

CONTENTS

Nagarlok, Vol. 56, Issue 4, October-December, 2024

<i>Articles</i>	<i>Pages</i>
Regulatory Framework for Town Planning in India: A Perspective <i>Radhika Sarda and R. Srinivas</i>	375-393
Provisions and Implementation of Real Estate Regulatory Acts in Various States of India - A Review <i>Richa Goyal and P.S.N. Rao</i>	394-410
Green-Blue Sustainability Initiatives for Higher Education Institutions <i>Vanshul and Ashwani Luthra</i>	411-429
Spatial Planning Strategies for Resilient Cities <i>Pankhuri Bhatia</i>	430-438
Digitalisation and Environmental Concerns <i>V. Gnaneshwar</i>	439-450
Investigating General Public's Perspective on Air Pollution Causes: A Study of Lucknow City's Residential, Commercial and Industrial Areas <i>Suleman</i>	451-471
Innovation, Sustainability and Citizen-Centricity through Smart Cities: Lessons for India <i>Bhawna Gupta and Tanya Ahuja</i>	472-487
Mushrooming of Unauthorised Colonies in Delhi: A Case Study of Sangam Vihar <i>Ashish Kumar, Soma Arora and Anand Prakash</i>	488-508
Spatial Organisation and Economic Impact of Manufacturing Sectors in Ludhiana: A Cluster Analysis <i>Mostafizur Rahman and Sandeep Dua</i>	509-525

Learnings from Past: Heritage Town of Saswad—Potentials and Challenges	526-546
<i>Ar. Vaidehi Lavand</i>	
Accelerating India's Electric Vehicle Revolution: Policy, Sustainability, and the Road Ahead	547-560
<i>Priti Rana and Amna Mirza</i>	

Regulatory Framework for Town Planning in India: A Perspective

Nagarlok
ISSN-0027-7584
56(4), 375-393
October-December, 2024
@ 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.1>

Radhika Sarda* and R. Srinivas**

Abstract

With India's urban population approaching 40 per cent of the overall population and cities estimated to contribute 75 per cent of national GDP by 2030, it is critical to take an integrated approach towards urban development and administration (World Bank, 2015). This approach requires not only effective planning tools but also a robust legislative and institutional framework for successful implementation.

The present paper reviews the planning legislations of all States and Union Territories in India by examining the status of Town and Country Planning Acts, institutional and implementation tools. It also discusses the need to incorporate modern concepts and rationalising implementation tools for more informed and project-oriented planning. The findings reveal that the states still need to make their legislations more comprehensive by revising their Town and Country Planning Acts.

This study has attempted to put a spotlight on the legislative framework impacting the efficacy of the planning process. As urban areas expand and complexity increases, an appropriate planning framework is critical for ensuring integrated plans and sustainable growth of cities.

Keywords

Planning legislations, Planning tools, Development plan, Comprehensive approach, Governance, and Institutional framework.

Background

Traditionally, "urban planning" was associated only with spatial planning. At present, urban planning is an approach that considers all the aspects of city-economic

** R. Srinivas, Urban Planning Expert, Asian Development Bank - Transit Oriented Development Cell (ADB-TOD), Institute of Urban Transport, Government of India.
Email: srinimetro@gmail.com

Corresponding author:

* Radhika Sarda, Young Professional, High Level Committee on Urban Planning, Ministry of Housing and Urban Affairs, Government of India.
Email: radhika.sarda06@gmail.com

development, physical environment, and social interaction – to develop a central and coherent view of urban space (UN-Habitat, 2020). However, the roadmap to achieve it is complex and needs to be dynamic, flexible, and collaborative for smooth implementation.

India is experiencing a significant demographic shift and rapid urbanisation. While the 2011 Census of India reported that the country's urban population was 31.16 per cent of the overall population, the 15th Finance Commission cites the World Bank (2015) research shows that estimated 55.3 per cent of India's population lived in areas with "urban-like" traits in 2010 (The World Bank, 2015). Moreover, the urban population is projected to constitute 38.6% of India's total population by 2036, with the urban population growth itself expected to rise to nearly 73% compared to 2011 (National Commission on Population, 2011).

Since urban planning and its enforcement are frequently blamed for India's "dysfunctional" cities, it is critical to investigate the underlying causes of the existing planning system. To identify some concrete reasons, it is important to dive deep into the governing and enabling mechanisms for urban planning and development.

Historical Perspective

In India, town planning dates back to the Indus Valley civilisation. The notable town planning principles of Manasara town planning concepts in ancient India focused on social geometry (Makkar & Gangwar, 2023, Koshy, C. K., Parikh, D., & Kapoor, M. 2020).

During the British period, modern-day town planning principles were used to plan economically beneficial settlements regardless of social needs. British constituted Town Improvement Committees/ Boards in Calcutta, Bombay, and Madras Presidencies for sanitary health which later, in 1864, addressed these specific issues by establishing a Sanitary Commission (Lata, 2022).

Similarly, the Bombay Improvement Act, 1898, was aimed to remove unsanitary dwellings and overcrowding for better living conditions, while the Bombay Town Planning Act, 1915, with these objectives also granted local authorities' power to regulate future town growth, and prevent slum formation (Sharma, 2019).

Post-Independence

The post-Independence period in India saw a federal structure of government, with functions defined in the Central, State, and Concurrent List of the Seventh Schedule of the Constitution. Urban planning was a classical top-down process, influenced by the United Kingdom Town and Country Planning Act, 1947, with planners preparing plans for cities and the state governments approving them (Sadaria, 2016).

Since, the Town Improvement Trust Acts in various states lacked provisions for master plan preparation, the Model Town and Country Planning Act was formulated in

1960 and later revised in 1985 to Model Regional and Town Planning and Development Law (Town and Country Planning Organization, 1985). It acted as a comprehensive legislation on urban and regional planning, land use, infrastructure and future development and redevelopment in states, aiming to execute town planning schemes.

Bihar, in 1951 enacted Town Planning and Improvement Trust Act to include urban development, while Maharashtra enacted the first Regional and Town Planning Act, 1966 which included provisions for regional planning boards, new towns, finance, governance and compulsory land acquisition (Koshy, C. K., Parikh, D., & Kapoor, M., 2020).

In 1985, India established a National Commission on Urbanisation to study urbanisation, recommending 329 Generators of Economic Momentum (GEM) areas and 49 Spatial Priority Urbanisation Regions (SPURS) for metropolis strengthening, employment creation, and identified 555 new growth centres into hinterlands, for being the catalysts for social transformation (Kundu, 1989).

The Government then introduced the Urban Development Plan Formulation and Implementation Guidelines, (UDPFI), 1996 to assist urban authorities in addressing deficiencies in the master plan focusing on spatial development plans, resource mobilisation and efficient implementation mechanisms like Perspective plan, special project plans, development plan, etc. The then Ministry of Urban Development revised its 1996 guidelines and published in 2015 as Urban and Regional Development Planning and Formulation Guidelines, emphasising sustainable regional and urban development, sector-specific planning, and incorporation of modern concepts (Town and Country Planning Organization, 2015).

India's planning and development have transitioned from a socially-driven to a more functional and economically focused model guided by legislative frameworks. The focus has now shifted from urban-centric growth to a comprehensive approach that integrates both urban and regional development.

Present Framework of Planning in India

Role of Government

In India, there is a three-tier system for urban planning. The Central Government plays an 'advisory' role for promoting orderly urbanisation and providing financial assistance through flagship programmes like Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Smart City Mission (SCM), Swachh Bharat Mission (SBM), Housing for All (HFA), etc. It also provides schematic, technical, and programmatic support to the state and local governments by setting Centres of Excellence, capacity building and training programmes, etc.

In India, land is a state subject. The Seventh Schedule of the Indian Constitution distributes the 'legislative powers' between the Union and the states. Therefore, it is

only state government that plays a ‘regulatory’ role enacting the legislative framework incorporating the roles, responsibilities and functions of respective urban development institutions and laws relating to land and local government (Vision IAS, 2021).

This planning process has now undergone change with bottom-up approach tracing back to 1990’s. The 73rd and 74th Constitutional Amendment Acts (CAAs) empowered local self-governments with ‘legislative and executive’ powers by delegating 18 functions including urban planning, social and economic development, urban amenities provision, regulation of land use, etc. to local self-government authorities and establishing Metropolitan Planning Committees in every metropolitan area.

Spatial Planning and Development – Related State Acts

State-level planning frameworks can be classified into planning and development acts, such as the Town and Country Planning Act, Improvement Trust Act, and Local Government Acts, such as the Municipal Corporations Act, Municipalities and Nagarpalika Act, and Panchayati Raj Act in each state. Under 73rd and 74th CAA, all the states have enacted state spatial planning and local governance acts. Table 1 elaborates the status of state-wise Planning and Development Acts in India.

Table 1: Status of Town and Country Planning Acts of States/UTs in India

S. No.	State/UT	Acts	Latest Revision
1	Andhra Pradesh	Andhra Pradesh (Andhra Area) Town-Planning Act, 1920	2020
2	Arunachal Pradesh	The Arunachal Pradesh Urban and Country Planning Act, 2007	-
3	Assam	The Assam Town and Country Planning Act, 1959	2022
4	Bihar	The Bihar Urban Planning and Development Act, 2012	2022
5	Chhattisgarh	The Chhattisgarh Nagar Tatha Gram Nivesh Adhiniyam, 1973	2017 (Adopted from Madhya Pradesh)
6	Goa	The Goa, Daman and Diu Town and Country Planning Act, 1974 and Rules, 1976	2020/Bill (2024)
7	Gujarat	The Gujarat Town Planning and Urban Development Act, 1976	2017
8	Haryana	1. The Punjab Scheduled Roads and Controlled Areas Restriction of Unregulated Development Act, 1963, 2. The Haryana Development and Regulation of Urban Areas Act, 1975 3. The Haryana Urban Development Authority Act, 1977	Revision under Consideration

S. No.	State/UT	Acts	Latest Revision
9	Himachal Pradesh	The Himachal Pradesh Town and Country Planning Act, 1977	2018/ Bill (2022)
10	Jharkhand	Adopted Bihar Urban Planning and Development Act, 2012	2022
11	Karnataka	The Karnataka Town and Country Planning Act, 1961	2021
12	Kerala	The Kerala Town and Country Planning Act, 2016	2021
13	Madhya Pradesh	Madhya Pradesh Nagar Tatha Gram Nivesh, Niyam- 1975	Bill (2016)
14	Maharashtra	The Maharashtra Regional and Town Planning Act, 1966	2015
15	Manipur	The Manipur Town and Country Planning Act, 1975	2023
16	Meghalaya	Meghalaya Town and Country Planning Act, 1973	2004
17	Mizoram	The Mizoram Urban and Regional Development Act, 1990	2004
18	Nagaland	Nagaland Town and Country Planning Act, 1966	2000
19	Odisha	The Orissa Town Planning & Improvement Trust Act, 1956	2021
20	Punjab	The Punjab Regional and Town Planning and Development Act, 1995	2006
21	Rajasthan	The Rajasthan Urban Improvement Act, 1959	Revision under Consideration (2021)
22	Sikkim	The Sikkim Urban and Regional Planning and Development Act, 1998	2008
23	Tamil Nadu	The Tamil Nadu Town and Country Planning Act, 1971	2022
24	Telangana	The Telangana Town-Planning Act, 1920.	2016
25	Tripura	The Tripura Town and Country Planning Act, 1975	2018
26	Uttar Pradesh	The Uttar Pradesh Urban Planning and Development Act, 1973	Revision under Consideration (2023)
27	Uttarakhand	The Uttarakhand Urban and Country Planning and Development Act, 1973	2013

S. No.	State/UT	Acts	Latest Revision
28	West Bengal	The West Bengal Town and Country (Planning and Development) Act, 1979	2015/ Bill (2023)
29	Andaman and Nicobar Islands	The Andaman and Nicobar Islands, Town, and Country Planning Regulations, 1994	2019
30	Chandigarh	Punjab New Periphery Control Act, 1952	Punjab Government Gazette (1952)
31	Dadra & Nagar Haveli and Daman & Diu	The Goa, Daman and Diu Town and Country Planning Act, 1974 and Rules, 1976	Adopted from Goa (2020)
32	Delhi	The Delhi Development Act, 1957	Proposed Amendment (2022)
33	Jammu and Kashmir	The Jammu and Kashmir State Town Planning Act, 1963	-
34	Lakshadweep	The Lakshadweep Development Authority Regulation, 2021 (Draft)	Revision under Consideration (2021)
35	Puducherry	The Puducherry Town and Country Planning Act, 1969	1978
36	Ladakh	Under Preparation	

Source: State-wise Town and Country Planning Department

Table 1 reveals that the Spatial Planning and Development Acts vary across different states. While majority of states have Town and Country Planning Act, Haryana and Rajasthan do not have a comprehensive T&CP Act. Chandigarh is also governed by a Punjab New Periphery Control Act, 1962 (Punjab Government Gazette, 1952).

- Most of the Town and Country Planning Acts were drafted and published around 1950s and 1970s, with 17 states revising their Acts in the past 5 years. However, there have been no major changes noticed leaving a few aside, thus causing serious gaps in the pacing urban legislative matrix.
- Out of remaining 18 Acts, only 8 got revised in the last decade while no revisions have been considered in the seven states (Punjab, Uttarakhand, Puducherry) including four North-eastern states, i.e. Mizoram, Meghalaya, Nagaland, and Sikkim. Moreover, Puducherry's latest update dates back to 1978, almost 45 years to the current date. The states of Jharkhand, Chhattisgarh, and Telangana, have adopted the parent state's Acts. The state-specific Acts and modifications have been addressed for Chhattisgarh and Telangana while Jharkhand is completely dependent on the Acts of Bihar.

- Amendment bills for Himachal Pradesh, Madhya Pradesh, Goa, and West Bengal are in place, while Haryana, Rajasthan, Uttar Pradesh, Delhi, and Lakshadweep are considering revising the Acts.
- Large states like Rajasthan, Uttar Pradesh and Haryana are examining a possibility for drafting a comprehensive Town and Country Planning Act.
- Kerala and Bihar have been actively amending legislation since its release in 2016 and 2012. Kerala released an ordinance in 2021 incorporating perspective and spatial planning elements into their state's framework and Bihar renamed the Act and incorporated application of area development schemes.

Table 1 thus establishes the need of the hour for revision of these Town and Country Planning Acts to govern the current planning process to match the emerging pace of urbanisation.

Institutional Provisions for Planning

TCPO (1985), the Model Regional and Town Planning and Development Law suggests planning and institution establishment at state, regional, city and metropolitan level. On a similar note, these Acts include provisions for three - tier authority structure: State Authority for State perspective, Regional for identified region (including districts), Local Development Authority for city and Detailed Town Planning Schemes or other area/city level plans while some states have two tiers of structure excluding the regional level.

State governments can declare areas as development areas under Town and Country Planning Acts, defining their boundaries, and forming Area Development Authorities. These authorities are then responsible for preparing spatial plans at different scales and monitoring socio-economic development. Table 2 shows the state-wise brief compilation of the statutory authorities at all tiers under Town and Country Planning Acts.

Table 2: Institutional framework of different levels of Statutory Planning and Development Authorities under State Town and Country Planning Acts in India

State Name	State	Regional				Local			
		Board	District	Regional	Capital Region	Metropol-itan	Devel- opment Authority	New Town	Special Area
Andhra Pradesh	✓	MiDA	MiDA	MiDA	MiDA	MiDA	✓	MiDA	-
Arunachal Pradesh	✓	MiDA	-	-	-	✓	-	MiDA	-
Assam	AC	MiDA	✓	MiDA	MiDA	✓	✓	✓	✓
Bihar	✓	✓	✓	-	✓	✓	✓	✓	-
Chhattisgarh	✓	MiDA	✓	-	✓	✓	-	MiDA	✓

State Name	State	Regional				Local			
		Board	District	Regional	Capital Region	Metropol-itan	Devel-opment Authority	New Town	Special Area
Goa	✓	MiDA	✓	-	-	✓	-	-	-
Gujarat	-	MiDA	-	-	-	✓	-	✓	✓
Haryana	✓	MiDA	MiDA	-	MiDA	MiDA	-	MiDA	-
Himachal Pradesh	A	MiDA	✓	-	MiDA	✓	✓	-	✓
Jharkhand	✓	✓	✓	-	✓	✓	✓	✓	-
Karnataka	✓	MiDA	-	-	MiDA	✓	-	✓	✓
Kerala	✓	✓	✓	-	✓	✓	-	✓	✓
Madhya Pradesh	A	MiDA	✓	-	MiDA	✓	✓	✓	✓
Maharashtra	Cm	✓	✓	-	MiDA	✓	✓	MiDA	✓
Manipur	✓	MiDA	-	-	-	✓	-	-	-
Meghalaya	AC	-	O	-	-	✓	-	-	-
Mizoram	✓	✓	✓	-	-	✓	-	✓	-
Nagaland	AC	MiDA	-	-	-	✓	-	-	-
Odisha	Trust	MiDA	-	-	-	✓	-	✓	✓
Punjab	✓	MiDA	✓	-	-	✓	✓	MiDA	✓
Rajasthan	-	MiDA	MiDA	-	-	MiDA	-	✓	MiDA
Sikkim	✓	MiDA	✓	-	-	✓	✓	✓	-
Tamil Nadu	✓	MiDA	✓	-	✓	✓	✓	✓	-
Telangana	✓	MiDA	-	-	MiDA	MiDA	-	-	✓
Tripura	✓	MiDA	✓	-	-	✓	✓	R	-
Uttar Pradesh	AC	MiDA	MiDA	MiDA	-	✓	-	MiDA	-
Uttarakhand	AC	MiDA	-	-	-	MiDA	✓	-	-
West Bengal	✓	MiDA	-	-	✓	MiDA	MiDA	-	-
A&N Islands	AC	-	-	-	-	✓	-	✓	-
Chandigarh	-	-	✓	-	-	✓	-	✓	-
Dadra & Nagar Haveli and Daman & Diu	✓	-	✓	-	-	✓	-	-	-
Delhi	AC	-	MiDA	MiDA	-	✓	-	MiDA	-
Jammu and Kashmir	-	MiDA	-	-	MiDA	✓	✓	MiDA	-

State Name	State	Regional				Local			
		Board	District	Regional	Capital Region	Metropolitan	Development Authority	New Town	Periphery
Lakshadweep	-	-	-	-	-	-	✓	-	✓
Puducherry	✓	-	-	-	-	-	✓	-	✓
Ladakh	Under Preparation								

AC – Advisory Council, Cm – Committee; A – Authority; O – Order Compiled by Authors

✓ Integrated into the State TCP Act; MiDA – Mentioned in Different Acts

Each state has enacted Spatial Planning, Development, and Regional Planning Acts. However, diversity is there in institutional framework, types and contents of the Plans proposed (Mukherjee Basu & Sharma, 2021). While Town and Country Planning Acts are prevalent in most states, the planning authority is different in each state. In Madhya Pradesh and Himachal Pradesh, the Town and Country Planning Authority is the designated authority, but a specific authority is not mentioned in West Bengal and Maharashtra Acts. The Rajasthan and Odisha Acts allow for the formation of Trusts to design certain components such as sanitation and housing.

Most Acts include provisions for Advisory Town and Country Planning Boards or Committees, but many states lack its existence, unlike Karnataka which has a functioning board.

