy, 2008). Swachh Bharat Abhiyan refers to sanitation as access to sanitary toilets, eliminating open defecation, promoting proper waste treatment, and encouraging hygiene practices, all aimed at improving public health and maintaining a clean environment (Ministry of Housing and Urban Affairs, 2014). From the above discussion, we may refer to sanitation as a service where improved and adequate facilities of the sanitation value chain are available for safe and hygienic disposal (recycle, reduce, and reuse) of waste generated with minimal adverse effects.

Urban sanitation situation in India especially in slums is one of the major concerns for India as a lot of pressure in terms of population is directed towards the cities due to the shift in the economy from primary sector to secondary and tertiary sector. The rapid urbanization in India has led to intensified problems in finding adequate space and housing for the growing population, resulting in the inevitable formation of slums in the major metropolitan cities (Maiti & Agrawal, 2005). These slum areas often lack access to proper sanitation facilities, clean water supply, and proper waste management, leading to poor hygienic conditions and an increased risk of disease outbreaks (Gupta et al., 2023) (Adane et al., 2017).

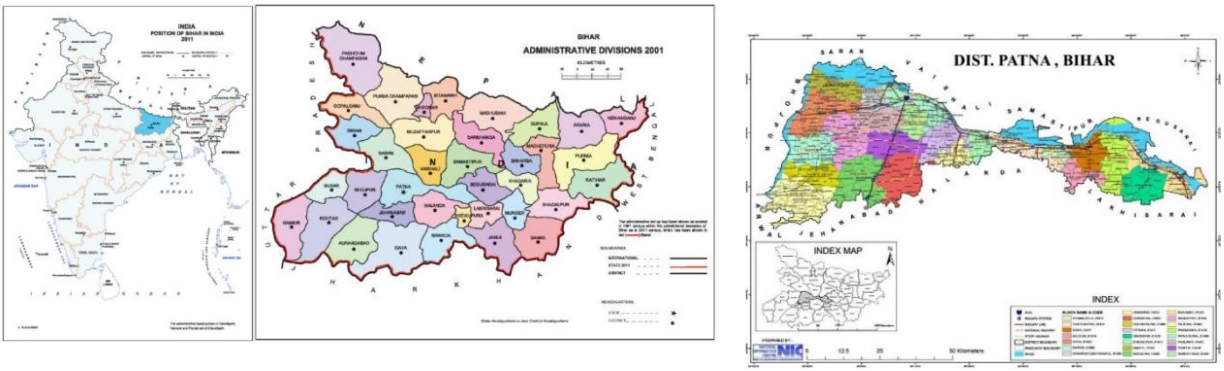
The deteriorating condition of the sanitation system in Urban India is because of exponential urban population concentration in major cities leading to stress on existing infrastructure especially in informal settlements. This rapid growth in urban population is putting pressure on informal settlements with limited infrastructure to support quality of life. Census 2011 states one in six Indian city residents lives in an urban slum with unsanitary conditions that are "unfit for human habitation (Census of India, 2011). Only 17% of the households in India have Flush/pour -flush-to-pipe sewer systems with 39.15 % in urban and 1.6% in rural. Half the household (50.1%) in India has flush/pour-flush to septic tanks with 50.9 % in urban and 48.9 percent in rural (National Sample Survey Office [NSSO], 2019). Water is one of the crucial resources for the sanitation system to work efficiently and nearly 80 percent of Indian households are without piped water connection, whereas only 21.4 % of household have piped water connections with 40.9% urban and 11.3% rural coverage. (National Sample Survey Office [NSSO], 2019).

In terms of treatment and disposal of the waste in urban India approximately 72,368 million liters per day (MLD) of sewage, but the installed capacity to treat sewage is only around 31,841 MLD. This indicates a treatment capacity gap of about 56%, meaning nearly half of the sewage generated in urban areas remains untreated. For the state of Bihar installed capacity is 10 MLD (0.43 %) only against the sewage generation of 2276 MLD indicating a gap in treatment capacity of 2266 MLD (99.56 %). Out of 10 MLD installed capacities, the operationalized capacity is zero. (Central Pollution Control Board, 2021).

**City Profile**

Patna is the capital city of Bihar enriched with a legacy dating back to ancient times. The historical roots of Patna trace back to the Mauryan Empire, known as Pataliputra and served as a capital city for the Empire. It is situated in the fertile floodplain Ganga. It is a riverine settlement, surrounded by the Ganges to the north, the Punpun to the south, and the Son to the east (Rodgers and Satija, 2012). It is located along the confluence of River Ganga and spans 15 km. The geographical location of Patna provides the strategic transitional position with respect to climate, economy, and culture as it lies between West Bengal in the east and Uttar Pradesh in the west resulting in eastern and western blends in weather patterns, characterized by the subtropical monsoon and continental climatic features (Singh & Verma, 2020).

**Figure 1:** Locational Map of Patna District




**Source: Master Plan of Patna 2031, Patna Master Plan Report**

The urban spread of Patna city is about 110 sq. km (Mandal and Dutta, 2009). Patna Urban Agglomeration Area (PUA) is a sprawling metropolitan area comprised of the Municipal Corporation of Patna and four census towns accounting collectively contributing to 61.4% of the total population within the Patna Planning Area (PPA). Patna Planning Area was delineated in October 2014 by the Bihar Urban Development and Housing Department (UDHD) in collaboration with the Bihar State Housing Board (BSHB) and other relevant urban planning authorities as part of the Patna Master Plan 2031 (UDHD, 2014).

**Table 1:** Patna Urban Agglomeration Area Composition

| Region | District | Status | Components | Population 2011 | Area (sq.m.) |
|---|---|---|---|---|---|
| PMC | Patna | Town | Patna | 16,84,222 | 110 |
| Part of Urban Agglomeration | Patna | | Phulawari Sharif | 81,740 | 6.48 |
| | Patna | | Dinapur Nizamat | 1,82,429 | 11.63 |
| | Patna | | Dinapur Cantonment | 28,723 | 3.42 |
| | Patna | | Khagaul | 44,364 | 3.66 |
| Patna Urban Agglomeration | | | | 20,49,156 | 134.64 |

**Source: Patna-MP-Report (2011-31)**

The Patna Municipal Corporation was established on the 15th August 1952, by The Patna Municipal Corporation Act, 1951, and currently manages 75 wards with a population of 1.7 million as per census 2011. PMC manages and maintains the water supply, sanitation, waste management, drainage, street lighting, building regulation, and birth/death registration (*Census of India, 2011).*

