



Sustainable Path of Urbanization in India, A Case Study of Prayagraj City

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Abstract: -

The future of humankind lies in cities. The Current scenario and trends of urbanization have become more miserable and alarming across the world including developing country like India. Urbanization has been described as a consequence of population shift from less concentrated areas to high concentrated areas. The path of urbanization is directly associated to other factors like - modernization, industrialization, technological progress, infrastructure, sociological conversions, economy, planning of policies and public health etc. A modern city would be environmentally sustainable when we take into consideration various factors such as climate resilience, disaster management, low-carbon energy system, ecological adaptation, basic primary public health facilities, occupational diversification, water resources management, and better sanitation facilities.

The paper is an attempt to assess the current status of environmental sustainability in emerging cities of India with special reference to Prayagraj city and to analyse the role of environmental sustainability in Prayagraj smart city transformation. The study is based on both primary and secondary data. Multi-criteria decision analysis is used as a method to produce consolidated outcome for each parameter.

The key focus of this paper is to develop a sustainable path of urbanization for Indian emerging cities in general by probing city of Prayagraj as an example for urban development, policies and strategies. The study will provide future strategies to make Prayagraj smart city with sustainable urbanization.

Keywords: - Urbanization, Multicriteria decision analysis, Prayagraj, Future strategies.

JEL Code: - Q01, P25,018

Introduction: -

Sustainable Development is defined in many ways. The universally recognised interpretation is from the Brundtland Report: 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987, p.43). The most accepted and dominant way of showing and introducing the concept of sustainable development has been through the concepts of three overlying forms, separately showing concerns related with the economy, society and the environment. Sustainable development lies in the three-fold overlap at the centre, where it integrates the three areas of concern (Connelly, 2007).

In this galloping world, 54 percent of the world's population resides in cities and this is going to touch to 66 percent by 2050 (U.N.,2014). The worldwide trend is in the direction of urbanization. It is expected that the world's population will reach to 8 billion by the year 2025 and 9 billion by 2040. All of the increased population is expected to live in urban areas as the total rural population is expected to remain persistent at about 3.3 billion by 2035 and then decline slightly to 3.2 billion by 2050.

Linked with the concept of sustainable development and the process of urbanization, the sustainable development of cities is therefore of great importance. Sustainable areas are economically beneficial, socially and politically inclusive and comprehensive and environmentally sustainable. In other terms, they definitely encourage efficient economic activities, assure that all persons can benefit from them, and certainly do so in an approach to conserve the biodiversity and ecosystem, clean air and water, physical health and safety and security of the people, especially in an era of climate change & rising vulnerability to severe climate calamities.