- The ‘regional framework’ is integrated into 21 states and UTs’ planning, with 16 states integrating its provisions into the state’s Town and Country Planning Acts. In Meghalaya, an order was released in 2004 to constitute Regional Planning and Development Council to review the natural and human resource potential of the region.
 - Andhra Pradesh (2014), Assam (2017), and Uttar Pradesh (in process) have State-Capital Region Authorities, while Delhi has a National Capital Region Planning Board (1985), allowing special Sub-regional Plans for Haryana, Rajasthan, and Uttar Pradesh (National Capital Region Planning Board, 1985).
- As per Article 243 ZD and 243 ZE of 74th CAA, all states were supposed to constitute District Planning Committees (DPCs) and Metropolitan Planning Committee (MPC). Bihar (Section 21 (a)), Kerala (DPC – Section 17-19 and MPC – Section 20-27), and Maharashtra (Section 42E) have completely incorporated it into their Act. However, these provisions have not been implemented across India (Government of India, 1950/Updated).
 - The District Planning Committee (DPC) Act is in place in 23 states, except Meghalaya, NCT of Delhi and other Union Territories. Sikkim (Section 4(5)), Maharashtra (Section 42E) and Mizoram (Section 3(10)), to provide a provision for the District Planning Committee to review plans.

- Metropolitan Development Authority has been established in nine states under the city authority act like Mumbai Metropolitan Development Authority Act, 1974 while six states (Bihar, Chhattisgarh, Jharkhand, Kerala, Tamil Nadu, and West Bengal) incorporate this provision into their respective Town and Country Planning Acts.
- Planning of urban periphery within Master Plan or otherwise is addressed in 25 states, with 15 integrating into their acts like Bihar (Section 9 (3)) and Assam (Section 10A) and 10 states through different acts like Panchayati Raj Act (Arunachal Pradesh, Uttar Pradesh) or rules (Tripura, Gujarat).
- The Town and Country Planning Acts of 12 states including Madhya Pradesh (Section 65), Maharashtra (Section 40), Himachal Pradesh (Section 67), Chhattisgarh (Section 65 –Mining, Tourism through riverfront), Kerala Ordinance 42 (2021) - Chapter VIIA (section 49A- disaster, environmental vulnerability, heritage conservation, urgent infrastructure) Odisha (Section 80) and Punjab (Section 29 (1)) incorporate a provision for Special Area Development Authority for large industrial estates, new towns and townships while 14 states including Section 113A of Maharashtra and Section 31(1) of Punjab and Section 4 of Tamil Nadu have a separate provision for New Town Development Authority.
- Section 3-A of Telangana Urban Areas (Development) Act establishes project specific Special Area Development Authority within the local jurisdiction for special planning while Section 9(5) of Arunachal Pradesh allows Local Planning Authority to constitute a project specific sub-divisional planning authority.
- The insertion of new Section 21E of Assam Town and Country Planning (Amendment) Bill, 2021 establishes special function agencies for specific functions that would affect economy and efficiency of the functions assigned.

In all, recently amended or formulated 12 Acts such as Bihar (2012), Kerala (2016), Tamil Nadu and Assam (amended in 2018 and 2022) have integration of almost all components into their state planning framework. Out of twelve, eight Acts were amended during the last 5 years, two in last 10 years and 2 (Punjab and Sikkim) in last 20 years. Although there has been no comprehensive revision in the Acts, the Town and Country Planning Acts have undergone periodic revisions.

Planning Provisions – Types of Plans

Many of our states have statutory provisions in their acts to prepare plans at every level – i.e., regional (including district), urban area plans, zonal plans, micro plans (Town Planning Schemes (TPS), Local Area Plan (LAP), District Development Plan (DDP) etc.) Shirsagar, J. K., & Srinivas, R. (2014). Table 3 depicts a quick summary of types of plans mandated by planning legislations at state level.

Table 3: State-wise status of provision of planning implementation tools within Town and Country Planning Acts

S. No	State/UT	Provisions for					Revision
		Regional Plan	Master Plan	Zonal Plan	Local Area Plan	Town Planning Scheme	
1	Andhra Pradesh	MiDA	MiDA	MiDA	-	✓	-
2	Arunachal Pradesh	-	-	-	✓	-	10 Y
3	Assam	✓	✓	-	-	✓	-
4	Bihar	✓	✓	✓	✓		10 Y
5	Chhattisgarh	✓	✓	✓	-	✓	-
6	Goa	✓	✓	-	-	✓	10 Y
7	Gujarat	-	✓	-	✓	✓	10 Y
8	Haryana	MiDA	-	-	✓	-	-
9	Himachal Pradesh	✓	✓	✓	✓		(No timeline)
10	Jharkhand	✓	✓	✓	✓		10 Y
11	Karnataka	-	✓	-	-	✓	10 Y
12	Kerala	✓	✓	-	✓	✓	5 Y
13	Madhya Pradesh	✓	✓	✓	-	✓	-
14	Maharashtra	✓	✓	✓	-	✓	10 Y
15	Manipur	-	✓	-	-	✓	10 Y
16	Meghalaya	-	✓	-	-	✓	-
17	Mizoram	✓	✓	✓	-	✓	5 Y
18	Nagaland	-	✓	-	-	-	(No timeline)
19	Odisha	-	✓	✓	✓	✓	-
20	Punjab	✓	✓	✓	-	✓	> = 5 Y
21	Rajasthan	MiDA	MiDA	MiDA	✓	✓	-
22	Sikkim	✓	✓	-	✓	-	3 Y
23	Tamil Nadu	✓	✓	-	✓	✓	5 Y
24	Telangana	-	MiDA	MiDA	✓	✓	-
25	Tripura	✓	✓	-	-	✓	-
26	Uttar Pradesh	MiDA	✓	✓	-	-	-
27	Uttarakhand	-	✓	✓	-	-	-
28	West Bengal	-	✓	-	-	✓	10 Y

S. No	State/UT	Provisions for					Revision
		Regional Plan	Master Plan	Zonal Plan	Local Area Plan	Town Planning Scheme	
29	Andaman and Nicobar Islands	-	✓	-	-	-	-
30	Chandigarh	✓	-	-	-	-	-
31	Dadra & Nagar Haveli and Daman & Diu	✓	✓	-	-	-	10 Y
32	Delhi	MiDA	✓	✓	-	-	-
33	Jammu and Kashmir	-	MiDA	MiDA	✓	✓	-
34	Lakshadweep	-	✓	-	-	✓	-
35	Puducherry	-	✓	-	✓	-	5 Y
36	Ladakh	-	-	-	-	-	-

Y – Year; MiDA- Mentioned in different Acts

Source: Compiled by Authors.

Observations from Table 3

- There are 10 states that address the planning from macro to micro plan level. These states are Andhra Pradesh, Bihar, Chhattisgarh, Himachal Pradesh, Jharkhand, Madhya Pradesh, Maharashtra, Mizoram, Punjab, and Jammu and Kashmir.
- In India, almost all states have provisions for Master Plans or Development Plans. However, D. K. Srivastava (2023) highlights that it is also important for the larger states experiencing either high or moderate levels of urbanisation like Gujarat (~43 per cent), Karnataka (~39 per cent), Rajasthan (~31 per cent) and north-eastern states to address the dire need of strategic planning at regional level (Srivastava, 2023).
- Zonal plans are extensive tools that translate that broad vision of the master plan into specific regulations. This provision is in 17 states, till date while large states, (Gujarat, Haryana, Kerala, Karnataka, West Bengal), North Eastern states and Union territories may also incorporate this.
- Local Area Planning and Town Planning Schemes are essential for local land management and development, yet 4 states (Karnataka, Nagaland, Uttar Pradesh, and Uttarakhand) and 4 Union territories (Andaman & Nicobar Islands, Puducherry, Daman, and Diu) lack these tools in their legislations.

- 10 states incorporated the provision of 10 years each for review of development plans and regional plans mentioned in the Model Law, 1985. Ten states align with the Model law while five states (Kerala, Mizoram, Punjab, Tamil Nadu, Puducherry) reduced the span to five years.

Discussions and Conclusion

The review of legislations in all the states and Union Territories shows that traditional approaches are still taken up for planning and development. The state planning framework incorporating institutional set-up, and types of plans varies for all the states. The latest revisions in the legislations have been made half a century back or more while 60 per cent of them are updated recently. Moreover, states like Haryana, Uttar Pradesh and Rajasthan have initiated the process of revision to enhance the comprehensiveness and effectiveness of their Acts.

The usual practice is to prepare a long-term spatial plan i.e. regional plan and development plan for the declared planning area by the Development Authority (Kate S.R., 2018). Moreover, Indian cities (Tier 2 and Tier 3) often prepare only Development Plan/Master Plan which also takes time for approval, resulting in haphazard development of the peripheral areas (villages and smaller urban settlements).

Some states took the initiative to incorporate these peripheral areas into development plans. However, the implementation of these development plans becomes difficult as parts of these plans are governed by village panchayats, which lack resources as well as competence. Out of 7933 Indian cities and towns, only 2853 (~36%) have approved Master Plans (MoHUA, 2023). Only 733 census towns have approved Master Plans (~19 per cent) of total census towns, i.e. 3892.

As a result, rural areas having villages and census towns on the outskirts of urban settlements, may have a provision for spatial planning, as Bihar and Assam. Since, all the states have provisions for declaring urban and rural areas as planning areas, it is limited to selected areas in practice. Unlike Mizoram, other states may explicitly integrate peripheries and rural areas into planning frameworks through Gram Panchayat Spatial Development Plan (GPSDP) and Village Development Plans (VDP).

An integrated planning mechanism for urban and rural areas is needed, considering regional context and growth (High-Level Committee on Urban Planning, 2023). The Articles 243 ZD and 243 ZE, provide a broad framework for preparation and consolidation of urban and rural plans, with district and metropolitan as a unit of planning. Since most of the Town and Country Planning Acts are silent on the incorporation of 74th CAA, there is a dire need for provisioning strategic and coordinated regional planning into the planning legislation. The provision for Integrated Development Plans in Mizoram and constitution of Joint Planning Area in Kerala, Maharashtra and Telangana at regional scale exists but a coordination provision of the same with District planning committee and Metropolitan Planning Committee may help in progressive balanced development, as mentioned in the Model Regional and Town Planning and Development Law, 1985.

Lack of planning framework in developing rural areas (SEZ, Industrial estate, etc.) can lead to unregulated expansion, creating unplanned small towns. Thus, identification of these as independent 'planning areas' with a declared 'planning authority' on the basis of specific criteria in the state urban legislation like those of Tamil Nadu, Assam and Punjab may help govern the development of the upcoming new town and economic growth centres.

First, integrated urban planning concept requires trained professionals to view plans comprehensively, bridging the gap towards economic and financial planning in traditional planning and integrating individual and regional growth drivers (Jit Kumar Gupta, 2022). Gujarat and Telangana have local advisory committees as Technical Support Institutions (TSIs), which can help address cross-sectoral issues. The Acts can have a provision of hiring a good number of full-time planning professionals in the authorities and in advisory committees as per the population of the city (detailed in URDPFI guidelines), involving economics, finance, and social experts.

The 74th CAA includes Article 243 Y, allowing the State Finance Commission to establish a City Infrastructure Fund for Urban and Regional Infrastructure development other than the Budget fund. Unlike Tamil Nadu and Mizoram, this may be promoted in all the states legislations specific to infrastructure (providing basic amenities) and urban and regional (preparation and implementation of plans) fund utilisation.

Secondly, to make the exercise of planning more comprehensive, dynamic and effective, states may work towards projectisation of the Development Plans. Kerala Ordinance, 2021 specifies preparation of Priority Action Plan for Priority Projects like revitalisation, TOD, etc., risk informed Land-use Plans and Special Area Plans for vulnerability risk and multi-hazard prone areas.

Third, by introducing a provision for Land Suitability Analysis (LSA) and Hotspot Analysis in Master Plan preparation leading to formulation of evidence-based Development Control Regulations and also to synchronise the provisions for projectisation within Special Area Plans. Maharashtra has taken a step further by introducing town specific regulations while Assam has introduced a provision for incorporation of relevant norms, rules and plans of the Disaster Management Authority at district and State level during the preparation of master plan.

Fourth, the Model Town Planning Law specifies revision of development plan and regional plan once in 10 years but given the unpredictability and rapidly changing scenarios, these provisions may be revised to 3-5 years.

Next is the assessment of these development plans which may be on the basis of KPIs (Key Performance Indicators) laid down by the Town and Country Planning Organization to analyse comprehensiveness of the future challenges of the city and its position. The KPIs may also include technology as a key indicator as it will help in real-time monitoring by analysing multiple scenarios.

The Land-use chapter in the State Acts should have a provision of digital repository and 3D twin for the urban areas. This will help to provide intricate understanding of these complex systems and facilitating real-time informed interventions.

In conclusion, an appropriate project-oriented and cohesive legislative and institutional framework is critical for ensuring integrated plans and sustainable growth of cities. The current framework of multiple institutions and limited scope in the planning framework has left a wide room for improvement.

Way Forward

India is at a threshold of massive transition from being predominantly rural to partly urban in the next few decades. Development challenges, including town and country planning has yet to receive adequate policy attention. At the juncture, it would be vital to get planning frameworks equipped for ensuring planned growth across different topographies of India.

The first and foremost step would be to integrate perspective planning and spatial planning in all the processes, leading to project-oriented results. Unlike Gujarat and Andhra Pradesh, State Vision@2047 may be exercised in alignment with planning goals.

Next, it is also important to acknowledge regional planning as the cohesive tool and further rationalise the layer of planning tools and institutions at city level on its size like larger cities with a triple layer (Regional/Metropolitan Plan, Master Plan, Local Area Plans) and smaller cities with two-layer (Master Plan and Local Area Plan).

The key features of all the Acts have been mentioned in Table 4. International and national legislations, States and UTs may take up the comprehensive and periodic review of their respective Town and Country Planning Acts as per their requirements which may involve:

- Integration of social, economic and environmental perspective planning as a first step into the process;
- Acknowledgement of 73rd and 74th Constitutional Amendment Act;
- Provision of Infrastructure Fund and Urban Development Fund other than budget;
- Rationalisation of hierarchy of Plans and Institutions for large and small cities;
- Mainstreaming economic and financial development (institutionally and spatially) as an integral part of Master Plan as well as Regional Plans;
- Making planning process a project-oriented exercise by diversifying and identifying future growth drivers and projects within City;
- Mainstreaming environment and climate with financial outlays (climate budgeting and green financing) into all scales of planning (Regional, City, Micro);
- Clearly defining the process of Land Value Capture mechanisms and its promotion through Transit Oriented Development, Complete Streets, Blue & Green Infrastructure, Riverfront Development, Heritage Conservation, etc.
- Leveraging technology to make planning a real-time tracking process.

The State Advisory Board/Council/Committee may conduct periodic review of planning and development and other relevant acts to make necessary changes. This may set up a streamlined procedure for incorporations as well as approvals. The State

Town and Country Planning departments may also regularly update this status of the amendments/ revisions on their websites to create a digital repository. This step may align at the national scale with the Model Town and Country Planning Law (1985) and the URDPFI Guidelines (2015).

The process of modifications for National Planning frameworks may involve stakeholders' consultation at both national and state levels. Collaborative, cohesive, and comprehensive changes are required in the planning framework by periodic brainstorming sessions, expanding the participation of stakeholders, incorporating emerging concepts, technology advancements, advancing urban and regional planning approaches, and state policies.

Table 4: Key highlights and learnings from Town and Country Planning Acts in India

S. No.	Key feature	Function	Section	State
1	State Urban Arts Commission	Make recommendations on urban design, restoration and conservation of archaeological and historical sites	Chapter 9	Andhra Pradesh
			Chapter 11	Bihar
			Chapter 11	Telangana
	The Hampi World Heritage Area Management Authority under Act 2008		Section 81E (amended in 2004)	Karnataka
2	Advisory Committee/ Council for Local Planning/ Development Authority	Prepare perspective plan, development plan, annual plan and development schemes	Section 9(5)	Arunachal Pradesh
			Section 6 (2)	Gujarat
			Section 3 (11)	Mizoram
			Section 37	Telangana
			Section 15 (1)	West Bengal
	Expert Consultation at regional committee	Section 10	Maharashtra	
3	Joint Planning Committee	Plan area comprising multiple Municipal Corporations, Municipal Councils, Town Panchayats, or Village Panchayats	Chapter VI – Section 41	Kerala
			Section 96(1)	Maharashtra
			Section 38	Telangana
4	Integrated Interim Development Plans	Prepare and enforce economic growth plans and review plans prepared by municipalities and village councils	Section 11 and 5(2)	Mizoram
	Rural or sectoral plan		Section 16	

S. No.	Key feature	Function	Section	State
5	State Perspective Plan	Prepare long-term plan (20-25 years) outlining goals, policies, and strategies for socio-economic and spatial development	Section 4(d)	Kerala
			Section 4(2)	Sikkim
6	Control of architectural features, elevation and frontage along major roads	To be incorporated in the development plan	Section-21 (3. v)	Bihar
			Section 8 (d.vi)	Jammu & Kashmir
		Elaborate restrictions, expenses, maintenance and improvement of facades of buildings abutting arterial roads	Chapter 14	Punjab
			Chapter 3-A	Uttar Pradesh
7	Public Streets	Setting the minimum widths of public streets based on traffic in the master plan	Chapter V	Assam
			Chapter V	Meghalaya
			Chapter V	Nagaland
8	Disaster resilience	Incorporate norms, rules and plans by Disaster Management Authority at district and State	Section 11(6)	Assam Amendment (2022)
		Risk-informed plans (special area as mentioned in 3.b) includes a development concept, strategy, situational analysis, mitigation proposals and development control regulations	insertion of clause (aca)	Kerala Ordinance, 2021
9	State Urban Development/ Infrastructure Fund	Urban Development Fund Rules	2003	Chhattisgarh
		Prepare and implement Development plans	Section 47(2)	Mizoram
		Provide adequate infrastructure and basic amenities	Section 64	Tamil Nadu
10	Diversification of Planning Authorities/ Boards	Chief Town Planner to hire officers and professionals with recognized educational qualifications in the state Advisory Board	Section 63(C)	Tamil Nadu
		Two eminent social workers nominated by the State Government, BDO of the areas in Master Plan, Zila panchayat (CEO) and President of Gaon Panchayat as members of the Development Authority	Section 13(1)	Arunachal Pradesh
			Section 8B (1)	Assam Amendment (2022)

S. No.	Key feature	Function	Section	State
11	Proposed circulation plan and utilities plan	TOD zones, road hierarchy, public and non-motorised transport	Amendment of sub-section 8D into Section 11	Assam Amendment (2022)
		Drainage plan, sewerage, and solid waste management plan		
12	Priority Action Plan	Prepare short, medium, and long-term sectoral programs, projects, and schemes based on the development priorities	substitution of new Section 15	Kerala Ordinance (2021)
13	Redevelopment Schemes	Create a detailed improvement scheme for implementation of the Master Plan	Section 34	Odisha
		General improvement, re-building, re-housing, street, development, housing accommodation, town expansion, drainage, sewerage disposal, and water supply schemes	Section 36-42	
14	Citizen-Friendly Planning	Prepare a Detailed Development Plan for land within the Planning Area and adopt it with or without modification, including those proposed by Co-operative Societies or landowners	Section 24	Puducherry
		Resident advisory council to advise the Metropolitan Authority on infrastructure, mobility, and environmental conservation	Section 12	Jammu and Kashmir

Source: Compiled by Authors

References

- Basu & Sharma, R. (2021). Urban-rural dichotomy in planning: Review of legal framework in four states of India, *Indian Journal of Public Administration*, Volume 67, Issue 1, <https://journals.sagepub.com/doi/full/10.1177/00195561211001610>.
- Government of India, Ministry of Housing and Urban Affairs. (2023, February 13). *Master plan for cities: Unstarred Question No. 1178, Rajya Sabha*. <https://sansad.in/getFile/annex/259/AU1178.pdf?source=pqars>.
- High-Level Committee on Urban Planning. (2023). *Pathways to Amrit Kaal: First report of the High-Level Committee on Urban Planning*. Ministry of Housing and Urban Affairs. https://www.nitiforstates.gov.in/public-assets/Policy/policy_files/RNC518L000551.pdf.