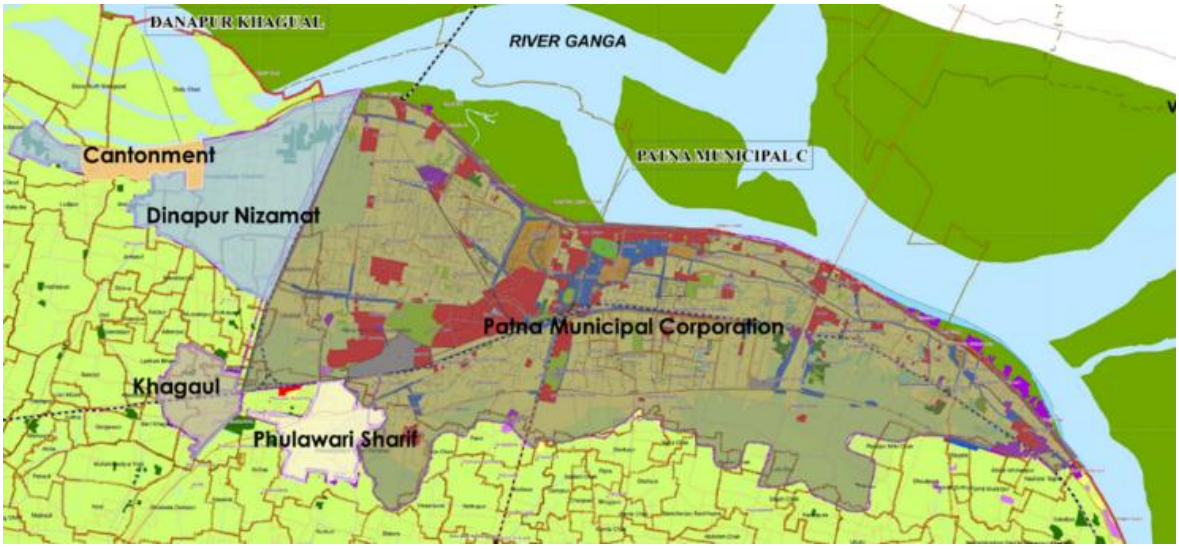



**Figure 2:** Patna Agglomeration

**Source: Patna-MP-Report (2011-31)**

There are 75 wards in the Patna Municipal Corporation subdivided into 6 circles namely New Capital Circle, Patliputra Circle, Kankarbagh Circle, Bankipur Circle, Azimabad Circle, and Patna City Circle. Each circle is managed by a State-appointed executive officer, assisted by the health and sanitary officer for looking after health and sanitation-related aspects. This subdivision will facilitate efficient administration across the Patna Municipal boundary. The administration of the circles is under the direct jurisdiction of the Municipal Commissioner (Patna Municipal Corporation).

**Table 2:** Wards distribution in six circles of Patna Municipal Corporation

| Circles | No. of wards | Wards |
|---|---|---|
| New Capital Circle | 16 | 3, 4, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 28, 37 |
| Patliputra Circle | 16 | 1, 2, 5, 6, 7, 8, 20, 22, 22A, 22B, 22C, 23, 24, 25, 26, 27 |
| Kankarbagh Circle | 11 | 29, 30, 31, 32, 33, 34, 35, 44, 45, 46, 55 |
| Bankipur Circle | 12 | 36, 38, 39, 40, 41, 42, 43, 47, 48, 49, 50, 51 |
| Azimabad Circle | 12 | 52, 53, 54, 56, 57, 58, 59, 60, 61, 63, 64, 65 |
| Patna City Circle | 8 | 62, 66, 67, 68, 69, 70, 71, 72 |

**Source: Patna Municipal Corporation ward and circle subdivision details**

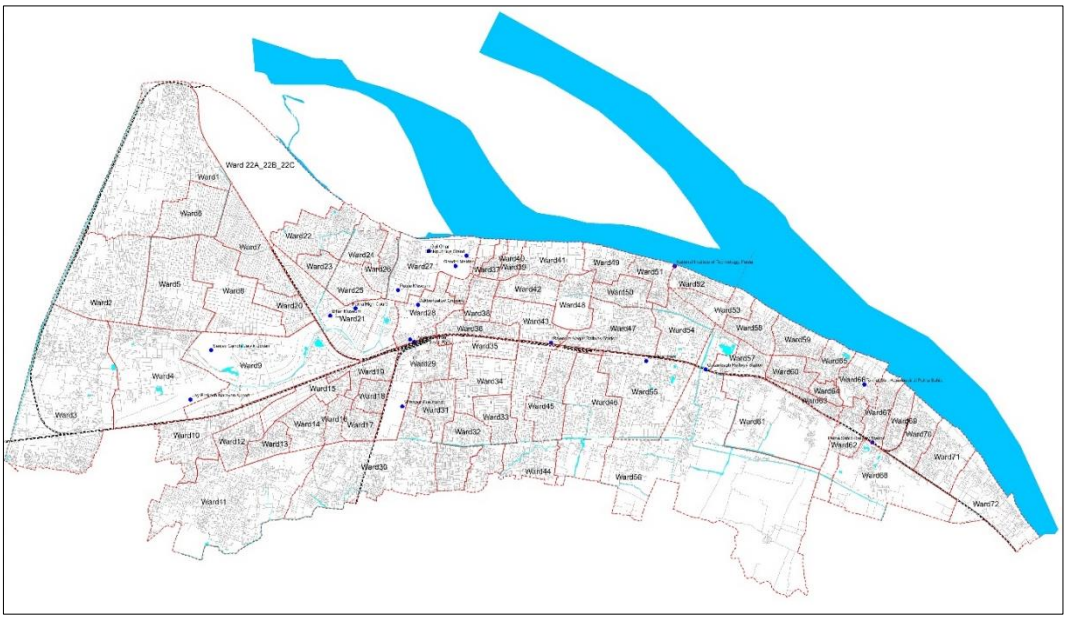


**Figure 3:** Ward Map of Patna Municipal Boundary

**Source: Patna Municipal Corporation ward and circle subdivision details**

The topography of Patna is predominantly flat, sloping towards the southern with varying gradients in east-west. The low-lying area extends from the railway line northward to Pataliputra colony bounded by the main railway line and Bailey Road forming the eastern and western ridge. As per the census 2011 data, Patna city had a population of 1,683,200 within its corporation limits, comprising 894,158 men and 789,042 women with 22.2 % of population growth rate from 2001 to 2011. Patna holds 19$^{th}$ rank for most populous city in India and with over 2 million residents, the city has 2.9 lakh households with an average household size of 6.1 persons per family. In terms of literacy 12.3 lakhs (83%) of people in the city are literate, among them about 6.9 lakhs (87%) are male, and 5.5 lakhs (79%) are female (*Census of India 2011).*

The PMC faces challenges in the core urban area due to land saturation and rapid population growth. The city has a linear growth pattern with high population density around the railway station and along the riverfront especially in the core area which is the oldest part of the city. The linear structure of the city, with its core near the eastern end and a densely mixed-use area around the railway station, indicates that further expansion within the current PMC area is constrained. Waterlogging issues have limited expansion to the east and south, suggesting that future growth should focus on the Patna Urban Agglomeration (PUA) area rather than within the saturated PMC. The core of the Patna PMC area has organic settlements as they were before any formal master plan was implemented. Out of 5390 hectares of residential land, PMC has organic development.