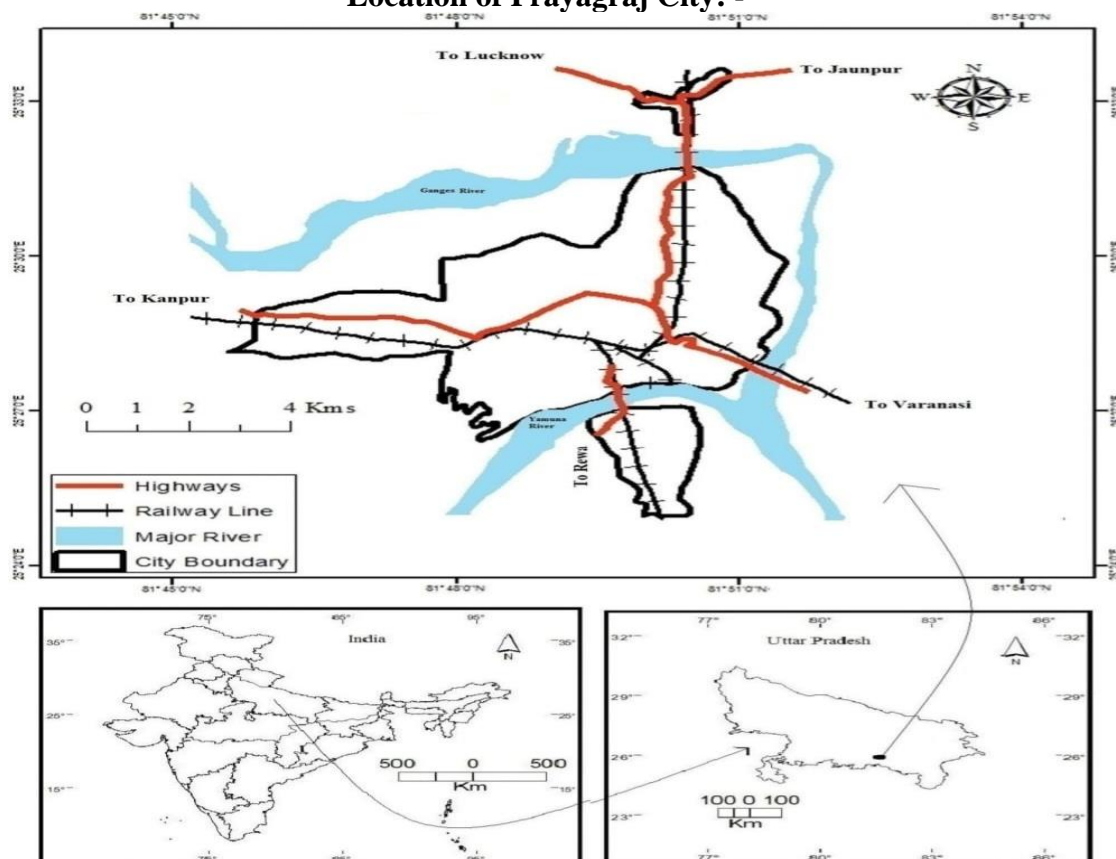
Importance and role of sustainability in cities can be understood by the fact that United Nations adopted seventeen (17) sustainable development goals (SDGs), Goal number eleven (11) is related to sustainable cities & communities. The accelerating trend of urbanization is putting pressure on city resources including space, social and physical infrastructure. The current status and trends of urbanization have become more challenging and miserable across the world including developing country like India. With fast and unplanned urbanization, proposed smart cities in India are characterized by high pollution, urban sprawl and slums, dense population, traffic jams, high cost of livings, corruption, irresponsible governance, poor health care and educational facilities, frequent power cuts, water shortages and inadequate sanitation facilities.

Approximately all the Indian cities have already utilized their resources beyond its carrying capacity limit and have become unsustainable. Continuous increase in flow of migrants to urban areas is only deteriorating the problem (Owen, 2009). Near about 31 percent of India's population lives in cities and contributes 63 percent of India's Gross Domestic Product (Census of India, 2011). With rapid urbanization, 40 percent of India's population is predicted to dwell urban areas and contribute 75 percent of India's GDP by 2030 (Ministry of Urban Development, 2015). Urbanization and the subsequent expansion of build-up areas at the urban city centre and resultant impact to the land and water resources have degraded the immaculate beauty of the environment which further impacting the health of city inhabitants (Singh et al., 2016). In the present scenario, development of physical, socio-economical & institutional infrastructure of urban area is the need of the hour. These are essential in sense of ameliorating standard of life and to attract persons and investment towards the urban area. Smart city mission of India for transforming cities is a crucial step in that path.

The Government of India has published the list of names of 98 smart cities in 2015. Prayagraj city wins the national competition among states organized by Ministry of Urban Development, Government of India. It is a selected 01 out of 12 future smart cities from Uttar Pradesh (Press Information Bureau, 2015). Trade and Development Agency of united states has already signed a Memorandum of Understanding (MOU) with Uttar Pradesh government to convert Prayagraj a smart city (The Hindu, 2015). In Prayagraj, few areas are selected for retrofitting under the smart city project of government of India. The paper is an attempt to assess the current status of environmental sustainability and urbanisation in emerging cities with case study of Prayagraj city and to suggest the expected path of sustainable urbanisation in emerging cities in India.

Study Area: Prayagraj city

Prayagraj City is one of the big cities of UP (Uttar Pradesh) in terms of population and area. Geographical location of Prayagraj is 25°28'N latitude and 81°54'E longitude. The city is famous in whole world for its magical convergence of religion history and culture. (City Development Programme of Allahabad, 2006). Topography of the city is mainly plain with some undulations and city may be classified into three physical parts – (i) Trans-Ganga or the Gangapar Plain, (ii) Trans-Yamuna or the Yamunapar tract and (iii) the Ganga-Yamuna doab (confluence), all three of which are shaped by Ganga and its tributary Yamuna, the latter joining the former at Prayagraj, the confluence is known as Sangam. As per Census of India, 2011, total Area of the city is approximately 70 km² with population of 1,168,385. City area of Prayagraj is categorised into 80 wards for administrative purposes.