- Jit Kumar Gupta. (2022). Redefining planning strategies for promoting sustainable urban development. *SlideShare*. <https://www.slideshare.net/slideshow/redefining-planning-strategies-for-promoting-sustainable-urban-sett/251223896#1>.
- Kate, S. R. (2018). Town planning and various levels of planning. *SlideShare*. <https://www.slideshare.net/slideshow/architecture-and-town-planning-unit-3spptown-planning-and-various-levels-of-planning-by-s-r-kate/108340268>.
- Koshy, C. K., Parikh, D., & Kapoor, M. (2020). A critical analysis of the efficacy of institutional framework in the urban planning process of Kochi and Coimbatore. *Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)*.
- Kundu, A. (1989). National Commission on Urbanisation: Issues and non-issues. *Economic and Political Weekly*, 24(21). https://www.epw.in/system/files/pdf/1989_24/21/specialarticlesnationalcommissiononurbanisationiss.pdf
- Lata, K. (2022). *Urban planning in India*. Indira Gandhi National Open University, New Delhi. <http://egyankosh.ac.in/handle/123456789/78353>.
- Makkar, Y., & Gangwar, G. (2023). Critical evaluation of ancient Indian town planning principles used in neighborhood design: A case example of Vidyadhar Nagar. *Journal of Civil Engineering and Environmental Technology*, 10(1), 1–11. https://krishisanskriti.org/vol_image/10Apr2023100435Ar.%20Yogesh%20Makkar.pdf
- National Capital Region Planning Board. (1985). *National Capital Region Planning Board Act*.
- National Commission on Population, MoH&FW. (2011). *Summary of findings (pp. 2–13), Population projections for India and states 2011–2036*. Census of India.
- Parth Sadaria. (2016). Evolution of planning legislation in India. *SlideShare*. <https://www.slideshare.net/slideshow/evolution-of-planning-legislation-in-india/57826482>.
- Punjab Government Gazette. (1952). *The Punjab New Capital (Periphery) Control Act*. Town and Country Planning, Haryana.
- Sharma, S. P. (2019). Planning legislation in India (town planning). *SlideShare*. <https://www.slideshare.net/sumitsharma377/planning-legislation-in-india-town-planning>.
- Shirsagar, J. K., & Srinivas, R. (2014). *Town planning and development laws: Evolution and current amendments*. SlideShare. <https://www.slideshare.net/slideshow/tcpo-69790338/69790338>.
- Srivastava, D. K. (2023). How India can align its policies based on varied demographics across states to optimize growth. Ernst and Young https://www.ey.com/en_in/insights/tax/how-india-can-align-its-policies-basis-varied-demographics-across-states-to-optimize-growth.
- The World Bank. (2015). Leveraging urbanisation in India. The World Bank Group. <https://www.worldbank.org/en/country/india/brief/leveraging-urbanization-india>
- Town and Country Planning Organization. (1985). *Model Regional & Town Planning and Development Law*. Ministry of Housing and Urban Affairs.
- Town and Country Planning Organization. (2015). *Urban and Regional Development Plans Formulation and Implementation (URDPFI)*. Ministry of Housing and Urban Affairs, Government of India.
- UN-Habitat. (2020). *Urban planning and design*. United Nations. <https://unhabitat.org/2-urban-planning-and-design>.
- Vision IAS. (2021). Urban planning in India: Building future cities of India, Case study: Integrated urban development. https://d19k0hz679a7ts.cloudfront.net/value_added_material/28e53-urban-planning-in-india--building-future-cities-of-india.pdf

Provisions and Implementation of Real Estate Regulatory Acts in Various States of India - A Review

Nagarlok
ISSN-0027-7584
56(4), 394-410
October-December, 2024
@ 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.2>

Richa Goyal^{*} and P.S.N. Rao^{}**

Abstract

The construction industry in India is a vital component of the country's economic development, serving as the second largest employer and contributing approximately 6.5 per cent to the GDP. Despite its significance, the sector has been largely unregulated and disorganised. To address these issues and curb the increasing malpractices, the Real Estate (Regulation and Development) Act of 2016, commonly known as RERA, was introduced. The primary objective of RERA is to regulate and promote the real estate industry efficiently and transparently while protecting the interests of home buyers. The Act came into force on May 1, 2016, initially notifying 52 of its 92 sections, with the remaining provisions implemented on May 1, 2017. Real estate governance in India is characterised by a combination of central and state-level laws. RERA mandates state governments to establish implementation rules within six months of the Act's commencement. This paper aims to investigate the regulatory provisions enacted by various states to govern the real estate sector, particularly in the case of Uttar Pradesh (UP). The analysis shows how these regulatory frameworks deviate from the Central Act, hampering consumer interests and the effectiveness of regulation in the states.

Keywords

Real estate, Real Estate Regulation and Development Act, 2016, UPRERA.

Introduction

Real estate is considered as a major revenue-generating sector in India, comprising the housing, commercial, retail, and hospitality sectors (Tiwari, Chauhan 2020). For this

^{**} P.S.N. Rao, Dean (Planning and Development), School of Planning and Architecture, New Delhi, India.
Email: drpsnrao@hotmail.com

Corresponding author:

^{*} Richa Goyal, Ph.D. Scholar, Department of Housing, School of Planning and Architecture, New Delhi, India.
Email: richa.goyal2010@gmail.com

reason, it has a significant impact on the country's economy and overall growth. The sector's estimated projected growth is approximately 25–30 per cent in the coming decade, mainly due to rapid urbanisation and population explosion in the country. However, the industry is highly sensitive to changes in government policy. As these policies can affect the industry both positively and negatively, their impacts can sometimes be unpredictable.

In India, real estate is both a 'central' and 'state' subject. Granted Article 246 under the Constitution of India, 'land' is a state subject, while 'transfer of property other than agricultural lands' is a concurrent subject on which both Parliament (Centre) and state legislatures can enact laws. Despite recent growth, the real estate sector has been largely unregulated from a consumer protection standpoint, leading to numerous real estate scams, highlighting the fact that the existing consumer protection laws are more curative than preventive (Tiwari, Chauhan 2020).

Additionally, the need for regulation arises from the increasing malpractices in the real estate sector, where consumers face significant risks like delayed delivery, lack of clear property titles, and poor facilities before deciding to purchase a property (Sharma, 2018). Consequently, the sector is expected to be operated in a transparent, accountable, and disciplined way. Given the necessity to supervise the industry and protect the interests of all participants, the Real Estate (Regulation and Development) Act of 2016 was introduced.

The paper examines real estate regulation in several key countries worldwide and also explores the implementation of RERA in various states of India, particularly concentrating on Uttar Pradesh to showcase the primary real estate policy practices, thereby providing insights into notable advantages and disadvantages, setting the stage for future research opportunities concerning UPRERA.

Background Study

Overview of Real Estate Regulation in Various Countries

Recognising the significant contribution of real estate in stimulating economic development, numerous countries worldwide have implemented focused strategies aimed at establishing a strong and flourishing real estate industry. These strategies prioritise the development of effective policies and regulatory frameworks, ensuring excellence in execution, and making the best use of technology. Dubai serves as a prime example of effective regulation through the Dubai Land Department (DLD), which manages real estate legislation and has launched a smart application for immediate access to information about licensed brokers, thereby improving transparency; additionally, Dubai encompasses all real estate ventures that are managed by the Dubai Land Department. The Real Estate Regulatory Authority (RERA) under the DLD, along with other organisations, enhances consumer protection and strengthens market trust through well-defined contracts. For instance, in the U.S., only registered agents

are involved in both primary and secondary sales transactions. Furthermore, in China, the State Department of Real Estate, 'New State 10' regulation places an accountability framework on the local government in an effort to stabilise local real estate prices, while Singapore features clearly outlined extension fees that developers must pay for project delays: 8 per cent of the land purchase price for the first-year extension, 16 per cent for the second year, and 24 per cent for the third year. This highlights the formalisation of real estate sectors, emphasising the necessity for transparency, accountability, and consumer protection to nurture strong real estate markets. Additionally, countries like Germany have implemented stringent tenant protection laws, ensuring stability in rental markets, while Canada is increasingly focusing on foreign buyer taxes to curb speculation and maintain housing affordability.

In conclusion, the examination of real estate regulatory frameworks in various countries, such as Dubai, the United States, China, and Singapore, highlights the importance of transparency, accountability, and consumer protection in fostering a thriving real estate market. By adopting best practices like usage of smart application like RERA apps, mandatory registration for real estate brokers for primary and secondary transactions in real estate, and control of rates to ULBs, India can improve upon its regulatory systems to ensure fair, efficient, and robust real estate markets that may protect investors and consumers alike.

RERA and its Implementation in Various States of India

The Real Estate (Regulation and Development) Act, 2016 (RERA Act) was enacted in India to enhance regulation and transparency in the real estate sector and to ensure sale of plot, apartment or building protecting consumer interests and facilitating speedy, transparent and efficient dispute resolution.

The RERA mandates that each individual state must establish its own State Real Estate Regulatory Authority (SRERA). Although RERA is designed to function at a national level, individual states have been granted the authority to facilitate the effective enforcement of the Act. In compliance with RERA, it is the responsibility of each state to implement four essential activities:

- Formulate official regulations in accordance with RERA.
- Establish a RERA Authority tasked with the enforcement of legal provisions while ensuring transparency in real estate transactions.
- Develop a specialised Tribunal to adjudicate grievances and provide timely resolutions.
- Launch an online platform to gain buyers' confidence.

Notwithstanding the foundational framework that has been established, the implementation of RERA by states continues to exhibit variability. It is critical to examine the additional measures undertaken by SRERAs and to identify any existing

gaps within the same. Consequently, a comprehensive analysis was conducted through literature reviews and semi-structured interviews with stakeholders, including government officials, real estate agents, developers, and members of the public, were taken in order to derive conclusions for the research paper under the four major components of SRERA:

- Establishment of authority,
- Setting rules and ensuring implementation,
- Redressal via RERA,
- Internet portal functioning of RERA.

Establishment of RERA Authority

According to the Ministry of Housing and Urban Affairs, Government of India (MoHUA), all States and Union Territories have received notifications under the RERA, 26 states and Union territories have notified rules and have setup a website under Central RERA Act as showcased in Figure 1. While Interim RERA has been established in only four States, the six states and UTs have still to set up their authority (BCG, 2023; IIHS, 2023).



Figure 1: Pie Chart showcasing the SRERA Setup progress in INDIA.

Source: Implementation Progress Report, January 2024.

Additionally, it can be observed that, the ten States have contributed to 90 per cent of total Project Registrations. As depicted in Table 1, Maharashtra oversees the charts with 43,729 projects, comprising a massive 35 per cent of all Indian registrations. Gujarat, Karnataka, Madhya Pradesh, Telangana, Uttar Pradesh, Tamil Nadu, Andhra Pradesh, Rajasthan, and Chhattisgarh round out the top ten. These states have collectively played a vital role in driving the real estate market forward, and their contributions will no doubt continue as this industry continues to flourish. In matter of complaint resolving, Uttar Pradesh leads the pack with an impressive 44,763 resolved grievances which form 38.09 per cent of the total grievances received in the State. This is followed by Haryana, Maharashtra, Madhya Pradesh and Karnataka.

Looking at the implementation progress of RERA, it is clear that the scheme has made significant strides in many states and has resulted in substantial progress

in resolving complaints filed by real estate investors. While the number of registered projects or agents alone cannot definitively measure implementation success, it serves as a valuable indicator of quantitative progress, raising awareness and fostering greater knowledge, ultimately paving the way for enhanced qualitative outcomes, and focusing towards improvement and development to ensure that the scheme reaches its full potential.

Table 1: RERA 2016, Implementation Progress

	India	Maharashtra	Gujarat	Karnataka	Madhya Pradesh	Tamil Nadu	Uttar Pradesh
RERA Registration	1,19,214	43,729	12,250	6,582	5,712	20,097	3,536
Agent Registration	84,424	46,275	2,100	3,763	1,491	2,994	6,714
Disposed Cases by Authority	1,17,527	15,943	4,865	4,035	5,745	2,988	44,763

Source: Implementation Progress Report, Jan 2024.

Setting Rules and Ensuring Implementation

The Real Estate (Regulation and Development) Act, 2016, is a landmark legislation by the Government of India. It aims to bring transparency and good governance to the real estate sector, a key part of the Indian economy (Merchant S. et al., 2018). The Act is designed to increase transparency, enhance accountability among promoters and developers, and establish efficient grievance redress forums (Patil S. et al., 2017).

Maharashtra was the first state to establish a regulatory authority for the housing sector. The Maharashtra Legislative Assembly passed the Housing (Regulation and Development) Bill, 2012, and adopted the RERA regulation in 2017, appointing the Authority Chairperson and Members in May 2017. Initiatives like the conciliation forum, digital mapping, virtual hearings, and helpline services by MahaRERA have significantly increased transparency in the state's real estate sector. Gujarat followed suit, notifying the Gujarat Real Estate (Regulation and Development) Rules in 2017, which led to the formation of Gujarat RERA (GUJRERA). Key initiatives include regional investment mapping and project progress monitoring. Uttar Pradesh notified its RERA Rules in 2016 and launched its RERA website on July 26, 2017. UPRERA established a Permanent Authority in 2018 to ensure efficient complaint resolution through authorised officers using a web-based management system. UPRERA has also introduced project grading to help homebuyers make informed decisions.

However, a comparative study depicted in Table 2 for the Central Act and the Acts in Madhya Pradesh, Maharashtra, Gujarat, Rajasthan, and Uttar Pradesh, reveals

significant deviations from the intended guidelines of the Central Act (Tiwari, Chauhan 2020). Many states have diluted the rules to favour builders, undermining the spirit of the Act (Rohilla, 2019). Specifically, in Maharashtra, Gujarat, Rajasthan, and Madhya Pradesh, discrepancies include the definitions of ongoing projects, penalty clauses for non-compliance, payment schedules, and liability periods for structural defects. There is also a lack of structured scheduling for construction stages and fund releases, along with inadequate quarterly updates on audits and construction (Khot, Shaikh 2019). The clarity of these rules and the extent of state powers to make such dilutions have been examined. The provisions of various states regulating the Central Act were studied and compared, with a particular focus on Maharashtra, Gujarat, Rajasthan, and Madhya Pradesh, as summarised in Table 2 (Tiwari K. et al., 2020).

Table 2: Comparing Provisions of Real Estate Regulatory Act in Various States of India

S. No.	Particulars	Central RERA	Madhya Pradesh	Maharashtra	Gujarat	Rajasthan	Uttar Pradesh
1	Title	Real Estate (Regulation and Development) Act, 2016	Madhya Pradesh Real Estate (Regulation and Development) Act, 2016	Maharashtra Real Estate (Regulation and Development) Rules, 2016	Gujarat Real Estate (Regulation and Development) Rules, 2017.	Rajasthan Real Estate (Regulation and Development) Rules, 2017.	Uttar Pradesh Real Estate (Regulation and Development) Rules, 2017
2	Commencement	1 May 2016	22 October 2016	20 April 2017	20 October 2016	1 May 2017	27 October 2016
3	Defining of ongoing projects	Included from the start date	No provision for ongoing projects	Aligns with central provisions	No definition of ongoing projects	Aligns with central provisions	Different from the original clause
4	Carpet Area	Detailed guidelines provided	No provision for carpet area	Aligns with central provisions	No provision for carpet area	Aligns with central provisions	No provision for carpet area
5	Common Areas	Detailed guidelines provided	No specific details	Aligns with central provisions	No specific details	Aligns with central provisions	Aligns with central provisions
6	Registration Fee		Residential: Rs 10/sq m. for up to 1000 sq m., then Rs 20/sq m. with no upper limit. Commercial: Rs 50/sq m. for up to 1000 sq m., then Rs 100/sq m. capped at Rs 10 lakhs	Any development land: Rs 10/sq m., minimum Rs 50000 and maximum Rs 10 lakhs.	Group housing: Rs 5/sq m. for up to 1000 sq m., then Rs 10/sq m. capped at Rs 5 lakhs. Residential and commercial housing: Rs 10/sq m. for up to 1000 sq m., then Rs 15/sq m. capped at Rs 7 lakhs. Commercial: Rs 20/sq m. for up to 1000 sq m., then Rs 25/sq m. capped at Rs 10 lakhs. Plotted development.	Group housing: Rs 5/sq m. for up to 1000 sq m., then Rs 10/sq m. capped at Rs 5 lakhs. Residential and commercial housing: Rs 10/sq m. for up to 1000 sq m., then Rs 15/sq m. capped at Rs 10 lakhs. Commercial: Rs 20/sq m. for up to 1000 sq m., then Rs 25/sq m. capped at Rs 10 lakhs. Plotted development.	Residential: Rs 10/sq m for up to 1000 sq m., plus Rs 500 per additional 100 sq m. over 1000 sq m. Commercial: Rs 20/sq m. for up to 1000 sq m., plus Rs 1000 per additional 100 sq m. over 1000 sq m.

S. No.	Particulars	Central RERA	Madhya Pradesh	Maharashtra	Gujarat	Rajasthan	Uttar Pradesh
7	Consent of Allottees for Change in Sanction Plan	No special Clause	No special Clause	Consent required only for change in Concept/ Proposed Plan attached to Sale Agreement.	No special Clause	No special Clause	No special Clause
8	Deposit of 70per cent realisation – past and future receivables by the builder	As per Central Act	Deposit of 70per cent of future receivables in separate account, not the earlier in case of ongoing projects	As per Central Act	As per Central Act	As per Central Act	No clause; SOP (Nov 2023) mentions certified withdrawal after completion stage.
9	Penalties for non-compliance with the Act	Detailed from sections 59–68	Reduced penalties by including compounding options to avoid imprisonment	No mention of imprisonment penalties	No penalty provisions	No penalty provisions	Reduced penalties by including compounding options to avoid imprisonment
10.	Schedule for Payment and Defect Liability Period	Ten percent advance or application fee with written agreement. Developers must fix structural defects within five years at no extra cost.	No clause for structural defects	No clause for structural defects	Aligns with central payment schedule but lacks clarity on structural defects	Clause is unclear on structural defects	No special clause for structural defects

Source: Author, Tiwari k et.al., 2020.

The definitions of carpet area, common area, and ongoing projects are consistent with the Central Act in Maharashtra and Rajasthan, but are missing in Madhya Pradesh and Gujarat. Similarly, penalties for non-compliance with the Act have been diluted by encompassing compounding fees to avoid imprisonment in Madhya Pradesh, Maharashtra, Gujarat, Rajasthan, and Uttar Pradesh. Other points of disconnect include the payment schedule and liability period for structural defects.

Online Portal of RERA

The website serves as a platform for homebuyers to access vital information about real estate projects, including project status and approvals, thereby empowering them to make informed decisions. It also plays a significant role in ensuring that developers

regularly update information on the financial and structural progress of their projects, which is essential for maintaining accountability and discipline in the sector.

Additionally, the portal facilitates the filing of complaints and grievances, allowing homebuyers to seek redressal for issues related to project delays or non-compliance with regulations. Still these portals are not without their challenges, as many users face difficulties like:

- **Efficacy and Usability:** While the RERA website is a step towards transparency, its efficacy can be improved by enhancing user interface and accessibility, ensuring that information is easily understandable and accessible to all stakeholders.
- **State-Level Variations:** The implementation and effectiveness of the RERA website can vary across different states, necessitating a standardised approach to ensure uniformity in information dissemination.