**Table 3:** Distribution of Housing Typology

| Typology | Organic | Planned -Plotted | Planned Apartment | Slum (Identified) |
|---|---|---|---|---|
| Area Wise | 91.71% | 5.2%% | 2.45% | 0.51% |

**Source: Patna-MP-Report (2011-31)**

**Table 4:** Housing Typology and Distribution

| | Total | Pukka | Semi pukka | Kutcha |
|---|---|---|---|---|
| Household (lakh) | 2.94 | 2.38 | 18.66 | 16.65 |
| Percentage | | 87.55% | 6.32% | 5.64% |

**Source: Patna-MP-Report (2011-31)**

The Bihar State Housing Board (BSHB) has developed several residential colonies and housing projects to provide affordable housing catering to the urban housing needs in the PMC area. Some of the notable housing colonies and projects are Bahadurpur Housing Colony, Hanuman Nagar Housing Colony, Lohia Nagar Housing Colony, Kankarbagh Housing Colony, Rajvanshi Nagar Colony, Gardanibagh Colony, Phulwari Sharif Housing Colony, Rajiv Nagar Housing Colony, Pataliputra Housing Colony. Kankarbagh Colony was one of the Aisa's largest colonies in its early years covering a significant area and known for its organized layout. Rajvanshi Nagar and Gardanibagh colony offers mixed residential units with infrastructure focused on catering to residential and recreational spaces to counteract the congestion and narrow roads of the old settlement area of Patna. Bihar State Housing Board continuously works to manage existing residential areas like Kankarbagh, Bahadurpur, Rajiv Nagar, etc., although Patna's growth and expansion in now managed by the Urban Development and Housing Department (UDHD) of Bihar and Patna Municipal Corporation (PMC) handling the urban planning and housing policies (Bihar State Housing Board).

Patna Municipal Corporation has a total of 99 slums with an area of 56.1 sq. km with a population of 77,034 distributed across 15,163 households. Bihar State Slum Policy defines slums as "A compact area of at least 20 'slum-like households' of poorly built congested tenements, in unhygienic environment usually with inadequate infrastructure and lacking proper sanitation and drinking water facilities." In terms of caste composition, the slum population has a distribution of approximately 1439 minority groups, 9645 from Scheduled Caste, 3781 from Backward Caste and 298 from General Category. Of the 99 Slums 56 slums are located on non-tenable government land as per the Bihar State Slum Policy while 12 slums are on Patna Municipal Corporation (PMC) land, 22 slums are on own/private land and 3 slums have been resettled (Census of India 2011).

**Table 5:** Slum list and ward location

| | Circle | No. of Wards | No. of slums | Households |
|---|---|---|---|---|
| | Azimabad Circle | 52,53,54,56,57,58,59,60,61,63,64,65 | 23 | 868 |
| | Patna city Circle | 62,67,69,72 | 8 | 352 |
| | Kankarbagh Circle | 29,30,32,33,34,35,44,45,46,55 | 25 | 1774 |
| | Bankipur Circle | 36,38,39,43,47,48,50,51 | 14 | 1175 |
| | Pataliputra Circle | 1,2,5,8,20,22, 22C,25,26,27 | 10 | 1647 |
| | Nutan Rajdhani Circle | 3,4,9,10,12,14,15,16,17,18,19,21,37 | 24 | 1263 |
| Total | | | 104 | 7079 |

**Source: Patna Municipal Corporation**

**Table 6:** Land ownership of Slum

| Social Hierarchy | Non-tenable Govt. land | PMC Land | Private Land | Resettled |
|---|---|---|---|---|
| Slums | 56 | 12 | 22 | 3 |

**Source: Master Plan of Patna 2031**

**Infrastructure and urban basic services**

For the operation and maintenance of urban services various institutes and agencies are working together in the Patna Municipal Corporation area. These agencies are Patna Municipal Corporation (PMC), Bihar Rajya Jal Parishad (BRJP), Public Health Engineering Department (PHED), District Urban Development Agency (DUDA), Urban Development and Urban Housing Department (UDHD).

**Table 7:** Implementing agencies and their services

| | Urban Basic Services | Implementing Agencies |
|---|---|---|
| 1 | Water Supply | |
| | Supply of water | PMC |
| | Maintenance of network | PMC, BRJP |
| | Construction and Upgradation | BRJP, PHED |
| | Water charges collection | PMC |
| 2 | Sewerage system | |
| | Construction of Sewage treatment plant | BRJP |
| | Lying of network | BRJP |
| | Construction of community toilets | DUDA, UDHD, PMC |
| | Maintenance of system | PMC |
| | Collection of user charges | PMC |
| 3 | Stormwater Drainage | |
| | Construction of drain | PWD, PMC, BRJP |
| | Clearing of drain | PMC |
| 4 | Solid waste Management | |
| | Collection of waste | PMC |
| | Collection of user charges | PMC |

**Source: Master Plan of Patna 2031**

The service level within Patna Urban Agglomeration comprises Patna Municipal Corporation, Nagar Parishad, and outgrowths, has been reviewed to assess their adequacy for the current population. The evaluation of the system focuses on six core civic amenities i.e. Water supply system, Sewerage, and sanitation network, Solid waste management, Roads and Storm Water Drains, Street Lighting, and Other Community Facilities and Amenities.

**Water supply**

Patna Water Board was established in 1952 with the formation of Patna Municipal Corporation and initially, it operates with only five water supply centers through Patna Water Board at the Collectorates, Patna City, Katra, University, and Bailey Road, Dhobi Ghat. With the increase in population, the number of water supply centers increased to 35 by 1974 and later the water supply centers continued to grow with the demand. Subsequent expansion led to further development, including the establishment of water supply centers in new areas post-1985. At that time, the responsibility for laying water supply pipelines in new regions was transferred to the Bihar State Water Board by the government (Patna Municipal Corporation).