Location of Prayagraj City: -

(Source: Census of India, 2011)

Facts of Prayagraj city: -

CATEGORY	YEAR 2001	YEAR 2011	REMARKS
MUNICIPAL WARDS	40	80	Election Wards
POPULATION	1018092	1117094	% of Population in Slum Areas – 31% % of Population in Non-Slum Areas – 69% (per Oxfam Study, 2005)
HOUSEHOLDS	136680	208000	No. of Households in Slum Areas – 59,357 No. of Households in Non-Slum Areas – 1,38,501
FAMILY SIZE (AVG.)	7.4	7.6	
NO. OF SLUM AREAS	185	356	Source: NNA
AREA(sq.km)	170.27	170.27	
POPULATION DENSITY		8786.05	
COMMERCIAL & OTHER ESTABLISHMENTS HOTELS & RESTAURANTS	3106	4046	Other establishments include offices, institutions and markets

(Source- City Sanitation Plan Prayagraj)

Methodology: -

Data for this case study has been obtained from both primary and secondary sources. Primary data is collected by interviewing city residents and officials. Secondary data is accessed through open publish sources like central government websites & portals, Uttar Pradesh government websites & portals, concerning research articles accessible as open source, public reports and statistics and surveys done by many institutions which are associated with research in the area of Sustainable Urbanisation. Findings, suggestions, conclusions and reports which are available as publications such as District Census Handbook of Prayagraj, the data for the smart city and sustainable urbanization components is gathered from various departments of UP i.e., Nagar Nigam Prayagraj, Jal-Kal Vibhag of Prayagraj, Department of Medical, Health and Family Welfare of Uttar Pradesh, Development Authority (PDA) of Prayagraj. I have used Multi criteria decision analysis as a method to analyse each parameter in detail..

Data analysis & discussions (Secondary data): -**A- Water supply**

Prayagraj city is divided into 12 water supply zones. The water supply zones, namely, Lukerganj, Khushroobagh, and Atala are covered by surface water sources. Civil lines and Kydganj zones are partially covered by surface water supply. A part of these two zones is also covered by ground water sources. The remaining seven zones, namely, Colonelganj, Daraganj, Rasoolbad, Sulem Sarai, Naini, Phaphamau and Jhansi are covered by tube wells.

Coverage of water supply connections is 72.5%. Total length of water supply distribution system is 1122 km of pipelines that is maintaining by Jal Kal. In the slum and LIG areas, deep bore hand pumps have been installed and provision of water tankers is made additionally to meet water supply needs of the community during emergency. The supply of water to the consumers is intermittent and spread over a period of 10 hours in three shifts i.e. 6.00 am to 10.00 am, 12.00 noon to 2.00 pm, and 6.00 pm to 10.00 pm.

INFRASTRUCTURE	NUMBER	CAPACITY (MLD)
Overhead Reservoirs	13	12.35
Zonal Pumping Stations	3	5.85
Tankers	4.7	
Total	285.7	

(Source: SLB Data, NNA)

Year	Projected population	Water supply demand in MLD
2031	20.1	347
2041	24.2	418

(Source – CRIS Analysis)

Water supply demand has been estimated for future population projections at 173 LPCD (including transmission losses).

We have observed the following challenges/issues regarding water supply in Prayagraj city.

- High dependence on ground water leads to high operations and maintenance cost.
- The failure rate of tube wells is high.
- The existing water supply system is quite old, and it suffers from leakages and inadequate carrying capacity.
- The storage capacity is inadequate, particularly in the extended areas of the city.
- Only 1% of the connections are metered.
- Water supply pressure is uneven at the consumer end in many places.
- A report has been published in Times of India (TOI) on July 7, 2021 which stated that “Water being supplied to 28 sites in four localities of Sangam city was found inferior as it did not have sufficient quantity of chlorine and other elements as opposed to the set norms, during a joint survey carried out by the health and Jalkal departments recently. Many of these localities are densely populated”.

B- Sewerage and Sanitation

The total sewerage treatment capacity is 254 MLD. As per the City Sanitation Plan, Allahabad, there is an acute scarcity of wastewater treatment plants in the city; but the quality of treated waste water is not good. The condition of the existing pumping stations too is not good. The list of the STPs along with their treatment capacity is given in the table below.