Table 3: Web Portal Analysis of RERA

	Maharashtra	Gujarat	Karnataka	Madhya Pradesh	Tamil Nadu	Uttar Pradesh
Web portal	1. No important judgement of SRERA is highlighted	1. No important judgement of SRERA is highlighted	1.No important judgement of SRERA is highlighted	1.No important judgement of SRERA is highlighted	1. No information on complaints, penalties and orders linked with project.	1. Poor upload of RERA Annual Reports i.e. 2 in 5 years
	2. Three RERA annual reports published in past 5 years	2. 5 RERA report update in past 5 years.	2. No information on lapsed Projects	2. No information on stuck or laps of project, No information on complaints and penalties	2. No information on stuck or laps of project	2. Irregular update of Quarterly Progress Report
			3. Zero RERA report update in past 5 years	3. 5 RERA report update in past 5 years	3. No RERA report update in past 5 years	3. Poor availability of RERA finance in public domain

Source: Jha et al., 2023.

The RERA web portals, aimed at increasing transparency and accountability in the real estate sector, face challenges across various states in terms of usability and

information dissemination. A key issue across Maharashtra, Gujarat, Karnataka, and Madhya Pradesh, is the lack of highlighting important judgments from their respective SREERA (State RERA) authorities. Tamil Nadu's portal lacks comprehensive information on complaints, penalties, and project orders, while Uttar Pradesh shows poor maintenance of the RERA Annual Reports, with only two updates in five years. Several states, including Gujarat and Madhya Pradesh, display inconsistent updates regarding lapsed projects and penalties. Notably, Maharashtra and Gujarat have more frequent annual report updates (three to five in the last five years), but Karnataka and Tamil Nadu show little to no reporting during this period. Overall, the analysis indicates that while the RERA portals represent a positive step towards transparency, their implementation and upkeep require substantial improvement across most states to ensure consistent and reliable access to critical information for all stakeholders.

Redressal through RERA

The effectiveness of RERA (Real Estate Regulatory Authority) in addressing grievances and ensuring project completion varies significantly across different states. While the Act aims to enhance transparency and protect homebuyers, its implementation has resulted in diverse outcomes.

Table 4: Grievance Redressal Analysis

	Maharashtra	Gujarat	Karnataka	Madhya Pradesh	Tamil Nadu	Uttar Pradesh
Status of Registered Projects	68 per cent of projects registered under RERA are not complete	65 per cent of projects registered under RERA are not complete	72 per cent of projects registered under RERA are not complete	94 per cent completed projects out of registered projects	88 per cent completed projects out of registered projects	99 per cent of projects registered under RERA are not complete
Complaint Resolving Time (literature and survey)	not sufficient data in public domain	not sufficient data in public domain	556-716 days	500-522 days	323-433 days	200-300 days

Source: Jha et al., 2023.

In states like Maharashtra, Gujarat, Karnataka, and Uttar Pradesh, a majority of projects remain incomplete, with Uttar Pradesh having the highest rate of unfinished projects at 99 per cent (Table 4). In contrast, Madhya Pradesh and Tamil Nadu show a more successful track record, with 94 per cent and 88 per cent of projects completed, respectively. Additionally, the time taken to resolve complaints also differs, with Uttar Pradesh demonstrating the most efficient process (200-300 days), while Karnataka

takes the longest (556-716 days). These variations underscore the challenges and inconsistencies in RERA's implementation across states, impacting consumer trust and project timelines.

Uttar Pradesh Real Estate Regulation Act (UPRERA) vs. Central RERA: Key Differences

More than eight years have passed since the Real Estate (Regulation and Development) Act, 2016 (RERA) was enacted, with the goal of improving consumer protection and the real estate sector across India. Despite notable successes, disparities in implementation within different states persist.

Table 5: Central RERA vs UP RERA Comparison

S. No.	Key Points	Central RERA (Chapter & Section)	UP RERA
1	Ongoing Project	Chapter 1, Section 2: Ongoing project without completion certificate.	Excludes projects where services are handed over, 60 per cent sale deeds executed, or development completed.
2	Carpet Area	Chapter 1, Section 2 (k): Net usable floor area excluding external walls, shafts, balconies, etc.	No definition; builders must disclose size based on carpet area.
3	Advertise/Marketing of Project	Chapter 2, Section 3: No marketing without registering with RERA.	No explicit clause. Many builders fined for missing mandatory details in ads. [Example: ₹2.66 crore fine on 91 developers]
4	Escrow Account	Chapter 2, Section 4 (2) D: 70per cent of funds to be deposited for construction and land cost in a separate bank account.	No clause; SOP (Nov 2023) mentions certified withdrawal after completion stage. [Example: Unnati Fortune "Aranya" case](Haidar, 2023)
5	Functions and Duties of Promoter	Chapter 3, Section 11 (1): Quarterly updates on project status, bookings, approvals, etc.	No explicit clause; not followed initially. Later penalised projects for failing updates. [Example: 1,088 projects fined]
6	Advertisement	Chapter 3, Section 11 (2): Must include website details, registration number, and stage-wise completion schedule.	Not explicitly followed initially. Penalized projects for advertising violations. [Example: ₹2.66 crore fine on 91 developers](<i>Hindustan Times</i> , 2025)

S. No.	Key Points	Central RERA (Chapter & Section)	UP RERA
7	Deposit/Advance Before Sale Agreement	Chapter 3, Section 13: Maximum 10 per cent advance allowed before entering a written, registered agreement for sale.	No explicit clause initially, later clarified by advisories enforcing the 10 per cent rule. [Example: UP RERA advisory Jan 2024]
8	Sanctioned Plans	Chapter 3, Section 14: 2/3rd allottees' consent needed for modifications in plans.	No explicit RERA clause; governed by UP Apartment Act requiring approvals from stakeholders. [Example: Supertech Emerald Court case]
9	Functions of Authority	Chapter 4, Section 34: Maintain database of defaulters and revoked registrations for public viewing.	No such clause; reasons for project revocation missing.
10	Real Estate Appellate Tribunal	Chapter 7, Section 43: Promoter must deposit 30per cent of penalty or amount due before appeal is heard.	No such clause, however, clarified by judicial rulings enforcing deposits. [Example: Allahabad High Court ruling](Arora, 2022)
11	Penalty for Non-Registration	Chapter 8, Sections 59, 64, 66, 68: Punishable by up to 3 years imprisonment or fine up to 10per cent of project cost.	Diluted approach; predominantly monetary penalties (up to 10 per cent) over imprisonment. [Example: Ansal API fined ₹14.4 crore] (TNN, 2025)

Source: RERA, 2016; UP RERA, 2019, 2024.

Registration statistics and grievance redressal records highlight considerable variations in the performance of states concerning RERA compliance. Many states have faltered in sustaining momentum, leading to substantial deviations from the parent Act. This paper delves into the performance of Uttar Pradesh specifically, examining the deviations between the Central Act and the delegated legislation enacted by the state, as showcased in Table 5.

Ongoing Projects: The Centre and Uttar Pradesh RERA (UP RERA), a state regulatory body, have differing interpretations of what constitutes an ‘ongoing project’. Under the central RERA, the term applies to projects that have not yet received a completion certificate. The UP RERA, however, defines an ‘ongoing project’ as an in-progress development where a completion certificate has not been issued; specifically excluding certain types of projects not covered under RERA’s authority those are:

- Cases where the Local Authority has taken control of services for upkeep;
- Where the care of shared spaces and amenities has been handed over to the Residents' Welfare Association;
- Where 60 per cent of the apartments, homes, and plots have had their sale or lease agreements finalised and all development work is finished; and
- When all development work has been completed and an application for a completion certificate has been submitted to the appropriate authority.

Additionally, discrepancies in the interpretation of terminologies and regulations may also exist between the Central Real Estate Regulatory Authority (RERA) and the Uttar Pradesh Real Estate Regulatory Authority, for instance.

Carpet Area

UP RERA lacks a formal definition for carpet area but mandates builders and promoters to disclose apartment sizes based on carpet area, even when apartments are sold according to other measures like built-up or super built-up area. Importantly, this disclosure requirement does not invalidate existing agreements between promoters and allottees. For example, despite carpet area disclosure requirements, numerous developers in Uttar Pradesh, such as those operating in Noida and Ghaziabad, initially marketed properties based on super built-up areas, leading to consumer confusion. UP RERA subsequently issued directives reinforcing the obligation to disclose carpet area explicitly to curb such misleading practices (Haidar, 2024).

Escrow Account (followed)

UP RERA does not specifically address escrow accounts in its guidelines, focusing instead primarily on defining land and construction costs. This omission has historically resulted in inadequate regulation of funds management by promoters. A significant example includes the Unnati Fortune “Aranya” project in Noida, deregistered due to financial irregularities and diversion of homebuyer funds (Bhowmick, 2019; Ramnani, 2018). Responding to such gaps, UP RERA introduced stricter banking guidelines in recent times, mandating separate project-specific accounts to enhance financial transparency and prevent misuse of funds (Haidar, 2023).

Functions and Duties of a Promoter

The Central RERA Act requires promoters to regularly update booked apartments, plots, and garages, maintain current project status, and publicly disclose all approvals and pending approvals post - commencement certificate issuance. It also necessitates advertising transparency, including registration numbers and authority website addresses. In contrast, UP RERA lacks explicit requirements for quarterly updates or stage-wise scheduling disclosures. In practice, this has resulted in instances where projects in regions such as Greater Noida faced penalties for failing to provide

timely and accurate quarterly progress updates, highlighting deficiencies in promoter transparency and accountability.

Quarterly Updates

In November 2023, UP RERA penalized 1,088 projects for not updating their Quarterly Progress Reports (QPR) on the portal (Moneycontrol News, 2023). Many had given no updated construction status or revised timelines (732 projects provided no targets; 356 gave partial updates). UP RERA fined each defaulting project ₹1–2 lakh, noting that not updating progress “is contrary to the RERA Act” and undermines buyers’ right to current project status.

Misleading Ads

In January 2025, UP RERA slapped a ₹2.66 crore fine on 91 developers for violating advertising norms (*Hindustan Times*, 2025). These builders had published ads with misleading information or without mandatory details like the UP RERA registration number, QR code, or project bank account, which is against the Act. UP RERA warned that any ad missing such details is illegal, and reiterated that all promotional material must display the project’s RERA registration prominently (*Hindustan Times*, 2025). This enforcement highlights promoters’ duty to truthfully advertise only registered projects with all required disclosures.

Advance Payments

While the Central Act caps advance payments or application fees at 10 per cent of the property’s cost, UP RERA does not explicitly reiterate this cap. This absence led to situations where developers demanded higher upfront payments. In response to multiple complaints about excessive booking amounts, UP RERA clarified through advisories that collecting over 10 per cent of the property’s cost without an executed sale agreement was illegal, reiterating compliance requirements under the Central Act (*Economic Times*, 2024).

Adherence to Sanctioned Plans and Project Specifications

Although UP RERA remains silent on modifications to sanctioned plans, the UP Apartment Act mandates obtaining explicit consent from purchasers, project architects, or engineers and securing approval from prescribed authorities before altering project specifics. Non-compliance is exemplified by the high-profile Supertech Emerald Court case in Noida, where unauthorised construction led to a Supreme Court directive for demolition (*SUPERTECH LTD. v. EMERALD COURT OWNER RESIDENT WELFARE ASSOCIATION* | *Supreme Court Of India* | *Judgment* | *Law* | *CaseMine*, 2021), emphasising the importance of adhering strictly to statutory requirements.

Functions of Authority

Central RERA guidelines require authorities to maintain detailed public databases of promoter details, project specifics, and reasons for registration revocations. UP

RERA has historically lacked transparency in publishing detailed reasons for such revocations. Between 2020 and 2023, UP RERA deregistered multiple projects without adequately publicising the rationale behind each revocation, highlighting a transparency gap affecting consumer interests.

Real Estate Appellate Tribunal

Under Central RERA, promoters appealing against Authority decisions must deposit at least 30 per cent of the penalty amount, including compensation and interest, before the tribunal considers the appeal. UP RERA does not explicitly enforce this requirement. However, case law from the Allahabad High Court has clarified this position (Arora, 2022), dismissing appeals lacking mandatory deposits and underscoring that compliance with deposit requirements is non-negotiable.

Penalties for Non-Registration

The Real Estate Regulation Act authorises stringent penalties for non-compliance, including failure to register projects. UP RERA's application has typically favoured monetary penalties capped at 10 per cent of the project's estimated cost rather than immediate imprisonment. Notably, the Ansal API group faced significant penalty for selling units without registration in Lucknow (TNN, 2025), reflecting UP RERA's emphasis on financial penalties over criminal prosecution unless warranted by repeated non-compliance.

These variations in interpretation and enforcement of RERA provisions within Uttar Pradesh significantly influence consumer protection efficacy and regulatory effectiveness in the real estate sector.

Conclusion

The research highlights the importance of the Real Estate Regulatory Act (RERA) in shaping India's real estate market by promoting transparency, accountability, and consumer protection. As a pivotal sector contributing to the country's economic growth, real estate is poised to expand significantly over the next decade. However, the industry's sensitivity to policy changes and its history of consumer protection issues make regulatory frameworks like RERA essential for fostering a healthy market environment. The Act's introduction in 2016 was a crucial step towards curbing malpractices, ensuring professionalism, and empowering homebuyers. The comparative analysis of global best practices in real estate regulation, such as Dubai's Dubai Land Department, the U.S.'s registered agents, and China's accountability framework, underscores the value of robust governance. These international models reveal the importance of enforcing stringent regulations to protect consumer interests and promote market growth. Similarly, RERA, despite its sound framework, faces challenges in consistent implementation across Indian states, revealing gaps that need to be addressed to maximise its effectiveness.

A key finding is the significant variation in RERA implementation across Indian states. Maharashtra, Gujarat, and Uttar Pradesh have made considerable progress in project registration and grievance redressal, with Maharashtra excelling in registrations and Uttar Pradesh demonstrating efficiency in complaint resolution. However, other states, such as Karnataka and Tamil Nadu, lag in transparency and updates on their RERA portals, affecting consumers' ability to make informed decisions. Furthermore, the analysis of state deviations from the Central Act, particularly in states like Uttar Pradesh, Madhya Pradesh, and Gujarat, highlights serious discrepancies in key areas such as project definitions, escrow accounts, and penalty structures. These deviations often favour developers at the expense of consumer protection, diluting the Act's core objectives.

In Uttar Pradesh, the research identifies critical gaps in UP RERA compared to the central RERA, such as a lack of clear definitions for ongoing projects and carpet areas, the absence of escrow account regulations, and weak provisions for promoter duties and project updates. Additionally, UP RERA's lack of clear guidelines on advance payments, weak provisions for sanctioned plan modifications (addressed only after prominent legal cases like Supertech Emerald Court), and diluted penalty structures further weaken its effectiveness. These omissions create inconsistencies in consumer protection and weaken regulatory oversight. Additionally, UP RERA's failure to limit advance payments, provide structured project updates, or enforce stringent penalties for non-compliance further undermines its effectiveness. The comparative study of other states like Madhya Pradesh, Maharashtra, and Rajasthan reveals similar dilution of central RERA provisions, particularly concerning penalties, project updates, and registration requirements. These discrepancies lead to uneven enforcement and create a regulatory environment where builders may exploit weaker regulations to the detriment of homebuyers.

In conclusion, while RERA has significantly reshaped India's real estate landscape, its full potential remains hindered by inconsistent state-level execution. To maximise its impact, states—particularly Uttar Pradesh—must align more closely with the central RERA provisions, emphasising consumer protection over developer convenience. Adopting lessons from international best practices, coupled with stricter compliance measures and robust oversight, is imperative. Such an approach will foster greater market transparency, strengthen consumer trust, and contribute to a fairer and healthier real estate environment across India.

References

- Arora, S. (2022, April 16). Compliance of Pre-Deposit Under Section 43(5) of the RERA Act Mandatory to be Complied Before Entertainment of Appeal in a Tribunal: Allahabad HC. Retrieved from <https://www.livelaw.in/news-updates/allahabad-high-court-compliance-pre-deposit-section-435-rera-act-mandatory-complied-entertainment-appeal-tribunal-196781>.

- Boston Consulting Group. (2021). Five Years On: An Assessment of RERA – *The Road Ahead for a Stronger On-Ground Regime*, Ravi Srivastava, Neetu Vasanta, and Amita Parekh.
- Bhowmick, S. (2019, May 25). Noida project first to be deregistered by UP-Rera | Noida News - Times of India. Retrieved from <https://timesofindia.indiatimes.com/city/noida/a-first-rera-cancels-projects-registration/articleshow/69489962.cms>.
- Chauhan, K., & Tiwari, P. (2018). *Challenges of RERA: An analysis of New Reforms*. <https://doi.org/10.3759/jocetm.v7i3.34>.
- Economic Times*. (2024, January 24). Planning to buy a property? Rera has issued a warning. Read this before investing. Retrieved from <https://economictimes.indiatimes.com/industry/services/property/-construction/planning-to-buy-a-property-rera-has-issued-a-warning-read-this-before-investing/articleshow/106810746.cms?from=mdr>.
- Haidar, F. (2023, December 9). UP RERA asks builders to maintain three bank accounts for a project. Retrieved from <https://economictimes.indiatimes.com/industry/services/property/-construction/up-rera-asks-builders-to-maintain-three-bank-accounts-for-a-project/articleshow/105859761.cms?from=mdr>.
- Haidar, F. (2024, January 3). UPRERA directs developers to sell apartments as per carpet area. Retrieved from <https://economictimes.indiatimes.com/industry/services/property/-construction/up-rera-directs-developers-to-sell-apartments-as-per-carpet-area/articleshow/106520936.cms?from=mdr>.
- Hindustan Times*. (2025, January 25). UP-Rera slaps ₹2.66 crore fine on 91 developers for violating project advertising norms. Retrieved from <https://www.hindustantimes.com/cities/noida-news/uprera-slaps-2-66-crore-fine-on-91-developers-for-violating-project-advertising-norms-101737744373889.html>.
- IIHS. (2023). *Efficacy of RERA Web Portals* (pp. 1–4). Retrieved from https://iihs.co.in/knowledge-gateway/wp-content/uploads/2023/04/Efficacy-of-RERA-web-portals_Policy-Brief-1.pdf.
- Jha, D., Manish, D., & Singla, S. (2023). *The State of Real Estate Regulation in India 2023*. Retrieved from <https://doi.org/10.24943/TSRERI11.2023>.
- Khot, S., & Shaikh, A. (2019). Impact of Real Estate Regulation and Development Act (RERA). *Cikitusi Journal for Multidisciplinary Research*, 6(6), 4–7.
- Merchant, S., Pednekar, R., & Arolkar, D. (2018). Analysis of dilutions of the Real Estate (Regulations and Development) Act 2016 by state governments: A case study. *International Journal of Creative Research Thoughts (IJCRT)*, 6(2), 742–749.
- Moneycontrol News. (2023, August 11). UP real estate regulator penalises over 1,000 projects for not submitting QPRs properly. Retrieved from <https://www.moneycontrol.com/news/business/real-estate/up-real-estate-regulator-penalises-over-1000-projects-for-not-submitting-qprs-properly-11700631.html>.
- Patil, S. P., & Waghmare, A. (2017). *Impact of Real Estate Regulation and Development Act (RERA) on India's Real Estate Sector*. <https://doi.org/10.32628/IJSRST184119>.
- Ramnani, V. (2018, November 22). UP RERA issues show cause notices to 12 builders for diverting Rs 3,000-crore funds. Retrieved from <https://www.moneycontrol.com/news/business/real-estate/up-rera-issues-show-cause-notices-to-12-builders-for-diverting-rs-3000-crore-funds-3207771.html>.