Currently, PMC operates with 110 water supply centres and water supply branches, Patna Municipal Corporation is being operated in the entire municipal area with 1500 kilometers of water supply pipeline being laid to serve the population. The water supply branch is currently divided into four headworks i.e. Patna City Headwork, Bankipur Headwork, Bailey Road Headwork, and Kankarbagh Headwork to manage and supply the water to the entire municipal area of Patna. Five gangs have been deputed for repairing all water supply pumps and 19 gangs have been deputed for maintenance of the pipeline, who are deputed in four headworks. The water supply system of Patna is a decentralized network system with a single or group of tube wells installed for the specific area to cater. The study conducted by the National Institute of Urban Affairs (NIUA) highlighted that despite 75% of the population having piped water connections 40 % of them are dependent on the public stand post due to low water pressure & poor supply system. 40% population is directly dependent on private tube

wells and 20 percent get their daily need of water from public stand posts. The piped water supply connection is low, and it accounts for only around 40 percent of the population of Patna (Economic Survey of the State, GoB, 2012). The leftover population relies on private borewells, public taps, and public and private hand pumps (ibid). Thus, the 'public' water is supplied only to a small section of the population, and the rest of the population depends mostly on private and public appropriation of the groundwater resources (Sharma, 2015). The total number of connections in the PMC Area is almost 90,000, out of which 80 percent are domestic connections and 20% are non-domestic connections. The cost of a new water connection will be – Rs. 940/- and the domestic charge per connection per month is Rs. 40/- as per Patna Municipal Corporation.

**Sewerage System**

The underground sewerage network system covers Patna Municipal Area along with some parts of Phulwari & Danapur Nagar Parishad. Patna covering an area of 110 sq. km is subdivided into five (5) zones namely Digha, Beur, Saidpur, Pahari, and Karmali Chakas shown in Figure 4 below. To cater to the sewage waste generated there are four sewage treatment plants were installed at Saidpur, Beur, Pahari, and Karmali Chak. As per the Census 2011, 62.51% of the households had water closet latrines, 20.37% had pit latrines and open defecation was practiced by 9.01% of households. The length of the underground sewerage network is estimated to be 27.4 km. The sewage generation in the town in 2011 was 181.8 MLD and this is expected to increase to 551 MLD by 2030 (Master Plan of Patna 2031).

**Table 8:** STP its actual capacity and working capacity

| STP and Year of Construction | Capacity (MLD) | Working Capacity(MLD) |
|---|---|---|
| Saidpur - 1936 | 45 | 28 |
| Beur- 1970 | 35 | 20 |
| Pahari1994 | 25 | 12 |
| Karmali chak- 2007 | 16 | 4 |
| Total | 121 | 64 |

**Source: Social Assessment and Management Plan for Sewerage Schemes for Patna City July 2015**

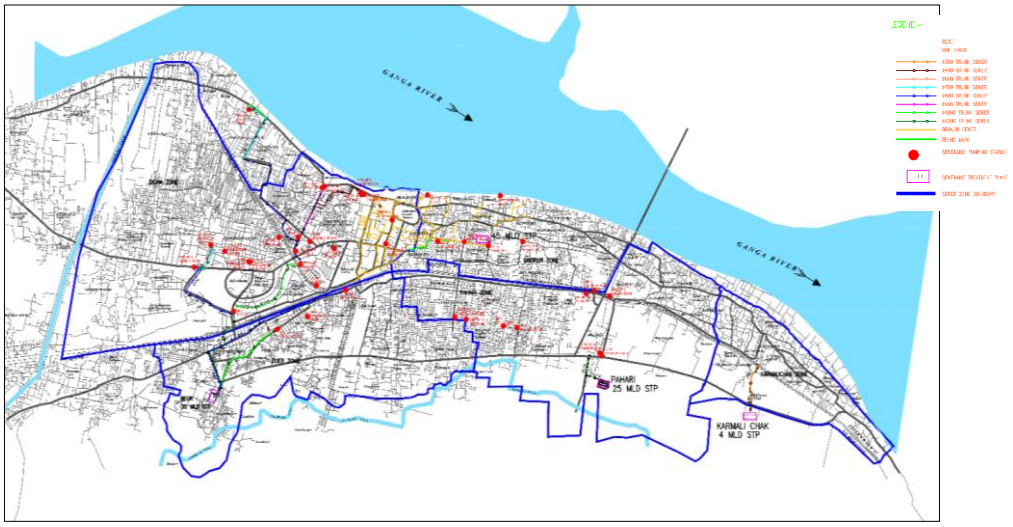



**Figure 4:** Five zone for Sewage management, Location of STP, and Location of Sewage Pumping Station

**Source: Urban Development and Housing Department, Bihar**

Table no.9 highlights the significant gap in the sewage generated and sewage treatment capacity of STP in the PMC area. With a total sewage generation of 181.8 MLD (million liters per day) for the city, the treatment capacity available is 64 MLD way below the required 181.8 MLD. The gap of 117 MLD is a large quantity of sewage untreated potentially leading to environmental and public health challenges. Furthermore, 21.7% of the population relies on the underground sewerage system which is which underscores the limited reach of proper sewage disposal mechanisms. Only 27.4 km of sewerage network runs in the city covering only 25 percent of the road network. The data in the table above show the stress on the system and the pressing need for the expansion and modernization of the existing network in terms of enhanced sewage treatment capacity, and broader UGD coverage to address the city's growing sanitation demands effectively.

**Table 9 :** Sewage generated and treated in PMC

| Components | PMC area |
|---|---|
| Sewage generated in MLD | 181.8 |
| Sewage Treatment Capacity in MLD | (121)64 |
| GAP in MLD | 117 |
| % age of Population with UGD | 21.7 % |
| Sewer Length in km | 27.4 |
| Road covered by UGD Network (%) | 25% |

**Source: Social Assessment and Management Plan for Sewerage Schemes for Patna City July 2015**

**Assessment of Sewage through Shit flow diagram for Patna at City Level**

Shit Flow Diagrams are a method used to analyse and anticipate excreta management in cities and towns. Only one-fourth of Patna's population has an off-site sanitation system while 21.7 percent has a sewer connection. Sewer networks connected to households in Patna have multiple breakpoints, causing wastewater leakages and cross-contamination between sewer lines and open drains (Thakur & Singh, 2017). As the exact quantity of waste discharged into open drains is not available, it is estimated that 70 percent of the waste is generated from the household connected to the piped sewer connection i.e. 15 percent of Patna's total household flows into the sewage network, while the remaining 30 percent i.e. 7 percent of Patna's total household discharged into the open drain along with that additional 2 percent of household release waste directly onto open ground. It is further assumed that only half of the wastewater entering the sewer network reaches sewage treatment plants (STPs), and from the wastewater discharged into open drains, only 50% is conveyed to STPs, where half of it undergoes treatment.