Sr. No.	Location of Sewerage treatment plants	Capacity (MLD)
1	Numaha Dahi	50
2	Naini	80
3	Rajapur	60
4	Kodra	25
5	Ponghat	10
6	Salori	29
	Total	254

(Source – Jal Nigam, Prayagraj)

Individual access to toilets – Prayagraj city: -

Total Population	1117094	Census, 2011
Total Households	208000	
% Slum Population	31%	Oxfam Study
Total no. of households w/access to toilets	63960	SLB Data
% of non-slum households w/access to toilets	75%	Assumption based on primary survey
	NON-SLUM AREAS	SLUM AREAS
Population	781966	335128
Households	136522	61336
Households w/toilets	102392	4308
Households without access to toilets	34131	57027

(Source- City Sanitation Plan, Prayagraj)

Future sewerage generation: -

Year	Projected population	Sewage generation in MLD
2031	20.1	277
2041	24.2	334

(Source –CRIS Analysis)

Access to Toilets - Community/Public Toilets: -

Agencies	No. of toilets	No. of seats
Sulabh Toilet Complex	115	138
Nagar Nigam	20	200
Toilets Constructed by PPP	4	68
J.B.I.C. Programme	185	2775
Total	324	4423
Number of Urinals	131	

(Source – Draft City Sanitation Plan, Prayagraj)

Performance gap assessment - access to toilets: -

COMPONENT OF SERVICE	DESIRED SERVICE DELIVERY	EXISTING SERVICE DELIVERY
Coverage of Toilets		
Individual	1 toilet per every household	0.54 toilet per every household
Community	1 seat per every 35 users	1 seat per every 150 users
Public Toilets in Commercial/Market Areas	1 seat per every 100 users	1 seat per every 320 users
Condition of Toilets		
Individual	100% in working condition	
Community	100% in working condition	50% in working condition
Public Toilets in Commercial/Market Areas	100% in working condition	50% in working condition
Toilets in Schools	100% in working condition	60% in working condition

(Source- City Sanitation Plan, Prayagraj)

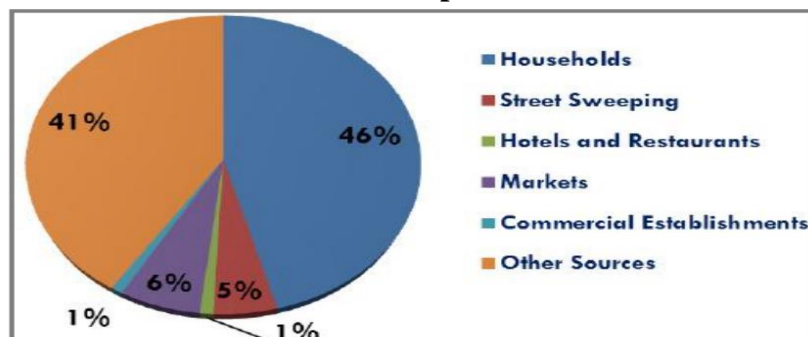
We have observed the following challenges/issues regarding Sewerage and Sanitation in Prayagraj city-

- The existing sewerage collection system is old and dilapidated.
- Coverage of the sewerage network is very low.
- Slums are not covered by the proper sewerage network.
- There is urgent need to refurbish the existing sewerage treatment plants.
- No separate account is maintained for sewerage, it is part of water supply operations.
- Involvement of multiple departments (Jal Sansthan, Jal Nigam and AMC) causes co-ordination issues.

C- Solid Waste Management

Solid waste Management is an important issue for the Prayagraj city. The major activities in the city contributing to waste production are households generated waste, Domestic and stray animals, Hospital and dispensaries, while waste generated from street sweeping, hotels & restaurants, markets & commercial establishments is rather an insignificant portion of the total solid waste generated in the city.

Generation of municipal solid waste: -



(Source: Nagar Nigam Prayagraj)

The amount of waste generated by each individual category is tabulated as below-

SOURCE OF SOLID WASTE	SOLID WASTE GENERATED (TPD)
Households	247
Street Sweepings	27
Hotels and Restaurants	6
Markets (vegetable markets, mandis etc.)	35
Commercial Establishments (Institutions etc.)	5
Other Sources (Construction Debris, Horticulture Waste etc.)	220

(Source: Nagar Nigam, Prayagraj)

With increasing population, the waste generation is expected to increase.