- RERA, Pub. L. No. S.O. 1544(E) (2016). Retrieved from [https://www.icsi.edu/media/portals/86/bare%20acts/THE%20REAL%20ESTATE%20\(REGULATION%20AND%20DEVELOPMENT\)%20ACT,%202016.pdf](https://www.icsi.edu/media/portals/86/bare%20acts/THE%20REAL%20ESTATE%20(REGULATION%20AND%20DEVELOPMENT)%20ACT,%202016.pdf).
- Rohilla, S. (2019). Plight of buyers and consumers and respite under the Real Estate (Regulation and Development Act 2016). *National Journal of Real Estate Law*, 1(1).
- Sharma, S. (2018). Impact of RERA on Indian economy: A critical analysis. *International Journal of Law Management & Humanities*, 1(3). ISSN: 2581–5369.
- Supertech Ltd. v. Emerald Court Owner Resident Welfare Association. (2021, August 31). Supreme Court of India Judgment. Retrieved from <https://www.casemine.com/judgement/in/62ba6741b50db90d4b55ee7d>.
- TNN. (2025, January 9). UP-RERA slaps penalty on Ansals for violating norms. Retrieved from <https://timesofindia.indiatimes.com/city/lucknow/up-rera-slaps-penalty-on-ansals-for-violating-norms/articleshow/117064597.cms>.
- The Real Estate (Regulation and Development) Act, 2016.
- Tiwari, R. K., & Chauhan, K. A. (2020). Strategies and analysis of RERA across the ‘State Cluster’ of India. *International Journal of Advanced Science and Technology*, 29(7s), 4217-4224.
- UPRERA. (2019). *Uttar Pradesh Real Estate Regulatory Authority (UP RERA) Report*. Retrieved from <https://up-rera.in/pdf/RERA%20REPORT6919.pdf>.
- UPRERA. (2024). UP RERA: Uttar Pradesh Real Estate Regulatory Authority. Retrieved from https://up-rera.in/Frm_view_NCLT_Projectlist.aspx.

Green-Blue Sustainability Initiatives for Higher Education Institutions

Nagarlok
ISSN-0027-7584
56(4), 411-429
October-December, 2024
@ 2024 IIPA
DOI: <https://doi.org/10.32381/NL.2024.56.04.3>

Vanshul* and Ashwani Luthra**

Abstract

Higher Education Institutes (HEIs) have always been the role model of innovative ideas and new thinking in the world, but with the environmental challenges growing more sharply, the role of the universities needs to be reimagined otherwise the transition to sustainable world will become much harder. With the rapid pace of urbanisation, the cities are more oriented towards concretisation rather than focussing on green-blue sustainability concerns. This paper attempts to appraise the green-blue sustainability initiatives taken up by various HEIs around the globe. The Indian Institutions need to learn from them and start giving due consideration to embedding green-blue sustainability initiatives into their campuses. The initiatives taken up by the different campuses can serve as the benchmarks for Indian Institutions to adopt and comply with them.

Keywords

Green-Blue Initiatives, Green Infrastructure, Sustainability, Sustainable Campus.

Introduction

Sustainability means meeting our own needs without compromising the ability of future generations to meet theirs. It involves not only the responsible use of natural resources but also the nurturing of social and economic systems that support long-term well-being (Tony Binns, 2012). Environmentalism is part of sustainability. By the late twentieth century, many of these ideas had coalesced to demand sustainable development. So many countries were still grappling with grinding poverty after decades of trying to

** Dr. Ashwani Luthra, Professor, Guru Ramdas School of Planning, Guru Nanak Dev University, Amritsar.
Email: ashwaniluthra1@gmail.com

Corresponding author:

* Vanshul, Research Scholar, Guru Ramdas School of Planning, Guru Nanak Dev University, Amritsar.
Email: vanshul11.96@gmail.com

elevate their living standards through industrialisation. Unsustainable economic growth came at the expense of ecosystem health and social equity; it did not yield enduring prosperity. It was evident that the world needs a way out for ecology to be in harmony with prosperity.

The United Nations constituted Brundtland Commission which in its final report, '*Our Common Future*', defined sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs (United Nations, 2015). The Commission succeeded in integrating environmentalism with social and economic priorities on the world's development agenda. Sustainability — a holistic notion combining ecological, social and economic dimensions — acknowledges that all three must be taken together to derive sustainable prosperity. Sustainable development is an approach to growth that aims to balance human developmental goals with the sustainability of the natural environment. The final goal is a state of society in which resources and living conditions are utilised to satisfy human needs without compromising the stability and integrity of the natural system. This paper attempts to appraise the green-blue sustainability initiatives taken up by various Higher Educational Institutions around the globe.

Literature Review

The term sustainability is broad and diverse. It is crucial to adapt it to the local context to remain relevant. Various terms such as Green Campus, Eco Campus, Low Carbon Campus etc., evolve around the sustainability concept. All these concepts focused on the campuses' physical, social, economic, and environmental concerns.

As per Centre for Science and Environment (CSE), a Green Campus is the one that uses little water, harvests rain, optimises energy, saves electricity, prioritises renewable energy, reduces waste, has large green cover and open spaces, encourages eco-friendly transportation and emphasises on healthy and environment-friendly living (Sareen, 2018).

A Sustainable Campus carries out these functions while maintaining a culture of environmental sustainability, ensuring that design and function are in harmony with available resources. It is a place where environmentally-conscious practices and education are closely intertwined, and where environmentally responsible principles are demonstrated through actions.

The green campus institution is a place where self-reflection, testing new ideas, and implementing them are encouraged. At its peak, it is an exemplary environmental community where all aspects, including operational functions, business practices, academic programmes, and individuals, are interconnected, offering educational and practical benefits to the institution, the region, and the global community (Taisce, 2016-17).

Eco-Campus is a programme that provides a flexible phased approach to higher educational institutions for implementing an environmental management system at the higher and further education levels. Participants get an opportunity to study this system and they receive recognition in the form of bronze, silver, gold, and platinum medals. (Limited, 2021).

Climate Neutral Campus is a campus that does not contribute to any net climate impact due to the emission of carbon or other greenhouse gases. The university can most effectively accomplish its goal by implementing a series of actions that decrease aggressive energy usage, transition to low or no impact energy sources, and ultimately, offset carbon emissions. (Laboratory, 2022).

The concept of Green School was first introduced in Europe in 1990's and later, following the Rio Earth Summit in 1992, a need was felt to take necessary actions in every area in which humans impact the environment. In late 19th century when primary focus was only on environmental considerations, the Kyoto Declaration of 1993 made it obligatory for institutions to review their operations and reflect as best practices of sustainability (Sauve, 2007). The World Summit on Sustainable Development in Johannesburg in 2002 further catalysed the efforts to bring about shift from "educating about the environment" to "educating for sustainability" developing the urgent need for awareness about over-exploitation and misuse of resources in the quest of our future development (Pandya, 2015). In the view of this crisis the need emerged to deepen our understanding to meet the environmental challenges that we are facing today by enabling the children with appropriate skills to intervene in environmental, economic and social issues which have been viewed earlier in isolation.

For too long, water-related issues have been pushed underground but with the changing times, people have become aware that the grey alone cannot cope up with the challenges of climate change. The Blue-Green Infrastructure (BGI) paradigm marries these two types of infrastructures and values together in a union that is greater than the sum of its parts. BGI integrates hydrological and biological water treatment trains into systems where green features are seamlessly overlapping with blue features (Fletcher, 2015). Throughout the evolution of cities securing sufficient water for health, hygiene and economy, has been a greater challenge. The era of industrialisation has given rise to water- borne diseases such as cholera, black fever and typhoid. Consequently, the municipal authorities promoted public health and sanitation in cities by providing sewerage systems and fresh drinking water for the residents. Although the global case studies of Green Interventions may differ in terms of density, nature, size and the goal that they want to achieve, the learning from these case studies would be very useful for other communities in creating their green infrastructure framework and addressing the problems and challenges faced by them. See Table 1.

Table 1: Blue-Green Initiatives Around the Globe

Location	Area (Sq. km)	Population	Initiative	Intent
Vancouver, Canada	114	6,31,486	Rain City Strategy	Increase resilience through sustainable water management. Improve liveability by improving natural and urban ecosystem.
Singapore	718	56,90,000	Active, Beautiful, Clean Water Programme	To utilise full potential of drainage network of 17 reservoir and 8000 km of drains, canals and rivers by integrating them and boosting the recreational values.
Portland, US	375.5	6,64,605	Grey to Green Initiative	30,000 trees planted to capture 18 million gallons of storm water annually, 7400 acres of land treated for invasive plant species, 398 eco-roofs covering 11 acres of area and indigenous vegetation restoration on 4100 acres of land in consultation with public and private property owners.
Wuhan, China	8569	1,06,00,000	Sponge City Programme	20% of land provided with sponge features for utilising 70% rainfall upto 2020 and increasing this to 80% of land by 2030.
Hoeksche Waard, Netherlands	325.8	6,53,000	Agro-land improvement through Blue-Green Networking	Optimise agro-biodiversity, reducing pesticides, efficient resource management and greater multifunctional value to land.
30 Locations, Netherlands			Room for the river	This approach is to restore rivers' natural flood plain and prevent flooding in cities.

Source: Rain Strategy, Vancouver; Active Beautiful, Clean Waters Design Guidelines, Singapore; Grey to Green Accomplishments, Portland and Wuhan Sponge City Programme.

Various universities around the arena are both planning or imposing their sustainable campus plans with incentives from federal and state governments in the form of tax incentives for buildings that surpass the standards set by using the authorities. Ball State University is making plans to install huge geothermal cooling and heating machine in its campus, Ecole Polytechnique Fédérale de Lausanne installed the sector's first solar glass window in 2013, University of Oxford changed electrical installations inside the old homes with energy green LED lighting, Massachusetts Institute of Technology has advanced a Leadership in Energy and Environmental Design (LEED)

gold-licensed studies laboratory, University of Minnesota's Morris Campus features a biomass gasification plant, fuelled by way of crop residues from the nearby farms, Georgetown College has prepared a grasp Plan for 2037 that heavily addresses campus-wide sustainability and energy, *Università degli Studi di Milano and Politecnico di Milano* has been working on the mission *Città Studi Sustainable Campus* that makes a speciality of redevelopment of an academic district (called *Citta Studi*) in Milan at the standards of sustainability, Yale College focused, as part of their strategic plan for sustainability, on sub-institutional level planning and action and many greater projects are being taken up globally (Network, 2014).

Methodology

This research paper attempts to appraise the green-blue sustainability concerns taken up by various HEIs for embedding sustainability into the institutions. The institutions are the growth centres where people from far away come together and then spread to different parts of the world. The paper studies the journey of green-blue sustainability concerns in India vis-a-vis other countries in the world.. It tracks down that how the journey of green-blue sustainability concerns evolved in the earlier stages from Harrapan civilisation in India and the legacy was even continued further but with coming up of urbanisation, the cities focused more on concretisation rather than giving due consideration to green-blue sustainability concerns in the city planning. In the case of round the globe scenario, the HEIs have well addressed the concerns by deriving various targets, themes and strategies to be achieved by them in the near future. They have set the timelines for achieving the various goals and also the Sustainable Development Goals (SDGs) have been modified so that they could be incorporated in the Institutional level. In case of India, no such research focusing on green-blue sustainability concerns in HEIs, has been carried out as yet. The studies carried out till now in India focus only on achieving the SDGs and their targets by 2030 as proposed by the United Nations. Through this research paper, the authors throw light on how the institutions round the globe have taken up various initiatives for achieving green-blue sustainability concerns into their institutions so, that these could serve as best practices for Indian Institutions to adopt and motivate them to practice sustainability on their campuses too.

Results and Discussions

HEIs have always been the role model of innovative ideas and new thinking in the world, but with the environmental challenges growing more sharply, the role of the universities needs to be reimagined by educating the students, staff and faculty to play a role in supporting sustainable development in their lives. Higher education Institutes shape the leaders of tomorrow and unless the future generations have sustainability embedded in their mindset and skillset, the transition to sustainable world will become much harder (Iain Patton, 2021). The HEIs conduct research and offer insight

to overcome the societal, environmental and economic challenges by breaking new grounds and putting back more into the society and environment than it takes. If designed and managed efficiently these campuses can depict how the cities can also operate efficiently within the limits of finite land, water, energy, biodiversity and waste. The institutional areas can act as laboratory to demonstrate ideas and technologies and innovate a practical approach. If all the educational campuses get involved in demonstration and being part of the change the multiplier effect of this localised action can also be conveyed at a big platform for cities to adopt.

Campuses have an important role not only in the development of knowledge and understanding in the students but also in creating the foundation of environmental ethics. Institutions have long been the catalyst for social and political actions as well as centres of learning. It is a well-established fact that ethics, skills, values, habits and attitudes are inculcated from early stage of an individual's life through their institutions and surroundings. All these efforts are augmented if we have a sense of belongingness towards our surroundings and environment by nurturing them growing capacities as the learners through its green environment connecting them with their surroundings. These are the seeds of change that are borne at the campus which will grow and eventually spread far away.

Environmental-friendly techniques that support sustainability, reduce waste, increase efficiency, employ renewable energy sources, and encourage recycling in the building, water, solid waste, energy, and landscaping sectors are crucial while tackling campus sustainability issues. The green campus programme would open avenues for the educational societies to practice sustainability and strive towards making their campus self-sufficient. This would educate the community at a larger level and foster environmental literacy into its educational mind-set, which is the need of the hour.

Indian Scenario

In the floodplains of the Indus Valley Civilisation in prehistoric times, green practices began to evolve throughout the Indian subcontinent. One of the first examples of a well-planned water management system that implemented green principles at the city level was Mohanjodaro. Historically all the major cities inhabited green practices in human settlements which was evident from Udaipur established in 1559 A.D. which had artificial lakes designed around the city to fulfil the water demands. Jaipur, built in 1726 A.D. was designed on the principle of *Shilp Shastra* which had a planned open space network. New Delhi, the last city designed in British era had British and American style influenced design of open spaces along with a hierarchy of green spaces spread all around the city.

Cities planned after the British era also featured extensive networks of green spaces. For example, Chandigarh, planned in the 1950s, the New Delhi Master Plan of 1962, and the Gandhinagar Plan of 1965, all incorporated a hierarchy of open and green spaces ranging from the city level to individual neighbourhoods. To facilitate

the urban planning in the developing cities in India, the Town and Country Planning Organisation (TCPO) created the Model Town and Country Planning Act in 1962 to incorporate the idea of green spaces into the Master Plan. However, due to inadequate planning and execution, the connection between the green spaces and natural drainage patterns was severed. As a result, Indian cities started to deviate from green methods that were widely used in ancient towns. From the 1970s to the 1990s, major cities like Delhi, Mumbai, Chennai, Kolkata, and Bangalore all experienced these kinds of variations.

In India, the term ‘infrastructure’ has traditionally been associated primarily with grey infrastructure—comprising bricks and mortar—often at the expense of green infrastructure in urban areas. The concept of green infrastructure was first mentioned in the Indian context during the Fourth Five-Year Plan (1969–74), which emphasised environmental protection as a key component of a healthy lifestyle, though only in a limited ideological sense. In 2008, India formulated National Action Plan on Climate Change (NAPCC) by Ministry of Environment Forestry and Climate Change (MoEFCC) in response to United Nation Framework Convention on Climate Change (UNFCCC) and United Nation’s Green Economy Initiative. The NAPCC included 12 missions dealing with sustainable habitat, water, agricultural, forestry and multi-sectoral approaches. In addition, two flagship projects by MoHUA, i.e. Smart Cities Mission and Atal Mission for Rejuvenation and Urban Transformation (AMRUT) were also launched focusing on improving urban living that includes blue and green components as part of mission intervention (Driver, 2021). In addition to these programmes, the Government of India (GoI) has proposed Mission Amrit Sarovar to harnesses the potential of ponds and rejuvenate them to tackle climate change and conserve water. Also, Green Highway Policy has been proposed by GoI that promotes eco-friendly national highways through community participation and sustainable development. In order to provide sustainable, resilient and liveable cities, the green infrastructure is the need of the hour for the Indian cities as well as round the globe. In Indian cities, since the blue and green infrastructure is declining rapidly and grey is increasing constantly, a number of initiatives have been taken as given in Table 2.

Table 2: India’s Blue-Green Initiatives

City	Area (Sq. km)	Population (Census 2011)	Initiative	Intent
New Delhi	1483	16.7 million	Blue-Green Master Plan	To ensure blue green features are systematically planned and help reducing the effects of climate change.
Bhopal	1017	1.8 million	Blue-Green Master Plan	To maintain and grow green cover thereby creating sustainable city and improving health.

City	Area (Sq. km)	Population (Census 2011)	Initiative	Intent
Madurai	148	1.02 million	Blue-Green Action Plan	Mitigate flooding and accelerate economic growth for compatible development.
Bengaluru	1307	9.1	Blue-Green Action Plan that culminated in the Water and Sewerage Masterplan 2050.	To achieve resource security, climate resilience, low carbon economy and ecosystem protection.

Source: Bengaluru Blue Green Action Plan, Madurai Plan, Bhopal Blue Green Master Plan and Delhi Master Plan.

The Institute of Town Planners India (ITPI) published the *Urban Development Plan Formulation and Implementation (UDPFI) Guidelines* in 1996 to further execute the agenda of green practices. The Urban and Regional Development Plans Formulation and Implementation (URDPFI) guidelines 2014 required that at least 15% of the total area of the city be set aside for green and open spaces and there should be at least 10-12 square meters of green area per capita in the city. An all-encompassing law for environmental protection from all angles was the Environment Protection Act of 1986. Nevertheless, there are no laws or regulations that expressly address the preservation and improvement of green areas. The Service Level Benchmarks (SLBs, 2008) and Atal Mission for Rejuvenation and Urban Transformation (AMRUT, 2014) directed the Urban Local Bodies (ULBs) to guarantee that there was 10–12 square meters of green spaces available per person.

The nation's top university, Indian Institute of Technology (IITs) took the lead in addressing environmental concerns and societal issues in 2013 by implementing the Green Agenda in a gradual phased manner. The energy sector is under a lot of strain due to urbanisation and economic growth, which is increasing greenhouse gas emissions. Given this, the Central Ministry of New and Renewable Energy (MoNRE) has launched the Solar Cities Programme to build Green Campuses, with the goal of reducing the demand for fossil fuels by at least 25 per cent and conventional energy by at least 10 per cent over the course of five years. For the same, the circular dated 10 March, 2016 circulated by the University Grant Commission (UGC) to all the educational institutions coming under UGC to become partners for the noble cause and send their proposals as per the guidelines of the MoNRE. This programme provides a financial assistance of up to 5 lakhs for preparation of master plan and a detailed project report focussing on energy efficiency measures, enhancing supply from renewable energy, water and energy audits.

The sustainable campus programme is intrinsically tied to the education sector's potential for future expansion. Higher education's gross enrolment ratio is expected

to rise from 26.3 per cent in 2018 to 50 per cent by 2035, according to the National Education Policy, 2020 (Ministry of Human Resource Development., 2020). According to the All India Survey on Higher Education (AISHE) 2018–19, there are currently 60,000 higher education institutions in India (MHRD, 2018-19). It can be surmised that by 2035, the universities would be triple in number and the colleges would be double making the higher educational infrastructure responsible for at least 2.9 billion tonnes of carbon dioxide emissions (Roychowdhury, 2021). With the rapid expansion of the education sector, the demand for green campuses is growing stronger. This aligns with the objectives of the National Education Policy (NEP), which advocates for a holistic understanding of the environment beyond the traditional syllabus, while also aiming to build essential skills and capacities among both students and staff.”