About 68% of the population in Patna relies on on-site sanitation systems, including 2.8% who use community toilets maintained by the Patna Municipal Corporation (PMC) (KII-PMC, 2016). Effluents from septic tanks are discharged into open or storm drains and open ground, with an estimated 50% of the supernatant (SN) going to each (Kumar, 2016). Emptying of these systems is mainly managed by private operators, with government vacuum tankers servicing only a few households. It is assumed that 95% of septic tanks are emptied, while 5% are abandoned or not regularly emptied.

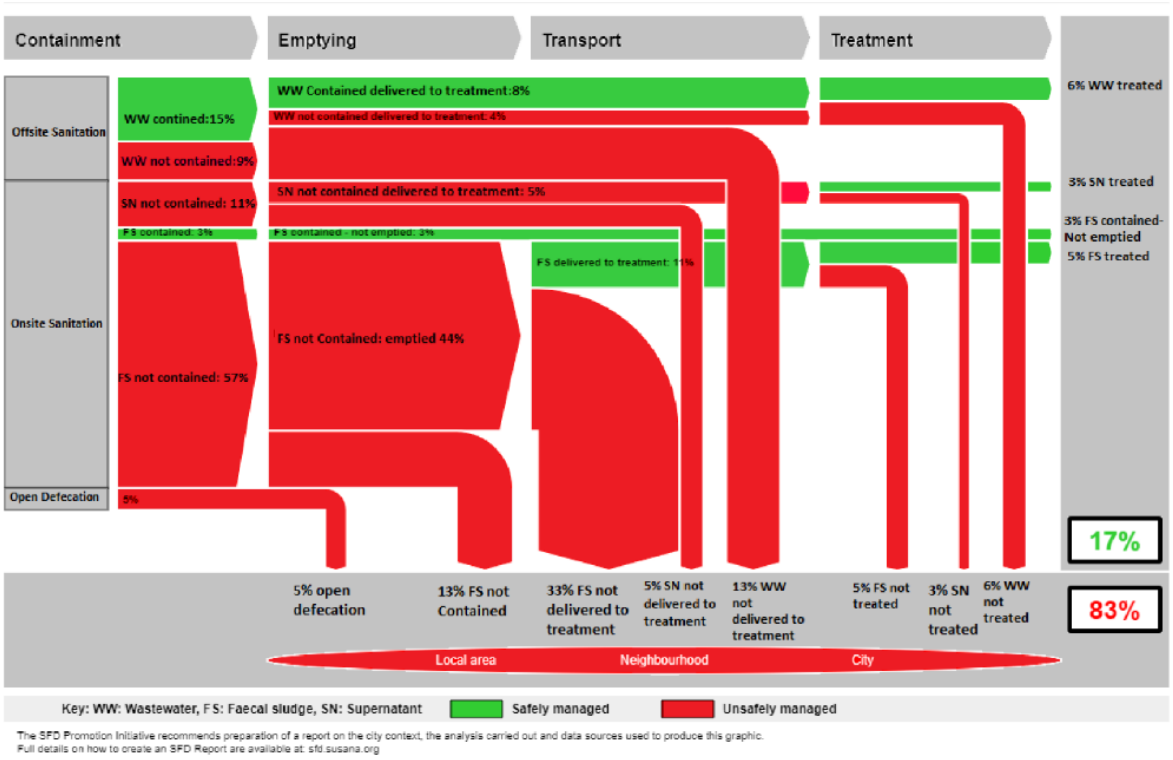



**Figure 5:** Shit Flow Diagram of Patna

**Source: Population Services International (2018), SFD report: Patna, India.**

Collected fecal sludge (FS) is either discharged into drains or open land, with 50% reaching sewage treatment plants (STPs) for treatment and the other 50% going to open ground (Kumar, 2016). Only 50% of the FS in drains and open ground is treated at STPs.

Approximately 2% of households (HHs) in Patna utilize lined pits with semi-permeable walls or unlined pit types of containment systems. It is estimated that 95% of the fecal sludge (FS) generated from these systems is emptied, with 25% being transported to sewage treatment plants (STPs) and 50% of that transported FS undergoing treatment. Additionally, 1% of the population uses unlined pits, and it is assumed that 95% of the FS generated from these pits is discharged into open drains, with 25% transported to STPs and 50% of that treated. Furthermore, 5% of the population practices open defecation (Thakur & Singh, 2017).

**Strom Water Drainage**

As mentioned above Patna is located over an elevated terrain along the southern bank of Ganga River ranging from Danapur in the west to Fatuha in the east. In terms of width from north to south direction, it is approximately 1.5 km towards the east and 3 km to the west. The natural slope inclines both southward and eastward making a saucer-like topography leading to a critical for drainage and flooding issues. The city's topography is distinctly defined by the railway line which cuts through the city. To the southern side of the railway line land is mostly flat, leading to challenges in water management and resulting accumulation of rainwater frequently. The waterlogging and urban flooding risk intensifies when the water levels in the Ganga, Punpun, and Sone rivers rise during the monsoon. To address the situation of drainage the whole PMC is subdivided into five (5) zones and a total of 38 pumping stations have been installed in the strategic location to address the waterlogging. The Eastern Zone stretches from north of the new bypass road to Didar Ganj, discharging into the Ganga River and nearby low-lying areas. The Western Zone ranges from Fraser Road to Danapur-Khagul Road, with

drainage directed toward the Ganga. The Southern Zone lies between the old and new bypass roads, bordered by Agam Kaun Road and the Patna-Gaya Railway Line, and drains into the Punpun River. Lastly, the Central Zone spans stretch from Patna Gaya Road to Nalanda Medical College, discharging through the Saidpur Pumping Station into the Punpun River. This zonal division ensures effective water management in line with the city's topography.