Future solid waste generation: -

Year	Projected population	Solid waste generation in MLD
2031	20.1	1115
2041	24.2	1638

(Source –CRIS Analysis)

Performance gap assessment – solid waste management: -

COMPONENT OF SERVICE	DESIRED SERVICE DELIVERY	EXISTING SERVICE DELIVERY
Household Coverage	100%	61%
Segregation at Source	100%	3.7%
Collection Efficiency	100%	84.5%
Extent of Reuse and Recovery	80%	55%
Extent of Scientific Disposal	100%	73%
Cost Recovery		
Extent of Cost Recovery	100%	30%
Efficiency of Collection of Charges	90%	11%
Customer Service		
Efficiency in redressal of customer complaints	80%	88%

(Source- City Sanitation Plan, Prayagraj)

We have observed the following challenges/issues regarding solid waste management in Prayagraj city-

- The waste collection canters are not being well managed.
- Door to door collection is inadequate.
- Segregation of recyclable waste at source is not practiced. There is need to spread awareness on practicing segregation of waste.
- Collection bins have huge waste overflowing on the streets- stray animals and other factors.
- Dumping of garbage into the drains, leads to choking of drains.
- User charge collection efficiency is low

D- Storm Water Drainage

Total length of road network in the city is 2364 km and total length of Pucca covered drains are 578 km this counts coverage of storm water drainage network to 25% However, the total existing drainage system covers only 40% of Prayagraj city. The system is very old and dilapidated, and 57 nallas/ drains carrying significant amount of stormwater. Out of the 57 nallas, 44 discharge into Ganga while 13 discharge into Yamuna.



(Source- City Sanitation Plan, Prayagraj)

Due to Inadequate storm water network has resulted into 165 frequent incidences of water logging and flooding in low lying areas. There are almost 33 areas in the city prone to water logging. The logging of storm water is major problem in following localities, and all these areas suffer from chronic water logging during the rainy season –

WARD NO.	WATER LOGGING AREAS	NUMBER
4	Rajapur	1
9	Ram Bagh, Shiv Kutti	2
14	Krishna Nagar upto Triveni Road, Alengung	3
25	Allahpur, George Town, Hashimpur, Bhardwajpuram	4
27	Beli Colony Village, Mourabad	2
28	Tagore Town, University Area	2
31	Liddle Road, Medical College	2
37	Baghambari Road, Baghambari Housing Scheme	2
46	Labour Crossing, Chak Bhataj	2
53	Matyara Road, Alopi Bagh	2
55	Tripathi Colony, Nai Basti Of Sohbatibagh, Chaukarda, Chaukhandi	4
61	Khalasi Lines, Khalashi Line	2
	Talab Nawal Rai, Copper Road, Stanley Road, Suraj Kund, Lukerganj Playground	5
Total Number of Water Logging Areas		33

(Source- City Sanitation Plan, Prayagraj)

We have observed the following challenges/issues regarding storm water management in Prayagraj city-

- The existing drainage network is grossly inadequate.
- Dumping of solid waste in drains reduces its water carrying capacity.
- In monsoons the sewerage system also acts as storm water drainage, thus substantial quantity of silt and debris is drained into the sewer system, which is detrimental to its life and efficiency.
- Also, the increased inflow of storm water into the sewerage treatment plant cause flooding and hydraulic overloads on the system.

Data analysis & Discussion (Primary data)

The study inquires public observations of sustainable urban challenges and their preferences for the Prayagraj city; it also investigates social awareness of urban sustainability within the city. A questionnaire (n=200) was conducted and participants' views were gathered on a 5-point Likert-type scale. The findings revealed that 80% of the participants considered 'providing green areas and parks' as the most important goal in urban development. This was followed by 'waste recycling and separation' (71.5%) and 'mitigation of traffic congestion' (70%). The 'minimisation of energy consumption' was poorly rated, as only 27.5% of the respondents voted this as the most important item. The results reflect the key important factors related to the services and utilities, coinciding with an actual need to raise the public services, in order to provide the required indicators with a level of importance focuses on the regional scenario. Therefore, these urban challenge indicators can play a vital role to provide effective public's indicators for decision-makers, in order to improve the existing applications and the future urban projects to achieve quality of life.