The World Green Infrastructure Congress held in Bangalore in 2018, conceptualised to address urban infrastructural development with environmental considerations taken into purview. The World Green Infrastructure Congress is an annual event held by World Green Infrastructure Network to showcase futuristic design projects, state of art technologies, best practices and green city planning initiatives taken worldwide. In 2018, Bangalore was chosen as the destination for the conference in accordance with Indian Green Infrastructure Network which is a Non-Governmental Organisation (NGO) driven to carry out nationwide environmental education programmes and activities. In 1906, Bangalore became one of the first cities in India to generate electricity from hydroelectric power plant and *The Forbes* magazine named it as one of the the fastest growing cities. With the fast catching concept of green infrastructure, the city retains its name of garden city due to the abundance of lush green parks, gardens and tree lined avenues (Network W. G., 2018).

Scenario Round the Globe

“Environment Management Plan (EMP) 2017-2021” of Australian National University (ANU) establishes challenging goals for its all campuses to innovate, take the lead in the sustainability issue, and cut emissions associated with university operations. The University’s major initiatives for 2021 and beyond were outlined in the Environmental Management Plan, and the progress of these initiatives had to be reported on an annual basis. The EMP has been founded on three principles: long-term economic sustainability, social sustainability, and environmental sustainability. The responsibility of implementing the plan resides with Vice Chancellor of the University and Facilities and Service division. The University also supports 17 SDGs that are outlined into nine themes by the EMP, i.e. culture, built environment, energy and emissions, water, recycling and waste management, pollution prevention, transport, landscapes and biodiversity, and heritage (Australian National University, 2014). The target and strategy for achieving the nine themes of the campus are given in Table 3.

Table 3: Targets and Themes of ANU

Theme	Target	SDG Achieved
Culture	To increase awareness of sustainability on campus.	3, 4, 6, 7, 8, 9, 11, 12, 13, 14, 15 and 16.
Built Environment	100% of building using Australian accredited tool by 2019.	9, 11, 12, 13 and 15.
	Buildings should be designed, built, and operated with consideration for the natural environment.	
	By 2019, provide environmental building management training to the building staff.	
	Every contract must adhere to the Campus Master Plan's environmental standards.	
Energy and Emissions	In 2021, cut energy use per person by 20%.	7, 9, 11, 12 and 13.
	By 2021, reduce overall carbon emissions to 30%.	
	In 2021, increase the production of renewable energy by 50%.	
Waste Management	By 2021, raise the recycling rate to 85%.	6, 9, 11, 12, 13, 14 and 15.
	By 2021, all e-waste should be diverted from landfills.	
	20% less garbage to be dumped in landfills per person by 2021	
Pollution Abatement	Reduce potential hazards and control current contamination concerns.	3, 6, 11, 12, 13, 14 and 15.
Potable Water	By 2021, cut the amount of potable water used per person by half.	6, 9, 11, 12, 13, 14 and 15.
	Cut the amount of potable water used in campus by 20% till 2021.	
	Reduce potable water use in landscaping by 80% till 2021.	
Sustainable Transport	By 2021, raise the percentage of sustainable commutes to 80%.	7, 9, 11, 12 and 13.
	By 2021, offset all vehicle fleet emissions.	
	By 2021, increase the number of bicycles by 10%.	
	By 2021, offset all emissions from air travel.	
Landscaping and Biodiversity	Sullivans Creek's water quality not to be deteriorated.	6, 11, 12, 13, 14 and 15.
	Comply with environmental regulations	
	Increase community awareness	

Theme	Target	SDG Achieved
Heritage	Identification and assessment of heritage sites on campus	11, 12, 13 and 15.
	Increase awareness about historic and natural heritage all over the campus.	

Source: ANU (2014), Environment Management Plan, 2017-2021.

Beyond the Buildings

Sustainability Report, 2017 by University of Copenhagen focuses on sustainability initiatives of the university from both teaching as well as research perspectives and environmental footprints of the university buildings. The university has approximately 50,000 students and staff working in more than 60 buildings covering an area of 247.10 acres. Since the establishment of Green Campus in 2008, the university has worked extensively to reduce energy consumption and carbon dioxide emissions. Air travel accounts for 25 per cent of University's emissions which is said to be reduced in 2017 by shifting to virtual conferences and meetings. The energy consumption as per full time equivalent has reduced by 33 per cent since 2006 due to retrofitting of current buildings, transition from steam-based heating to water-based heating, energy efficient building operations and making energy efficiency as an integral part of building planning in the campus. The waste generation of the university is 22 per cent lower in 2017 than in 2012 and the recycling rate fell from 33 per cent in 2012 to 31 per cent in 2017 (University of Copenhagen, 2017).

Incineration is still the most common method used for waste disposal. The waste of the campus is sorted into 18 different groups and recycled as much as possible. The water consumption on campus is monitored by works department to reduce water losses. Every year in May spring festival is held in the campus displaying variety of sustainability activities including Sustainability Science Centre spread talks, sustainable food solutions, green campus initiatives and climate innovation workshops. In 2017 the Sustainability Science Centre mapped the courses related to sustainable development and found 100 such courses being taught with at least 5 in every faculty. The university is also a member of Copenhagen Sustainability Initiative and offers 2 master - level interdisciplinary courses on sustainability on an annual basis.

“Sustainability Strategy 2020-2025” of University of Bristol offers 15 major themes that address sustainability challenges in its operations, teaching, research, and community. The 15 themes stressed upon by the university along with the aim and areas of action that need to be undertaken by the university are as follows (University of Bristol, 2019):

Table 4: Themes and Action of University of Bristol

Theme	Aim	Actions	SDG
Education for sustainable development	Through both formal and informal curriculum, students should become deeply involved in sustainability.	1. Incorporating sustainability into curriculum. 2. Develop staff and students training and resource sharing. 3. Interdisciplinary courses on sustainable development for students.	All 17 goals
Research and knowledge transfer	Research on sustainable development and sharing the findings with communities and policy makers.	1. Organise partner engagement events, such as festivals. 2. Promotion of postgraduate research focussed on environmental problems.	3, 4, 8, 9 and 16
Staff and students engagement	Using communication effectively to deliver sustainable change and advance sustainability.	1. Run “Be the change” behaviour campaign. 2. Develop volunteer programs for “Go Green.”	11, 12 and 13
Engaging with other community	Establishing diverse communities that engage in and influence research, instruction, and university life in general.	1. Provide opportunities for active learning in the city and surrounding areas. 2. Create public art that is civically active. 3. Enhance students employability and learning.	3, 4, 8, 10, 11 and 17
Space Utilisation	Adopt performance management framework for effective space utilisation.	1. Putting the workplace reform agenda into action. 2. New requirements for the postgraduate and academic communities. 3. Updating current administrative space standards. 4. Creating space standards for teaching and learning.	11 and 13
Construction	Creating sustainable buildings.	1. Implement BREAM plus standards in the campus buildings. 2. Review sector approaches for sustainable construction.	9, 11, 12 and 13

Theme	Aim	Actions	SDG
Biodiversity	Create water-sensitive designs for green infrastructure.	1. Involve students and staff to enrich the biodiversity. 2. Effective land management for new buildings in the campus. 3. Use of technology and social media to enrich the biodiversity in the campus.	14 and 15
Energy, Carbon and Water management	1. To have carbon emissions from Scope 1 and 2 that are net zero. 2. Develop integrated climate change adaptation plan.	1. Efficiency and conservation techniques for buildings that use the most energy. 2. Create carbon objectives that are based on strong science. 3. Create an internal carbon offset program.	12 and 13
Transport	Minimize environmental impact from transport activity.	1. Develop travel plan and parking policies for the campus. 2. Plan for fleet and business travel strategy. 3. Developing campus wide cycling network. 4. Implementation and review of bus strategy.	11 and 13
Emission discharge and prevention of pollution.	Reducing emission and discharges to air, land and water.	1. Hold university wide management reviews. 2. Keep a register of elements and impacts that you review once a year.	6, 14 and 15
Circular Economy	1. Economic and environmental objectives to improve resource efficiency. 2. Deliver 7 key principles of circular economy.	1. Develop life costing model for goods and services of the campus. 2. Integrating circular economy in day to day operations of the campus. 3. Manage the waste effectively.	12
Procurement	Enable responsible procurement into all the aspects of campus.	1. A component of the sustainable impact assessment approach is life costing. 2. For every tender, a sustainability evaluation tool will be employed. 3. Employee education on sustainable procurement.	1, 2, 10 and 12

Theme	Aim	Actions	SDG
Responsible Investment	Pay attention to fossil fuels and the reduction of carbon through prudent investment.	1. Low carbon investment strategy for investments. 2. Engaging policymakers to encourage low carbon investment.	1, 2, 13, 16 and 17
Ethical and sustainable food	Reduce the adverse consequences that the offered goods and services have on the environment and society.	1. By 2020, it will be illegal to sell beverages in plastic bottles. 2. Run fair trade scheme in the campus. 3. Deposit return scheme for cafes and bars. 4. Promote plant based food. 5. Sustainability criteria for every food supplier.	1, 2, 3, 10, 12 and 13
Governance	Integrate sustainability into all governance scheme and decision making.	1. Deliver sustainable criteria by 2020. 2. Trial social impact assessment within the university committee.	10 and 16

Source: University of Bristol (2019), Sustainability Strategies 2020-2025.

“The University of Bayreuth’s Sustainable Strategy” published on 28 January 2021. The university is committed towards goal of climate neutrality by 2030 and describes their path to green campus in this report. The University attempts to shape the process of coexistence on campus and beyond the campus in a sustainable and responsible manner with the involvement of all the stakeholders. It strives to achieve sustainable development into all the fields of action i.e. governance, teaching research and infrastructure (University of Bayreuth, 2021). (Table 5).

Table 5: Measures Taken by University of Bayreuth

Indicator	Sub-indicator	Measures Taken
Governance		Create your Campus competition on topic of sustainability.
		Awareness raising measures for behaviour conducive to sustainability.
		Introduction of environment management system at the university.
		Expand the idea of green campus and campus sustainability
		Establish advisory committee for sustainability.
		Establishing an internal university sustainability fund.

Indicator	Sub-indicator	Measures Taken
Infrastructure	Energy Efficiency	Reduce energy demand for heating, cooling and optimising energy demand per floor with renewable energy measures.
	Material Consumption	Reduce paper consumption and increase the recycling rate.
	Water Consumption	Optimising the rain water harvesting potential and improving drinking water management system.
	Waste Generation	Installing 3 part waste bins and optimising the recycling rate of the waste.
	Biodiversity	Monitoring system for biodiversity and optimising the naturalise and renaturalised areas all over the university.
	Emissions	Reduce carbon dioxide emissions for travel related to university, for visiting the university and movement within the university.
	Procurement	Procurement for fair trade and sustainably produced university products.
	Co-operation	It aims to deepen its cooperation with the students, staff and society considering the aspects of greenhouse gases, use of ecosystem services and health.
Research	Sustainability Research	The University researches on sustainability with publications on sustainability, research projects and collaborations and propagation of their initiatives
	Sustainability in context of research	By training documents for action, equipping the labs with scientific personnel and development of database for analysing and researching on sustainability.
Teaching		Incorporating sustainability into the university's main curriculum.
		Interdisciplinary and compulsory courses for students on sustainability.
		Supplementary studies linked to sustainability.

Source: University of Bayreuth (2021), Our Path to Green Campus.

“University of Auckland Sustainability Report 2019” by the University of Auckland, New Zealand outlined some of the activities of the university that contribute to the achievement of 17 Sustainable Development Goals. The actions taken up by the University to achieve sustainability on campus are given in Table 6 (University of Auckland, 2019).

Table 6: Strategies of University of Auckland

Themes	Strategies	SDG
Zero Hunger	Sustainable food production methods through waste by products from food processing such as fruit peels and meat waste.	2
	A Budgie Meal concept where the staff and students can buy food at affordable rates from any food outlet of the campus.	
Clean Water and Sanitation	Water accounting system to enhance campus water quality and effectively manage wastewater	6
	Cost effective removal of pollutants from water and innovative storm water design for improving the water quality and quantity.	
Affordable and Clean Energy	Institute is a hub of renewable energy research to develop energy saving measures and reduce dependence on fossil fuels.	7
	Carbon free electrical system like smart grid, resilient solar system and electrification of transport.	
Decent Work and Economic Growth	Working towards the migrant worker exploitation with workers working for 90 hours a week and being paid for just 45 hours.	8
	The Institute is also ranked number 1 in the country for providing employment to its graduates.	
Industry, Innovation and Infrastructure	Developing robust and resilient infrastructure for the campus mandating the building codes in all the universities	9
	Various programmes such as Velocity for equipping students and staff with the required skillset, Get Good Done for solving real life environment problems and fostering innovation	
Sustainable Cities and Communities	Sustainable transport options for movement across the campus by providing bicycle stations and charging points for electric vehicles	11
	As per the reports 93 percent of the university students use public transport, bicycle or walk to get to their universities.	
Responsible Consumption and Production	Institute has added the 4 th R in 3R's i.e. rethink for responsible procurement.	12
	It has started paperless classroom projects and strive towards reducing the food waste.	
	The single use plastic is banned in the campus and sustainable materials are used for the university events.	

Themes	Strategies	SDG
Climate Action	University hosts a number of events for students and staff to get involved in combating climate change	13
	Tree plantation drives are organised by the students and staff for carbon sequestration.	
Life on Land	Research by School of Biological Sciences has led to widespread implementation of island conservation in the New Zealand.	15
	It visions to create new sustainable forest system and deliver high value products from it.	
	The university also offers courses on sustainable agriculture and environmental protection.	
Partnership for Goals	The University belongs to three prominent networks of research-intensive universities: the Worldwide Universities Network, Universitas 21, and the Association of Pacific Rim Universities.	17
	The university is also an active member of UN Sustainable Development Solutions Network.	

Source: University of Auckland (2019), Sustainability Report.

Conclusion

Incorporating sustainable development into HEIs is still a new subject for India as they are in their early stages. Even though some campuses might have taken initiatives but they are largely not known to the masses. Due to absence of monitoring and evaluation system of sustainability initiatives, no holistic rating or ranking system could be developed in India. Thus, any benchmarks for higher educational institutions cannot be defined as there is no information about extent of sustainable development in Indian universities. In India the sustainability initiatives are taken only on an *ad-hoc* basis to fulfil the National Assessment and Accreditation Council (NAAC) criteria and get NAAC accreditation. So far, not a single higher educational institute has published its sustainability reports since coming up of the SDGs.

A number of case studies presented in this paper can help us learn about the various goals and targets set by various foreign institutions for embedding sustainability into their higher educational institutions. Various sustainability rating systems have also been established all over the world such as Sustainability Tracking Assessment and Rating Systems (STARS), College Sustainability Report Card, Sustainability Campus Index by Association for Advancement of Sustainability in Higher Education (AASHE), etc. but no such sustainability rating systems is present in any of the Indian institutions. A holistic and comprehensive guide for the campuses regarding the kind of measures, their extent of development and benchmarks for their assessment and measurement is the need of hour for Indian institutions.

References

- Australian National University (ANU). (2014). Environment Management Plan 2017-2021. Australia: ANU Green Publications.
- Bajpai. (2017). Energy Conservation Building Code. New Delhi: Ministry of Power, Government of India.
- Card. (2012). Factors contributing to institutions achieving environmental sustainability. *International Journal of Sustainability in Higher Education*, pp. 166-176.
- Climate. (2014). Better Growth, Better Climate: The New Climate Economy Report. New Climate Economy.
- Driver. (2021). Blue-Green Infrastructure: An Opportunity for Indian Cities. Observer Research Foundation, pp. 1-37.
- Education. Greening the Campus. New England: New England Interstate Water Pollution Control Commission and Environmental Training Center.
- Fletcher. (2015). The evolution and application of terminology surrounding urban drainage. *Urban Water Journal*, pp. 525-542.
- Iain Patton. (2021). The UNEP Sustainable University Framework. (pp. 1-20). United Kingdom: UNEP.
- IEA. (2017). Retrieved from http://www.iea.org/publications/freepublications/publication/The_Future_of_Cooling.pdf.
- Laboratory. (2022, March 20). Climate Neutral Research Campus. Retrieved from nrel.gov.in: <http://www.nrel.gov/climate-neutral/>.
- L. Yang. (2014). Application research of ECOTECT in residential estate planning. *Energy and Buildings*, 195-202.
- Limited. (2021, March 20). nqa.com. Retrieved from Eco Campus: <https://www.nqa.com/en-gn/certification/standards/ecocampus>.
- MHRD. (2018-19). All India Survey on Higher Education. New Delhi: MHRD.
- Ministry of Human Resource Development. (2020). National Education Policy. New Delhi: MHRD.
- Network. (2014). Best Practices in Campus Sustainability: Latest Examples from ISCN and Gulf Schools. Switzerland: Global University Leader Forum.
- Pandya. (2015). Towards a Green School: Resource Book on Education for Sustainable development for Elementary Schools. New Delhi: NCERT.
- Roychowdhury. (2021). Green Campus Movement. New Delhi: Center for Science and Environment.
- Sareen. (2018). Green Sense: Educational Campus Inventory. New Delhi: Centre for Science and Environment.
- Sauve. (2007). Three decades of international guidelines or environment-related education: a critical hermeneutic of the united nations discourse. *Canadian Journal of Environmental Education*, pp. 33-54.
- Sustainia. (2014). Green Guide for Universities. Copenhagen: International Alliance of Research Universities (IARU) and Sustainia.
- Taisce. (2016-17). The Green-Campus Programme. Dublin: The Environmental Education Unit, Taisce.

- Tony Binns. (2012). *An Introduction to Sustainable Development*. London: Taylor and Francis Group.
- University of Auckland. (2019). *Sustainability Report*. Auckland : The University of Auckland.
- University of Bayreuth. (2021). *Our Path to Green Campus*. Bayreuth: The University of Bayreuth.
- University of Bristol. (2019). *Sustainability Strategy 2020-2025*. Bristol: University of Bristol.
- University of Copenhagen. (2017). *Beyond the Buildings: Sustainability Report*. Copenhagen: University of Copenhagen.
- United Nations. (2015). *The 2030 Agenda and Sustainable Development Goals*. New York: United Nations.

Spatial Planning Strategies for Resilient Cities

Nagarlok
ISSN–0027-7584
56(4), 430-438
October-December, 2024
@ 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.4>

Pankhuri Bhatia*

Abstract

Cities worldwide confront numerous urban development issues due to rapid changes in urbanisation. They face persistent challenges such as water scarcity, lack of affordable housing, poor air quality, high unemployment, poverty and inequality, inadequate public transportation, and acute shocks like earthquakes, floods, severe storms, extreme rainfall, and disease outbreaks. In response, various development concepts—such as Smart Cities, Sustainable Cities, Green Cities, and Healthy Cities—have emerged globally. However, these approaches often overlook the critical aspect of resilience. It is essential to integrate resilience and its core principles into the planning, development, and implementation of urban policies and initiatives. This paper explores spatial planning techniques that can support the creation of resilient cities.

Keywords

Resilient Cities, Urban Resilience, Spatial Planning, Infrastructure.