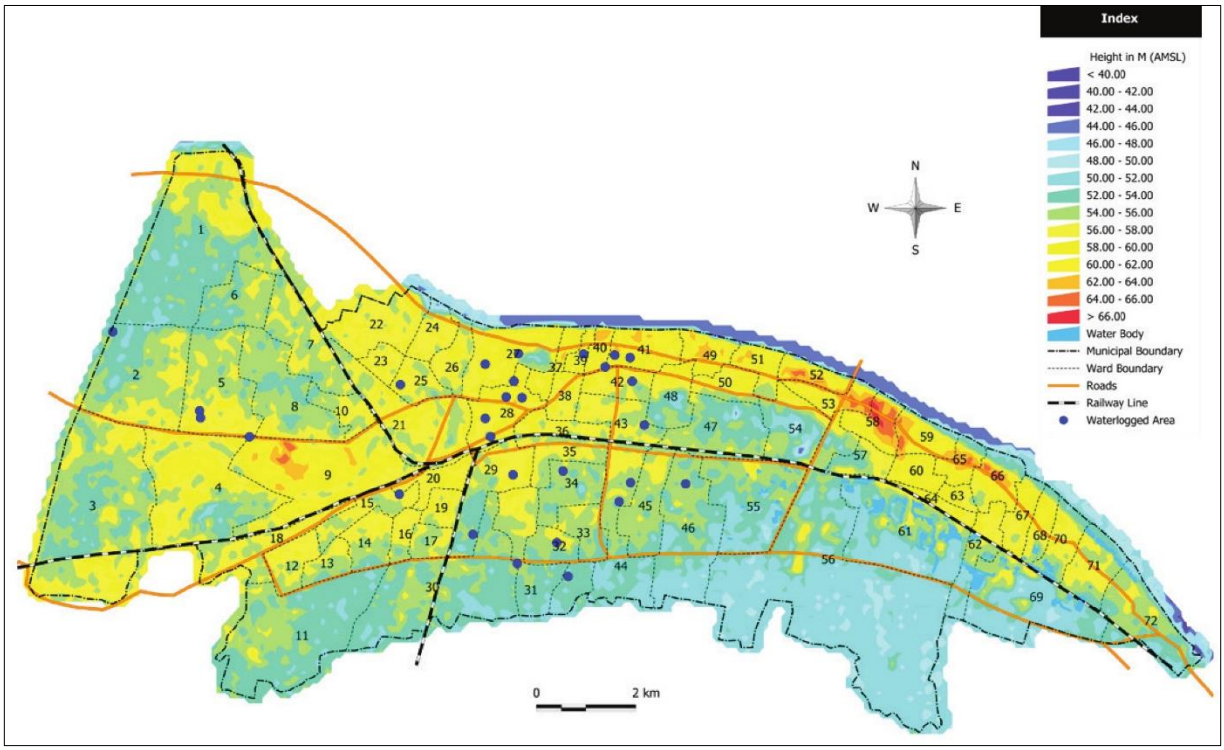



**Figure 6:** Topography and area prone to waterlogging in Patna Municipal Area

**Source: Climate-Focused City Resilience Action Strategy for Patna Urban, GEAG, 2017**

| Drainage Zone | The total length of the Drainage channel | Name of drain |
|---|---|---|
| Eastern zone | 18 km | Agamkuan Nala |
| Western zone | 21.5 km | Serpentine canal<br>Boarding canal<br>S.K. Puri Canal<br>Kurjee Canal |
| Southern Zone | 12 km | Barmutta Nala |
| Central Zone | 33 km | Bakarganj Channel<br>Kadamkuan/ Agamkuan Nala |

There are a total of 38 pumping stations installed in various locations in the PMC boundary. This pump will pump out the rainwater from the city to the river through various channels to the river. The normal rainfall in May is 44 mm, 168.4 mm in June, 311.7 mm in July, and 303.8 mm in August.

| Agency | Total no of pumping station | Discharge Capacity |
|---|---|---|
| Bihar Rajya Jal Parshad(BRJP) | 25 | 10670 MLD |
| Patna Municipal Corp.(PMC) | 10 | |

| | | |
|---|---|---|
| BHB | 1 | |
| National Building Construction Corp.(NBCC) | 2 | |
| Total no of pumping Station | 38 | |

**Community/Public Toilets**

Patna Municipal Corporation maintains sanitation and public health in the corporation boundary for the urban poor and floating population by providing civic amenities like toilets and urinals in public places. This service is managed by dividing the PMC area into three circles. Each circle is administered by an executive officer, and assistant health officer along with other officers and staff to look after the sanitation work.

There are a total of 78 Community toilets constructed by the municipal corporation with the help of center and state funding.
Sulabh International was the main agency that built these community toilets.
Initially maintenance of these community toilets was under the supervision of Sulabh International but later due to some issues, MCP withdrew all the maintenance right from Sulabh International.
All these community toilets are spread all over the city and cater large number of the population without toilet facility.

**Figure 7:** These toilets are termed deluxe toilets cost of construction is around 17 lakhs.

**Source: Author**

- These community toilets are termed deluxe toilets having the cost of construction around 17 lakhs.
- There are a total of 4 toilets and 1 bathroom each in the men's and women's section and 2 urinals in the men's section.
- A septic tank is provided for collecting the excreta and cleaning of the septic tank is done every 6 months by municipal corporation.


**Figure 8 :** Community toilets are encroached on by migrated and homeless people

**Source: Author**

- Out of 78 community toilets more than half of them are not in working condition and the local people or the people from outside have encroached on the toilet complex and area near it.
- The urban development department had spent around Rs 5.38 crore on the construction of 32 deluxe toilets. The cost of one deluxe toilet is around Rs 16.84 lakh. Apart from the deluxe toilets, 58 general lavatories are constructed and maintained by PMC.


**Source: Author**


**Figure 9:** Toilets complex for both men and women and Digester Tank were bio gas is decomposed from the human excreta Under the plantation

**Source: Author**

**Figure 10**: Electricity and cooking gas from the biogas generated from waste

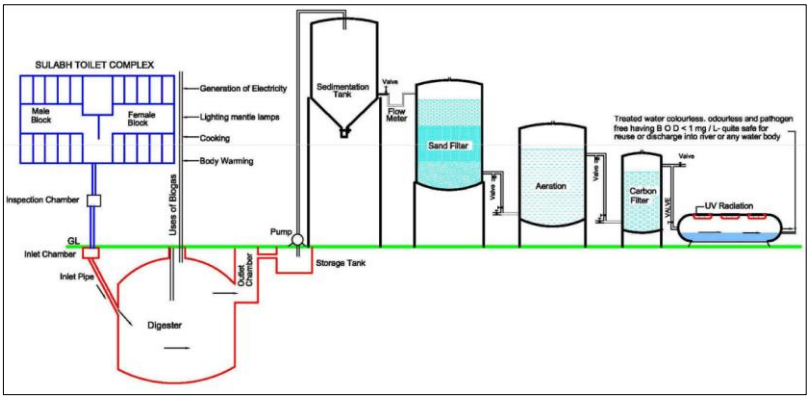



**Figure 11:** Thematic diagram to show the complete recycling and reuse of human excreta from public toilet: Sulabh Bio Gas Digester

**Source: Author, Sulabh International**

## Finding, Issues and Problems

The urban sanitation structure in Patna Municipal Area is fraught with challenges across multiple dimensions, encompassing operational, managerial, and maintenance deficiencies. Patna is the most populated city in Bihar and ranks 19$^{th}$ in population at the national level, with 1.7 million people, as per the 2011 census. Due to the high density and large population, the city sanitation infrastructure is under tremendous pressure. Some of the major issues and problems were identified and listed under different categories.