Demographic factors: -

		Frequency	Total (%)
Gender	Male	109	54.5
	Female	91	45.5
Age group	18-24	20	10
	25-30	40	20
	31-35	23	11.5
	36-40	29	14.5
	41-45	23	11.5
	46-50	20	10
	51-55	17	8.5
	56-60	15	7.5
	61 & above	13	6.5
Occupation	Government employee	109	54.5
	Private sector employee	42	21
	Retired	20	10
	Other	29	14.5
Qualification	Post-graduate degree	62	31
	Under-graduate	95	47.5
	Up to high school	33	16.5
	No qualification	10	5
Location	Municipalities of the capital	148	74
	Suburban	52	26

Source- Authers information & analysis)

Challenges/Questions	Responses* (%)					Mean	Mode	S. D.
	1	2	3	4	5			
Providing parks and green spaces	03	04	08	25	160	4.675	5	0.774
Separating waste and waste recycling	03	06	12	40	139	4.53	5	0.853
Mitigating traffic congestion	05	09	12	34	140	4.475	5	0.969
Reducing pollution	05	10	20	37	128	4.365	5	1.015
Using renewable energy resources	13	09	18	36	124	4.245	5	1.189
Improving public services	14	11	17	35	123	4.21	5	1.227
Using public transport	07	04	21	47	119	4.305	5	0.992
Promoting investment	06	09	15	43	127	4.38	5	1.007
Minimizing energy consumption	20	35	43	47	55	3.41	5	1.319

(Source- Authers information & analysis)

Note- *1=Not important 2= Of little importance 3= Moderately important 4= Important 5= Very important

Understanding public views and perceptions are important in order to achieve successful urban development. The public's perceptions, priorities and ambitions reflect their experience of daily activities, standard of living and work, in addition to their views on current urban challenges. From analysing the responses to the questionnaire, these urban sustainable challenges, the 09-items investigated have been ranked in terms of their priority and importance to respondents statistically by the mean value of the recorded high-ranking range, from 4.675 to 3.41, top to down, on a 5-point Likert scale (1–5), as shown on the urban challenges items in above table.

As presented, there are many factors that hinder urban sustainable development in Prayagraj city. Overall, 80% of the participants selected 'providing green areas and parks' as the most important item for urban sustainable development in Prayagraj city. This factor has been ranked as significant with a mean score (\bar{x} =4.675), and has the lowest SD (σ =0.774). The next most important was 'waste recycling and

separation', followed by the indicator 'mitigate traffic congestion', and then 'promote investment'. The participants viewed 'minimise energy consumption' as the least important factor of the identified public aspects, with the lowest mean (3.41) and the highest SD ($\sigma=1.319$).

The findings indicate that the respondents are widely concerned about the items related to environmental and development aspects including green areas, waste recycling, transport modes, reducing pollution, promoting investment and increasing renewable energy with smart management. The public's views broadly suggested the need for a comprehensive improvement in their standard of living. Eight of the investigated nine indicators had mean scores more than 4 (=important), while only one had a mean rank greater than 3 (=moderately important).

Conclusion & Suggestion: -

The city and its citizens need to adapt to the technology for making a city sustainable. Retrofitting of old building, efficient use of the services, self-sufficient building and energy generating devices need to be implemented. The life choices of individuals need to be improved. An aware society can lead to a sustainable surrounding. To make a sustainable smart city, carrying capacity of the city must be taken into consideration. In terms of environmental sustainability, the Prayagraj city has consolidated score is a low score. Prayagraj city has not performed well, due to sub-standard level of mechanism and policies related to pollution control, recycling of waste water, and solid waste management.

Cities like Prayagraj needs complete overhauling infrastructure related to pollution control, sanitation and solid waste management. Overall, Prayagraj has not performed well on many parameters of environmental sustainability. In terms of technology intervention, Prayagraj has to go long way. There are substantial gaps in proper functioning and management that need urgent attention. Government of India has launched many schemes to fulfil the gap for cleanliness, which requires proper implementation.

Finally, transformation of Prayagraj into smart city requires great cooperation and coordination among various stakeholders like city administrators, private sector, NGOs, academicians and community along with public -private partnership. The accountability of associated responsible people should be fixed in order to achieve sustainable development goal with inclusivity in Prayagraj city.

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