Introduction

In India, the rapid pace of urbanisation and associated challenges aggravate cities' chronic stresses, making them vulnerable to serious shocks. Cities, being the economic drivers, have the opportunity to provide residents with subjective well-being that has access to better service provision and infrastructure. However, cities are currently underprepared for future urbanisation prospects. The common citizens still have to face numerous challenges in an effort to meet their basic needs. In response to this, multiple new concepts such as Sustainability, Smart Cities, Compact Cities, Green Cities, Zero Waste Cities, etc. have been introduced worldwide, however, the factors of resilience have not been considered. Also, each concept required a detailed study at a large scale and integration among the components for achieving resilient cities.

Although the term resilience is not new, it has recently become prevalent in nearly all fields, including science, environment, technology, and spatial planning. The term

* Dr. Pankhuri Bhatia, Assistant Professor, Guru Ramdas School of Planning, Guru Nanak Dev University, Amritsar.
Email: pankhuri.plan@gndu.ac.in

resilience is termed as a tendency to adjust to the constant changes occurring at various levels in . Many definitions have been given for different fields. In the context of urban areas, it refers to an ability to absorb, adapt and respond to changes in an urban system so that living and functioning of the area can still be retained (Kevin C. Desouza, 2013). UN-Habitat has defined urban resilience as the measurable ability of any urban system, with its inhabitants, to maintain continuity through all shocks and stresses, while positively adapting and transforming towards sustainability. It is also defined as the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow regardless of chronic stresses and acute shocks, subjected to them. (National Institute of Urban Affairs, 2017).



Figure 1: Characteristics of Resilient Cities

Source: Resilient Cities Network, 2023

Characteristics of Resilient Systems

To build resilience, cities must be planned, designed and operated in a way that must have resilient characteristics. Integration, reflection, resourcefulness, inclusion, flexibility, robustness and redundancy are a few of the qualities of resilience (Turton, 2015) (Figure 1). Integration brings together the different actors and institutions that play a key role in urban development and management. Reflection describes how individuals and institutions use past practices to make future decisions. It covers the modifications in plans, policies, norms and standards at national, regional or local levels. Further, it will help make reflective planning processes to respond to changing circumstances. Resourceful means optimum utilisation of current resources and recognising alternative ways to use resources in a smart way to meet future needs or to achieve benchmarks.

Inclusion means bringing together different associations or communities to provide immediate responses that are realistic for their distinct circumstances and building risk awareness and preparedness to confirm that every individual has the opportunity to contribute to policymaking, planning and response measures meaningfully. Also, it gives a joint vision to build urban resilience. The ability and willingness to change plans when faced with unexpected events or crises is called flexibility. It is possible to increase the flexibility of systems by incorporating new knowledge or technologies, such as acknowledging conventional practices. Robust design is well-conceived, constructed, and managed and it includes making provisions to ensure that failure is predictable, safe, and not disproportionate to the cause. The term redundancy refers to creating extra capacity to handle disruptions caused by extreme pressures, surges in demand, or an external event. It includes diversity where there are multiple ways to achieve a given need (Arup and The Rockefeller Foundation, 2015).

Case Studies

100 Resilient Cities support the adoption and incorporation of a view of resilience features which include not just shocks such as floods, fires, riots, but also stresses such as growing diversity and ageing infrastructure that could threaten and weaken the fabric of the city on a day-to-day or cyclical basis (National Institute of Urban Affairs, 2017). According to Rockefeller Foundation, 2015 three best practices of resilient cities are—New Orleans (U.S.A.), Melbourne (Australia) and Semarang (Indonesia). New Orleans (U.S.A.) has experienced figure of challenges - rising sea levels and climate change, land subsidence and coastal erosion, and lack of equity and opportunity. To cope with these challenges, city developed a vision on topics ranging from equity to energy, from education to emergency planning. The prime goals set up are— Adopt to Thrive, Connect to Opportunities and Transform City System. The government has appointed a Chief Resilience Officer and Resilience Design Review Committee — an inter-departmental committee to review all capital projects that are meant to enhance resilience to ensure consistency, quality, coordination, and public transparency. The city has developed and implemented new resilience design standards for public works and infrastructure, including re-examining street design standards to incorporate stormwater management, multi-modal transit, and recreational amenities. The city has also updated their existing development plans. In addition, the city focuses on educating and advancing understanding of resilience principles at the local, regional and state levels (Rockefeller Foundation, 2015).

The city has developed a pilot project named Gentility Resilience Districts to reduce flood risk, slow land subsidence and encourage neighbourhood revitalisation. The pilot project followed five different strategies: community adaptation, workforce development, reliable energy and smart systems, urban water infrastructure, and resilience strategies. Flood Free Designs, Rain Water Harvesting, Creating Landscape Areas, and Beautify Neighbourhoods are among the proposals that have been encouraged to make it a successful project (Rockefeller Foundation, 2015).

In the case of Melbourne, the city has faced numerous challenges due to its strategic location. Since the city has experienced significant climate change impacts and has many upstream dependencies, it has adopted significant measures to enhance its resilience, including developing adaptation strategies and plans, establishing networks, developing emergency management plans and undertaking risk assessments (Rockefeller Foundation, 2015).

In India, several initiatives have been taken by the Government of India for making the cities resilient. World Bank is working with the Government of India to strengthen its climate resilience, and to promote both adaptation and mitigation measures across a broad range of sectors (World Bank, 2023). A few of the sectors are lowering carbon footprints, restoring the dwindling forest cover, promoting resilient agriculture, strengthening large dams, conserving groundwater, planting mangroves to protect India's coasts, making flood-prone areas safer, ramping up solar power, green hydrogen, storing renewable energy in batteries, rethinking the development paradigm and many more.

Methodology to Build Urban Resilience Strategies

While preparing an urban resilience plan, be it an action plan, a short-term strategy, or a long-term strategy, the risks and vulnerabilities that the cities confront should be carefully considered. It should also incorporate monitoring, assessment, and adaptation to address emerging trials and prospects. According to Alvarado (2017), to develop urban resilience strategies, the following steps should be followed. The first stage is to assess and analyse the existing risks and vulnerable areas to prioritise key aspects and lay the foundation for long-term strategies.

The next step in the process is to formulate goals and objectives consistent with the city's vision for resilience and sustainability. It may also include upgrading the existing infrastructure, promoting social cohesion, enhancing economic stability and sustainable development.

Integration, coordination, and participation constitute the third phase. The stakeholders like corporations, government agencies, community organisations, and academic institutions play a vital part in the social and economic development of cities; therefore, they must collaborate and integrate to build urban resilience. It will further encourage the exchange of knowledge, asset and proficiency.

The next step in building the urban resilience process is to develop integrated planning and policies. The organisations must ensure the integration of resilience strategies into the city's overall planning and policy framework. In addition, it is necessary to include it in sector-specific plans like transportation, housing, land use and disaster management plans. This holistic approach guarantees that resilience becomes a core principle across all sectors.

After preparing the resilience plans, it is critical to determine possible public and private funding sources to ensure the effective implementation of resilience projects and initiatives. The competent administrations pursue creative funding channels and form partnerships with national or international funding agencies to secure funds for long-term resilience investments.

The latter step involves capacity building and education programmes to upgrade the skills and knowledge of city officials, urban planners, and community members in resilience planning and implementation by organising training programmes/workshops/seminars. In addition, it is necessary to promote educational and awareness campaigns that can contribute to resilience efforts for residents and communities.

The last step involves regularly monitoring and evaluating the implemented strategies and re-formulating the objectives if required. This will increase the efficiency of plans, and overcome the problems and gaps. This iterative process further ensures constant improvement and flexibility to changing circumstances. Figure 2 clearly depicts this process.



Figure 2: Process to Build Urban Resilience Strategies

Source: Author, 2024

Strategies and Tools to Build Resilient Cities

Building resilient cities requires shifting the approach from an atomistic to a holistic and proactive, encompassing various aspects of city planning and management. The planners must adopt an innovative mechanism for planning, designing, implementation, and monitoring to reduce combined effects. It can be started at the building scale by replacing the old structure with green building concepts. In addition, other strategies are proposed that can be exercised at an urban scale—

- *Long-Term Plans with Regular Monitoring:* Cities worldwide have long-term strategies, including master plans or development plans, mobility plans, and infrastructure development plans, but resilience, which is a crucial aspect, has not been unified into these frameworks. Consequently, resilience elements must be introduced into existing master plans/development plans. This becomes crucial in enhancing urban sustainability and preparedness for unforeseen challenges and disasters. To ensure the efficiency and effectiveness of resilience-based master plans, it is important to integrate regular monitoring at regular intervals.
- *Integrated and Inclusive Planning:* Urban resilience can be effective and efficient when integrated as a core component in the planning of different sectors like housing, transportation, infrastructure, environment, industries, etc. The integration and coordination of the stakeholders, policymakers, and community members should be encouraged to identify vulnerabilities, set goals, and implement resilient solutions. The competent authorities should prepare Integrated City Plans that enable a city to deal with multi-disciplinary issues like climate change, disaster risk reduction, or emergency response through coordination. It must be incorporated into the city's overall planning and policy framework. Also, resilience considerations must be aligned with land use planning, transportation strategies, housing policies, and disaster response plans.
- *Risk Assessment and Management:* A city may encounter, thorough risk assessments to comprehend the possible risks. This includes evaluating vulnerabilities, identifying the hazards allied with climate change, and creating risk management strategies. Cities may mitigate and respond to potential hazards by identifying them and putting relevant safeguards in place.
- *Building Strong and Resilient Infrastructure:* The core component for building urban resilience is to have resilient infrastructure. This includes designing and constructing buildings, roads, bridges, and utilities that can withstand natural and manmade disasters. Also, it should be well-integrated with the up-to-date skills that will enhance resilience by enabling real-time monitoring and response. Some examples of strong and resilient infrastructure are building strong transportation that can survive in extreme weather conditions, upgrading water and sewage systems to prevent contamination or advancing renewable energy resources that can provide power during power shutdown.

- *Community Engagement and Participatory Planning:* Community engagement and participatory planning are critical to urban planning, propelling development towards sustainability and inclusivity. It is considered a vital aspect of building urban resilience. Communities also play a significant role in identifying risks and preparing plans that consider local needs. It enables varied communities to express their distinct viewpoints promoting knowledge sharing, their needs, and aspirations and encouraging a balanced approach to planning. Urban initiatives involving citizens in decision-making might better reflect the collective interest, improving the livability and functionality of the urban environment. Furthermore, community engagement develops residents' sense of ownership and responsibility, leading to enhanced urban area management and preservation.
- *Sustainable Transport System:* Sustainability and urban resilience go hand in hand. In addition to being resilient to shocks and strains, resilient cities highly value social, economic, and environmental sustainability. By incorporating sustainable practices, urban planning and development can enhance a city's resilience and the well-being of its residents. Sustainable transportation system is a crucial component of urban design therefore, it needs to be considered while planning for cities. Encouraging walking and cycling, supporting various initiatives that enhance safety and environmental quality for pedestrians, cyclists, and public transportation users, promoting mass transit facilities, replacing outdated vehicles, and encouraging transit-oriented development are effective ways to promote sustainable transport in our cities. These projects contribute to diversifying city transport options, saving money and energy.
- *Promoting Green Infrastructure:* Green Infrastructure plays a substantial role in building urban resilience. Cities are facing several challenges such as climate change, urban flooding, pollution, etc. Promoting green infrastructure aids reduce GHG emissions, combating urban heat effects, reducing chances of urban flooding, mitigating climate change effects and promoting better health and life for its residents. Green infrastructure can be provided by encouraging natural features and ecosystem services like adding more trees, parks, wetlands, urban roofs, rain gardens, bioswales, permeable pavements, etc.
- *Water, wastewater management and conservation techniques:* Water is a key to life and is considered a valuable resource. The current concerns like rapid urbanisation, climate change, and deteriorating and outdated infrastructure have further aggravated the water challenges in the settlements. To guarantee reliable, sufficient, and excellent water services, cities must immediately create resilience-based water management strategies. Effective waste water management helps diminish the pollutants from the water leading towards protecting the urban environment. Also, reducing the potential for catastrophic water supply system and sanitation failure helps make an urban community more resilient.

- *Solid waste management by 3R approach:* Urban areas generate large quantities of solid waste. Poorly managed disposal approaches like uncontrolled dumping, desegregated waste, open-air incinerators, and landfills have negative impacts, including air and water pollution, land dilapidation, methane and hazardous leachate emissions, and climate change. These impacts impose significant environmental and public health costs. Adding recycling/reusing practices leads to less pressure on natural resources and mitigates associated GHG emissions. The emissions can be further evaded by ‘proper processing, treatment and disposal’ facilities which can be done according to the Solid Waste Management Rules, 2016. Also, various well-established methods are being published by different organisations like the Inter-Governmental Panel on Climate Change (IPCC), World Resources Institute (WRI), International Council for Local Environmental Initiatives (ICLEI), and C40 to quantify the GHG emissions from processing, treatment and disposal facilities. This may reduce the adverse well-being and environmental bearings, conserve resources, and improve the livability standards of cities.
- *Framing of resilience toolkit as a guide:* Implementation of resilience as a key component to planning can only be done with the guiding design principles. Cities follow norms and standards for urban development aspects. However, these have not been updated for so long. Resilience is the need of the time, therefore, it becomes necessary to incorporate resilience-specific standards and publish them as a toolkit that will be helpful for the areas having similar characteristics.
- *Good Governance:* Strengthening urban governance is key to the effective and inclusive delivery of basic services amid and later shocks and stresses. This includes strengthening the capacity of cities to improve and enforce land use, zoning and other plans and regulations; improving community engagement; strengthening communication, transparency and accountability; and aligning across diverse actors and levels (national/subnational) that contribute to urban governance. Also, an organisation is required to make an effort towards resilient cities. Several administrations have already been set up worldwide that work on the various issues of urbanisation making the environment a major concern like Rockefeller Foundation, ICLEI – Local Government for Sustainability, C40 and United Cities and Local Government. Rockefeller Foundation has identified 100 resilient cities and four Indian cities – Surat, Chennai, Pune and Jaipur have also been acknowledged among them. Bengaluru, Chennai, Delhi, Jaipur, Kolkata and Mumbai have been identified by the C40 organisation.
- *Innovative financing mechanism:* City governments have limited financial resources. Actions to build resilience often require far more financial resources than city governments can mobilise on their own. Strengthening financial resources through resource mobilisation and use, development of blended finance solutions) of cities and help them unlock financial capital for the physical and social infrastructure needed to support resilience.

Conclusion

Due to the complex structure of the cities, changes are occurring continuously. The issues in urban areas are lifting and going beyond their limits. In these circumstances, urban areas have not remained livable. Thus, planners must prepare effective strategies that can hold the present and future development. Resilience is a very imperative mean nowadays. Therefore, it is necessary to rethink design, planning and implementation of the upcoming projects along with incorporating them with the existing plans. It will prevent the urban areas from any vulnerable situation not for present only, but also for the future too. But, above all, there is a need for public participation to involve them in the complete process with the joining hands.

References

- Alvarado, Daniela Idrovo. (July, 2017). "Urban Resilience: Building Sustainable and Future-Proof Cities" retrieved from <https://www.e-zigurat.com/en/blog/urban-resilience-sustainable-cities/#:~:text=Conclusion,livable%20environments%20for%20their%20residents> accessed on September 2023.
- Arup and The Rockefeller Foundation. (2015). "City Resilience Framework. 100 Resilient Cities" Retrieved from <https://assets.rockefellerfoundation.org/app/uploads/20140410162455/City-Resilience-Framework-2015.pdf> accessed on September 2023.
- Desouza, Kevin C. and Flanery, Trevor H. (2013). "Designing, Planning and Managing Resilient Cities: A conceptual framework", Cities--- *The International Journal of Urban Policy and Planning*, retrieved from https://www.researchgate.net/profile/Trevor_Flanery/publication/259122914_Designing_planning_and_managing_resilient_cities_A_conceptual_framework/links/558039b208aea3d7096e4467/Designing-planning-and-managing-resilient-cities-A-conceptual-framework.pdf accessed on September, 2017
- World Bank, (2023) "India: Helping People Build Resilience to Climate Change", retrieved from <https://www.worldbank.org/en/country/india/brief/advancing-climate-adaptation-building-resilience-to-climate-change-in-india> accessed on December 2023
- National Institute of Urban Affairs. (2017). "Building Resilient Cities: Enabling Local Action" retrieved from <https://niua.in/intranet/sites/default/files/2242.pdf> accessed on September.
- Resilient Cities Network. (2023). What is Urban Resilience retrieved from <https://futuresready.resilientcitiesnetwork.org/what-is-urban-resilience/> accessed on September.
- Rockefeller Foundation. (2016). "*Resilient In Action – 100 Resilient Cities*", retrieved from <http://action.100resilientcities.org/page//100rc/pdfs/Resilience%20in%20Action%20100RC%20Report%20October%202016.pdf> accessed on September, 2017.
- Turton, Polly. (2015). "*Designing Resilient Cities and Communities*", Montreal Summit on Innovation 'Climate (of) Change: Cities, People and Prosperity, 5th Edition retrieved from www.cmmm.ca/Documents/.../2014.../Montreal_SMI15_PollyTurton_final_v2.pdf accessed on September, 2017.

Digitalisation and Environmental Concerns

Nagarlok
ISSN-0027-7584
56(4), 439-450
October-December, 2024
@ 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.5>

V. Gnaneshwar*

Abstract

Of all the technological revolutions the world has experienced, the digital revolution stands out as the most transformative, game changing, developmentally critical and a challenging field. It is game changing because it has brought-out radical shifts in the lifestyles and development of the countries. Today digital technology has become indispensable to every sector including core areas like manufacturing, agriculture, communication, transport, defence, space, environment, finance, business, medicine, wellbeing and leisure activities. The economies are already reaping the benefits of digitalisation. Even global environmental monitoring agencies are dependent upon the growing digital knowledge and technologies. Digitisation is transforming the entire developmental maps of the countries and in the process, the digital infrastructure itself is undergoing constant transformation inventing new devices and technologies to meet the changing needs of the societies across the world. Unfortunately this global party is being spoiled by certain environmental concerns. Its intensive energy use, pollution-ridden device manufacturing and the e-waste are the prime environmental issues confronting the countries today. This paper, while explaining the significance of digitalisation in the current development scenario across the world, discusses the emerging energy, environmental and public health problems. Besides, the paper attempts to present an environmentally sustainable digitalisation framework.

Keywords

Digitalisation, E-waste, Global Environment, Public Health.

Introduction

Digitalisation has emerged on the global development scene in a wider and faster way. It is contributing tremendously to the developments in almost all the sectors. With pronounced and realised benefits in its kitty, digitalisation is being promoted by the

* Prof. V. Gnaneshwar (Retd.) Regional Centre for Urban and Environmental Studies Osmania University, Hyderabad.
Email: vgnan@yahoo.co.in

governments and the private sectors equally. In fact, it has become an integral element in the current globalisation scenario where the countries are connected digitally, though they may have their differences on other issues. The explosion of data, the rise of internet connectivity, and the rapid advancement of artificial intelligence have indeed transformed the landscape of human capability and knowledge sharing. The digitalisation has become more significant with the automation initiatives in the industrial, transport, communication and a host of other areas. The automation primarily depends on digital technology applications. Automation reduces human burden but shifts that burden to digital technology that provides smart solutions. In the urban sector too, a global trend of applying the smart solutions under the umbrella of smart cities is developing fast in recent years. The smart cities aim at efficient management of city planning, transportation, traffic control, civic services, finance and pollution control activities. About 280 cities around the world have launched smart-city projects (Pitron, 2023). India also launched the smart city development programme in June, 2015 under which about 100 cities were selected. The main objective is to develop inclusive and environmentally sustainable cities with a focus on core civic infrastructure, shelter and pollution. In smart cities, data on various aspects is collected and processed by information technologies like sensors, geopositioning systems and even emerging Artificial Intelligence methods. All this will increase the digital interactions exponentially. Accompanied by these developments, certain environmental concerns are also emerging primarily due to intensive energy consumption and e-waste management issues. The crucial dimension here is the development of a massive digital infrastructure based on the critical resource of energy and natural resources like water and other valuable materials.