### City-Level Issues

At the city level problems and issues are exacerbated due to the low-lying topography of the city resulting in the retention of the wastewater, especially during the monsoon period. Badshahi Nala is the channel that carries the treated waste from the STPs to the Punpun River and during the monsoon season, this flow of waste to the river is interrupted by the Raksha Bandh (barricade) to protect the city from the flood water. The flow of sewage stops during the monsoon in the river ultimately leading to a flood-like situation in the southern part of Patna. The underground sewerage system covering only 21% of total households is insufficient to meet the needs of the city's population, resulting in the dependency of a large population on septic tanks and low-cost sanitation systems. These systems such as septic tanks and low-cost sanitation while serving a critical function, contribute to environmental degradation, as untreated effluents are often discharged into open drains, polluting water streams and rivers. In terms of public sanitation facilities, such as community toilets and public toilets, they are equally insufficient, with only 78 public toilets in the entire PMC area, more than half of which are non-functional due to poor maintenance. In 2011, the Union environment minister announced that Rs. 3,000 crores would be spent to set up STPs in 19 towns of Bihar. These 4 STPs were proposed in the PMC boundary in the next five to six years under the National Ganga River Basin Authority (NGRBA). But the Sewage Treatment Plants (STPs) which were proposed under the National Ganga River Basin Authority (NGRBA) nearly a decade ago, were delayed in implementation and have left the city without sufficient sewage treatment facilities, particularly in the fringes, which continue to discharge untreated sewage directly into stormwater drains. Patna will have the biggest plant for which about Rs. 1,500 crores for the project but it takes almost a decade to implement them and there is no backup plan for these years.

### Household level issues

Around 80 percent of households in Patna Municipal Area are dependent on septic tanks and low-cost sanitation. The lack of proper monitoring and maintenance of the septic tanks and low-cost sanitation system leads to an unhealthy and unhygienic environment. The shallow depth of groundwater, ranging from 1 to 8 meters, increases the vulnerability to microbial pollution, posing severe public health risks. The seepage increases the risk of contamination, potentially introducing pathogens, nutrients, and other pollutants into the water table, posing serious risks to public health and water quality. A poorly maintained septic system can be a breeding ground for flies and insects that can transmit infectious diseases that can put life in danger**.** The disposal of the sewage collected by the suction vehicles into the stormwater drains without proper treatment further contributes to environmental pollution. These unethical and illegal practices suggest that there is a critical need for a more robust, efficient, and well-regulated sanitation system at the household level. Regular cleaning service is required to remove sludge and wastewater, which is not carried out effectively both at the residents as well as at the government level.

### Institutional Level Finding, Issues, and Problems

The poor sanitation conditions in the city are not solely a result of ineffective infrastructure or public negligence but are also influenced by challenges in institutional functioning and the implementation

of various schemes and programs. Poor coordination among municipal departments undermines effective planning, resource allocation, and timely response to sanitation needs. Monitoring and accountability mechanisms are inadequate, leading to inefficient implementation of sanitation projects and their deterioration over time. Budget constraints and delays in fund disbursement further hinder the quality and accessibility of sanitation services, particularly in underserved areas. Limited public engagement within sanitation initiatives often reduces community adherence to hygiene practices, while excessive bureaucratic procedures create administrative bottlenecks that impede both immediate and long-term improvements. A lack of consideration for pre-implementation planning, post-implementation impacts, and comprehensive preparation ultimately leads to the failure of the scheme. Without addressing these factors, the scheme's sustainability and effectiveness are compromised, reducing its potential to achieve long-term benefits.

**Problems Faced by Non-Government Organisations working for sanitation**

The non-Government organization plays a vital role in the efficient sanitation system at the city level, especially for the marginalized population at the grassroots level. Many NGOs such as Nidan, Muskhan, Vishwas Shuddhi, and Sulabh International are quite actively working in the city for the betterment of the sanitation services at different levels. These organizations are facing significant operational and financial constraints due to the lack of cooperation from government agencies. Approvals for critical services such as water and electricity supply were often delayed by Municipal authorities, affecting the operation and maintenance of community sanitation projects. Resistance from the local community regarding the maintenance of sanitation facilities is one of the concerns due to the prevalent issue of unpaid maintenance charges. Lack of collaboration and knowledge exchange amongst the NGOs restrict the collective action required for better results. Delays in the recovery of the security deposits worsen the situation as it affects operational flexibility. NGOs working in the area often struggle to get support from the agencies for septic tank cleaning and utility services, resulting in discouragement and a decline in their intent to benefit the community.

**Suggestions and Recommendations**

Improving sanitation in Patna demands a multi-faceted method addressing centralized sewage infrastructure, decentralized treatment solutions, reinforced municipal responsibilities, community involvement, and sustainable financing. Municipal bodies must establish clear bylaws to regulate septage management effectively and increase the capacity of existing sewage plants (STPs), for centralized sewage management. Presently, Patna’s STPs have at a total capacity of 121 million liters per day (MLD) but only 64 MLD is fully utilized due to a shortage in staff and management strategies. The city of Patna is generating approximately 181 MLD of sewage, which leaves a significant treatment gap. The delay in the proposed STP is the burden to the 117 MLD of waste generated by the city, the acceleration in the installation of the proposed STP will help to minimize the gap. The situation becomes worse as Patna faces the challenge of overflow and blockages, especially during the monsoon season when untreated wastewater mixes with stormwater due to an obsolete drainage system and the topography of the city. A separate stormwater and sewage system would lessen this risk, ensuring that treated wastewater is managed more effectively without having an adverse impact on the environment and nature. Further, strict legal action and imposing monetary fines for untreated wastewater discharge could enforce compliance and encourage environmental protection standards in society. The sanitation problem in Patna can be addressed by the decentralized sewage treatment systems (DTS) by providing localized treatment options. These localized treatment system decreases the load on the centralized machinery promoting energy generation and sustainability. During the planning phase of residential and commercial projects, it is essential to incorporate wastewater treatment and drainage systems in their plans to reduce the pollution of groundwater and soil impurity. Local bodies in charge such as Municipal corporations and Pollution Control authorities must be very vigilant for the implementation of these laws by the people for compliance with the environmental

standards. To maintain and promote the adoption of a decentralized sewage treatment system, private developers and cooperative housing groups should be given tax benefits and changes in the municipal bylaws so that they invest in the operation and maintenance of the system. Professionals such as architects and engineers, should be provided with special training in DTS and pollution control practices so that they can further enhance the development and long-term sustainability of these decentralized options. Such training equips the professional with the required expertise to design, manage, and operate effectively the wastewater treatment system.

The Patna Municipal Corporation (PMC) has a critical role to play in managing both centralized and decentralized sanitation systems. To improve onsite sanitation, PMC should formulate specific regulations for septage management, enforce regular inspection and desludging of septic tanks, and ensure septic tank designs meet sanitary standards. At present Patna city operates with limited machinery which has three jetting cum suction machines, which is insufficient to meet the growing demand of the city. There has been a recent allotment of funds for the procurement of additional equipment, thus PMC must accelerate the attainment and deployment of vacuum trucks and other related machinery to boost the service and meet residents' needs effectively. PMC while performing the technical duties, should regularly implement desludging and must develop a standard protocol which includes safety measures for desludging operations.

To maintain sanitation services government must introduce a dedicated tax or cess for septage management, which in turn will help to generate sustainable revenue. With the growing population of Patna, it is important to integrate provisions for sanitation facilities into real estate development plans, which will ensure that the new housing projects follows the set rules of the city's sanitation goals. To attain open defecation-free status in Patna depends on ensuring universal access to toilets and implementing solutions which are specific to the diverse spatial and financial constraints. The individual toilet is the most preferred option but in densely populated areas with limited land and other resources, they are not feasible. In such cases the option of community and shared group toilets serves as an effective alternative. The shared toilets which are jointly maintained by two to four families, provide a very cost -effective solution to meet the various community needs, in areas particularly where facilities are not possible. Improved water supply is very essential as water plays key role in reducing open defecation rate.

To ensure financial possibilities, authorities must adopt both traditional, innovative, and problem-specific funding strategies. Prevailing sources of funding, like government sanctions are not adequate to cover the growing sanitation expenses of the city. Thus, emphasizing on exploration of alternative ways to meet the monetary gap. One upcoming model is the use of Social Impact Bonds (SIBs), which link funding to an accessible amount of improvement in social outcomes. This model (SBIs), has demonstrated success in various international projects and could provide a solution for the sanitation finance challenges. Performance-based funding, which gives financial support to the achievement of specific, time-bound objectives, can serve as an effective motivation for sanitation projects to remain focused and provide outcomes with substantial efficiency. In public sanitation, corporate social responsibility (CSR) funds assigned under the Companies Act for large companies, present a significant opportunity for private sector investment. By encouraging private sectors to assign a portion of their CSR contribution in sanitation of Patna, authorities can promote collectively helpful partnership that align corporate objectives with community development needs. In totality, addressing the sanitation challenges of Patna requires a mixed approach involving the development of both centralized and decentralized sanitation frameworks, strengthening of municipal government, encouragement of community-led sanitation initiatives, and the adoption of varied financial mechanisms. Implementing the above measures and strategies can enable Patna to achieve significant

progress in public health, sanitation, and environmental sustainability, thus, increasing the comprehensive liveability and resilience of the city.

## CONCLUSION

In Patna to improve the city-level sanitation system and infrastructure, a multi-dimensional approach is required as the existing sanitation system lacks efficiency and maintenance, making it difficult to address the needs and requirements of the growing population of the city. For instance, the four existing sewage treatment plants (STPs) in the city are operating below their capacity due to lack of maintenance and lack of resources. This lack of maintenance results in the direct disposal of untreated wastewater into the river, thus, intensifying water pollution and posing significant public health risks. For the full capacity functioning of the sewage treatment plants, it is essential not only to upgrade the system and infrastructure but also to work towards the proper functioning, maintenance, and adequate use of resources. The lack of collaboration among the various organizations, which includes municipal bodies, government departments, and NGOs, further increases the challenges of maintaining a clean and healthy environment. Disorganized efforts often lead to duplication of work or gaps in service provision, leaving some areas of the city deprived of the services. To maximize the citywide impact of the sanitation program, it is necessary to establish a collaborative structure among these organizations in streamlining the efforts and pooling of resources. The topography of Patna City presents a unique challenge to the conventional sanitation methods, making them less effective. These unique geographical features require specific solutions for the problems, such as decentralized wastewater treatment systems, and innovative eco-friendly waste management approaches, which are designed particularly for the city's specific needs and conditions. The adoption of non-conventional sanitation methods can address the limitations of traditional sewage systems, particularly in those areas where installing or maintaining conventional infrastructure and facilities is challenging. These innovative methods offer practical and sustainable solutions to meet the city's diverse sanitation needs.

Achieving an open defecation-free (ODF) city status requires a comprehensive strategy that goes beyond infrastructure to include community engagement and education. Empowering and encouraging government organizations and NGOs, raising awareness about sanitation practices amongst the population, and providing continuous education to citizens are essential components of this approach. Engaging the community with the initiatives will ensure a sense of ownership and responsibility for the user and encourage residents to contribute actively to maintaining their environment.

various national programs and policies aim to address these sanitation challenges. The Swachh Bharat Mission (SBM) has made significant strides in improving sanitation infrastructure and reducing open defecation, yet there is a need for greater synergy between this mission and local initiatives. Additionally, programs like the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) focus on improving urban infrastructure, including sanitation facilities, sustainably. The Smart City projects, under the Ministry of Urban Development, also aim to modernize urban infrastructure, integrating smart technology for better waste management and sanitation services.

Despite these efforts, achieving sustainable sanitation improvements in the city will require not only infrastructure upgrades but also a strong institutional framework, public engagement, and innovative, context-specific solutions that can adapt to the city's unique challenges. Enhanced cooperation, consistent funding, and proactive community education will be essential in transforming the city's sanitation landscape, ultimately improving public health, urban liveability, and environmental quality.

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