Digital Infrastructure

The 21st century has been witnessing an amazing digital technology revolution powered by high-tech products like computers, mobile phones, tablets and routers. It is estimated that in near future, almost every one of us would be making about 5,000 digital interactions per day and to meet such demand, the manufacturers of digital equipments are competing to produce more versatile and sophisticated, and easy to use products to woo the users. Further, vast networks with high powered transmission cables are laid in space, water and surface to transmit information across the consumers. To facilitate cloud technology, large data centers are being built. The major concern here is that the gigantic digital infrastructure is consuming considerable resources of the Earth. Regarding metals involved in the production of ICT products, it is estimated that the ICT accounts for about 12.5 per cent of global copper production, 7 per cent of global aluminum production, 15 per cent of palladium, 23 per cent of silver, 40 per cent of tantalum, 41 per cent of antimony, 42 per cent of ruthenium, 70 per cent of gallium, 80 per cent of germanium, 80 per cent of terbium, 60 per cent of indium, 50 per cent of erbium, europium and gadolinium, 63 per cent of dysprosium, and 26 per cent of neodymium. It may seem ironic to claim that digitalisation is dematerialising

our economies, especially when the infrastructure enabling this transformation relies heavily on physical resources. From data centers and servers to the devices we use daily, digital technologies consume vast amounts of materials and energy. In fact, the digital sector now accounts for about 10 per cent of global electricity usage and contributes to roughly 4 per cent of worldwide carbon dioxide emissions—challenging the notion that virtual progress is environmentally light. (Pitron, 2023).

Modern life is based on billions of digital interfaces everyday that produce data every minute. This massive data is processed, transported through cables, stored in energy intensive data centers and sent to people for further interfaces in a never ending continuum. The world has become truly connected at personal, community and country levels. The key element of the digitisation process is the volume of data—its generation, storage, transmission and consumption across the geographies. The digital technologies like 5G, Global Positioning System (GPS) and Artificial Intelligence (AI) enabled machines unfolding recently are further boosting the volume of data hugely.

Wonderland of Emerging Digital Technologies

In recent years, wondrous technological developments like 5G, GPS navigation, AI enabled robots and driverless cars have been emerging on the global digital scene. If 5G promises unimaginable data transmission, the GPS navigation and driverless cars transform the very face of the auto and transport sectors. AI enabled robotic technology boasts to reduce human roles in a multitude of fields like defence, space research, health, finance and manufacturing. The AI technology, on one hand, reduces human burden, on the other, it poses a potential threat to human beings as it may overtake human intelligence. The repercussions of the AI technologies cannot be forecast at the present juncture though several speculative claims are under circulation. Let us discuss the potential of these technologies and their effects on data volume and digital infrastructure.

The main claim of the 5G technology is that it facilitates super fast transmission of the data. It is estimated that this technology can transfer 10 times more data with 10 times more speed than the 4G. South Korea has already developed 5G on mobile networks on a massive scale covering about 20 per cent of contracts and 13 million people (Pitron, 2023) Many other countries including India have big plans to implement 5G technologies. The extraordinary speed and volume of the data transfer naturally attracts the customers in both the developed and developing countries. It has been observed that 5G is much easier to install and its latency can open gates for the introduction of automated and remote controlled gadgets like drones, robots and driverless cars. Application of these gadgets will transform the entire human and machine interface spectrum. On an advantageous side, it has great potential to optimise efficiencies in road traffic management, electricity distribution systems, and a myriad other areas.

On the infrastructure side, installing a 5G network requires more antennas as each antenna can cover only about 100 meters. Some primary assessments indicate that the need for 5G antennas will be double than that of 3G or 4G antennas. This implies installation of more antennas which consist of rare materials like gallium and scandium. From these antennas, individual coverage is done through fiber cables to relay data. The Fiber Broadband Association has estimated that this needs about 2.2 million kilometres of wired fiber—amazingly 55 times the circumference of the Earth. If the expected 60 per cent of the world population is to be covered by 2026, wired fiber demand will be mind boggling. Along with these, the mobile manufacturing companies also should produce 5G enabled phones, the business of which is already going on briskly (Pitron, 2023). Regarding volume of the data transmission through 5G, the Ericsson tech company estimated that by the end of 2025, 20 per cent of the internet users will use 200 gigabytes on 5G devices every month. This estimation excludes the Internet of Everything applications which is also catching-up steadily in the world (Ericsson, 2019).

Another technological innovation relates to GPS—the Global Positioning System. GPS technology helps space research and travel. In space research, it helps to measure the distances of the stars, planets, etc., in a more accurate manner. In the sphere of travel, the GPS-enabled navigation helps safer travel for both, road and air. Without GPS, it is difficult to imagine air travel today. GPS navigation has already become widely popular in respect of road travel too. With this technology, it is claimed that vehicular carbon dioxide emissions would reduce by 5 to 20 per cent. The negative aspect, however, relates to the effects on volume of data generated, stored and transmitted. For capturing necessary information, the GPS depends on a large number of cameras, radars and sonars. A GPS-enabled car is equipped with about 150 electronic control units, producing over 25 gigabytes of data per hour. Its onboard computer needs processing power of 20 laptop computers and a total of 100 million lines of code to run its software. In terms of data generation, it is far ahead of spaceships, telescopes, drones, etc. For instance, a spaceship needs 4,00,000 lines of code, Hubble Space Telescope requires two million lines of code, a military drone needs 3.5 million lines of code, and a Boeing 787 requires 14 million lines of code. Further, a smart car's software is equivalent to 250 spaceships, or 50 Hubble Space Telescopes, or seven Boeing 787 planes. The forthcoming totally automated or driverless car is another technological wonder. It is estimated that a driverless car requires some 300 million lines of code to function. It has also been observed that a million driverless cars need as much data as the entire world population connected to the web (Pitron, 2023).

Another area that consumes considerable electricity concerns with the blockchain technology that employs digital encryption networks to establish distributed ledgers of information. This technology requires a substantial amount of electricity to track and verify digital transactions. For example, Bitcoin, a digital currency supported by blockchain technology consumes an annual electricity supply of 45.8 TWh surpassing

the energy consumption of all consumers in Nevada, USA as per 2019 data. Further, China's bitcoin industry is projected to consume 296.59 TWh of energy in 2024 contributing to 130.5 million tons of carbon emissions (Haisen Wang et al., 2023).

The most puzzling aspect of the digitisation process today concerns the emerging Artificial Intelligence (AI). Artificial devices like robots are slowly replacing human activities while reducing their role. It is claimed that apart from humans, in future, even machines can produce AI, confining human role to minimum like supervision. Already digital APPs like trolls, bots and spam bots are being used not only to dispatch spam mails but also to inflate social media rumours. For instance, in 2018, YouTube developed tools to detect inflated or fraudulent videos. All this shows that data production and communication is not only the prerogative of humans as machines are taking human roles and performing the tasks even more efficiently than humans in several fields. All this unfolds a complex web of networks of humans and machines, and even machine to machine. It is observed that if robots start producing data, it becomes difficult to control the data production and its measurement. Already, automated machines are being used in different sectors. For instance, there is an increasing role of algorithms in the financial sector. Today, bots perform over 70 per cent of the trades worldwide due to efficiency factors representing about 40 per cent of total world's traded value. Further, algorithms are being developed by various fund management companies who manage hedge and other passive funds. The financial analysis is done more efficiently by machines making human role obsolete (Pitron, 2023).

Data Generation, Storage and Transmission

In the information and digital era, it is evident that data has become a critical element occupying the crucial place. As per the 2020 estimates, every minute 1.3 million people connect to Facebook, 4.1 million internet searches on Google, 4.7 million videos viewed on YouTube, \$ 1.1 million spent on e-commerce websites, 190 million e-mails sent, 2.5 million images viewed, 59 million messages sent, 1,94, 444 tweets, 6,94, 444 scrolls, 4,00,000 apps downloaded, 19 million texts sent, and the list goes on and on. Among all these video streaming consumes more data. All these escalate pressure on the internet while adding to the global volume of data on an annual basis. For instance, the volume of data produced in 2010 was 2 zettabytes which grew to 47 zettabytes by 2020 and, it is predicted to increase to 175 zettabytes by 2025, 2,142 zettabytes by 2035 (Pitron, 2023).

Handling of this mountainous data is the critical problem in digitalisation process. Data is generated by software professionals spread across the globe. This data is generally developed, stored and transmitted in the myriad servers set-up in the offices. But, with the emergence of Cloud Technology, the entire scene has changed. Cloud computing technology in simple terms is delivering hosted services over the internet. Different services are rendered through cloud systems. Three common services are: Infrastructure as a Service (IaaS); Platform as a Service (PaaS); and Software as a

Service (SaaS). Big companies maintain their own cloud services but many other tech firms cannot afford cloud infrastructure. In order to serve them, the strategy of constructing data centers is being adopted. The data centers render professional services and have become more popular in recent times. Construction of the big data centers requires huge amounts of money. The infrastructure consists of thousands of server computers networked together into parallel processing or grid computing systems. They employ sophisticated virtualisation technologies which allow computer systems to be divided into many virtual machines that can be rented temporarily to customers. As the data centers consume huge amounts of electricity, they are usually located in places where sufficient electricity is assured (Carr, 2023). Further, as the data centre services are rendered 24/7 running on electricity, frequent cooling is necessary. Electricity and water are the main resources for running the data centers. If data centers stop working, these cause heavy costs to companies. For instance, important services like travel, health, financial markets, security surveillance, etc., may be disrupted causing heavy losses to the concerned institutions, and inconveniences and hardships to people who avail the services. The data centers therefore, take utmost care in ensuring uninterrupted electricity and water supply. The quantum of electricity consumed by the data centers and networks sector is estimated to form two per cent of the global electric consumption (Wang et al., 2023). In the context of fast growing cloud services across the world, this figure may reach 8-10 per cent by 2030, that is, 4-5 times increase in over a decade. Bulk of this will be consumed by the data centers (Pitron, 2023).

The current digital physical infrastructure is very huge consisting of several devices manufacturing and selling centres, cable networks, offices and the data centers. This infrastructure will increase in future with the continued innovation and growth in digitalisation. Like industrialisation and urbanisation, digitalisation appears to be irreversible. This trend demands more and more electrical energy which adds to the problems of the already crisis-ridden energy sector today. Further, this will contribute to the increasing greenhouse gases as bulk of the energy is produced by burning the fossil fuels. The increasing digital devices and the constant innovations results in the accumulation of e-waste products, disposal of which has become a pollution threat today. Thus, digitalisation will further worsen the current global environmental crisis if appropriate measures are not taken in time. The following section discusses the emerging environmental concerns caused by digitalisation.

Digital Transformation and Pollution Concerns

On the positive side, digitalisation contributes to efficiency in all human activities; leads to several facilities and comforts, on the negative side, it has become an environmental issue posing pollution and public health threats. There are mainly two areas where pollution problems arise, one relates to the manufacturing of various electronic devices and the other concerns e-waste management.

Manufacturing electronic components

At the outset, while the size of the electronic items are becoming smaller and smaller, their capacities are increasing manifolds. But the manufacturing of these tiny products reveals that they contain several material inputs and metals, some of which are precious while some others are dangerous and susceptible to pollution. For example, the smart mobile phone comprises 54 elements including metals like gold, silver, copper, lithium, silicon, bromine, magnesium, and platinum, etc., which adorn the phone's chips, battery, casing and screen. Further, manufacturing of the electronic parts needs large quantities of other resources. For instance, a two kilogram weighing laptop requires 22 kilograms of chemicals, 244 kilograms of fuel, 1.5 tons of clean water and several such other items. The manufacturing companies involve thousands of sub-contractors to get raw materials who are located across a dozen countries (Pitron, 2023).

Production of the semiconductors may lead to pollution as the microprocessor industry releases several liquid, solid and gaseous wastes into the environment. Treatment of all the solid and liquid chemical wastes is a challenging task. However, greenhouse gases like carbon dioxide may escape into the atmosphere. Apart from this, emission of about 50 fluorinated gases, that is, F-gases, (the HFC family) which are little known—is another pollution threat. Earlier, the HFC gases were not considered so harmful for global warming but Indian climatologist Veerabhadran Ramanathan warned as far back as 1975 that HFCs contribute to global warming. The world's biggest producer of HFC gases, is India today. The pollution from the graphite mines is causing immense suffering to the people in those areas. Economic interests often take precedence over ethical or environmental concerns in many government decisions. Industries that generate significant revenue—whether it's through natural resource extraction, arms manufacturing, or even exploitative labour—can be shielded from scrutiny or regulation because of the financial benefits they provide. (Pitron, 2023).

E-waste generation and management

The e-waste is inevitable in the fast changing digital world. The electronic devices like mobile phones, computers, servers, household and medical equipments, and network fibre cables, etc., could be dumped for reasons like breakages, upgrades or functional failures. The frequent upgrades to emerging technologies make the existing devices obsolete and compel the users to dump the old devices. Technological obsolescence is thus rapid in the digital world. Faster upgradations and inventions are the main reasons for digital obsolescence. The recent trend of digital manufacturing companies is rapid upgrade to attract users. Another important technological shift has been Cloud technology. Moving to the cloud implies dumping of existing servers. The illegal transboundary e-waste dumping is reported occasionally in different parts of the globe despite restrictions due to ineffective controls and monitoring.

All these factors add to the e-waste problem. It was estimated that over 34 billion pieces of digital equipments weighing 223 million tonnes are under circulation on the

planet (WHO, 2023). Further, it has been observed that e-waste is the fastest growing component of the total solid waste and is increasing three times faster than the world's population (Alves, 2024). These trends undoubtedly point towards increasing e-waste generation in the future. Managing the increasing e-waste is a critical challenge today. The e-waste could be simply disposed of as municipal waste or disposed of after proper treatment through the recycling process. The disturbing aspect is disposing of e-waste without proper treatment.

If e-waste is recycled properly, valuable resources could be drawn and reused. It is here the big problem of potential pollution lies. In case, recycling is not done appropriately, there is a threat of releasing about 1000 different chemical substances including harmful neurotoxicants. As per the ASSOCHAM-EY study, the volume of e-waste in India was 2 MMTs which more than doubled to 5.2 MMTs by 2020. Today India stands as one of the top five e-waste producing countries along with China, US, Japan and Germany (Shenoy, 2019). Further, only 32.9 per cent of the e-waste was recycled in India in 2021 (Sonal, 2023). The disturbing aspect of the e-waste recycling business is that the bulk of the recycling business is done in the informal sector without following proper guidelines especially, in developing countries like India. For example, 20,000 tonnes of e-waste was handled with bare hands in Delhi by 25,000 workers (Monika and Kishore, 2010). Another problem relates to lack of effective control and monitoring by the regulating authorities and necessary technical expertise for proper disposal and recycling in both the underdeveloped and developing countries. As a result, people especially children and women are exposed to e-waste pollution. Further, this may contaminate air, soil, dust and water near the recycling sites and the communities. Burning of the electronic waste is considered as the most hazardous as it releases poisonous gases into the air. The common health effects due to improper recycling methods include premature births and stillbirths, leading to associated neuro problems, and reduced lung and respiratory function. It is observed that children and women are more vulnerable groups to these health problems.

The potential of e-waste is thus clear and demands international action. The WHO identified strategies for dealing with e-waste related pollution. Adopting and enforcing international agreements, devising and implementing national-level legislations, effective monitoring of e-waste sites, eliminating child labour, and educating and training health workers at all levels are the main steps of the WHO strategy (WHO, 2023). In India, the pollution monitoring agency Central Pollution Control Board, issued guidelines in the form of schedules 1.2 and 3 to the Hazardous Waste (Management and Handling) Rules 2003 and Municipal Solid Waste Management Rule, 2000 in 2007. Later, the Ministry of Environment, Forest and Climate Change, has comprehensively revised the E-Waste (Management) Rules, 2016 that came into operation on April 1, 2023. The main purpose of this initiative is to manage e-waste in an environmentally safe manner. In this endeavour, all the agencies involved like

manufacturers, producers, refurbishers, and recyclers have to register on a portal developed by the Central Pollution Control Board (Public Information Bureau, 2023).

Sustainable Digital Transformation-a framework

Sustainable digital transformation is a comprehensive subject consisting of three major components: sustaining the digital transformation itself through innovative technologies and business models, applying digital technologies for achieving the global sustainable development goals in various sectors and, making digitalisation environmentally sustainable. As part of the technological revolution, digitalisation is taking place in almost all the sectors of development like governance, manufacturing, business, agriculture, communication, defence, transport, energy, medicine, education, and a host of other areas. Digitalisation has contributed a lot to the growth and development of all these sectors. Similar to other technologies, digital technology naturally becomes obsolete in the context of a fast changing world and emerging needs of societies. In order to meet the emerging changes and needs, digital technology developers are already in the process of transformation through various innovations. The present competitive business environment compels the developers to strive for constant innovations in their technologies to make them relevant and sustainable in the business.

In view of the global resource constraints and negative effects of modern technologies, the concept of sustainable development was devised. Sustainable development has become the top agenda of discussions globally. The UN and its bodies have formulated global policies and guidelines for implementation by the governments at various levels across the world. Digitalisation has also been supporting the sustainable development initiatives in various sectors. For example, in the energy sector digital technologies are helping energy optimisation initiatives in the fields like manufacturing, production, agriculture and business. In the sustainable environment field also, digitalisation is helping in collecting the data, monitoring and assessing the periodic environmental changes and mapping the probable future scenarios.

The present digitalisation model is defective from an environmentally sustainable perspective. Its huge energy consumption is unsustainable in the context of the present global energy crisis. The unscientific handling of e-waste poses a threat to public health and the environment. To be more specific, the information and technology sector contributes to about 4 per cent of global greenhouse gas emissions as the bulk of the present energy production is based on fossil fuels (UNEP). In this situation, the increasing energy demand by the IT sector increases the risk of a global footprint. On the energy front, it is paradoxical that digitalisation has been used in different sectors to achieve energy efficiency in their operations whereas the digital sector itself has become a major consumer of energy. In this tricky situation, there is a need for energy efficiency initiatives in the digital sector too and for developing low energy consuming

devices. Further, digital agencies must also focus on using alternative energy sources like solar and wind energies.

The entire digital business environment has to undergo changes to make it sustainable. It is a welcome measure to observe that the digital sector is already responding to this need by slowly moving to energy efficiency business models. This step is beneficial for the digital agencies too to make their infrastructure cost effective and at the same time making its operations environmentally sustainable. The steps like turning off lights and equipments, adopting efficient power management settings like putting computer equipments on sleeping mode when not in use, deploying smart power strips in the office to combat energy waste, and automating repetitive tasks across the IT infrastructure to reduce the need for always-on devices, will go a long way in making digital operations energy efficient. Another area could be upgrading to energy efficient devices like computers, monitors, printers and other peripherals which are becoming popular these days. One more measure could be adoption of server virtualisation techniques to reduce the number of physical servers, especially in data centers to serve on a single server (ION). The companies should also invest in energy-efficient storage solutions like the solid state drives that consume less power than the traditional hard disc drives and, data duplication and compression technologies to reduce data storage needs. Migrating to cloud computing is also considered as an efficient method for reducing energy consumption. Further, adopting eco-friendly cooling systems in the data centers is another energy-efficient measure. The optimisation of heat, ventilation and air conditioning systems are significant energy savers in the IT environment especially in the data centers. All these techniques and methods being advocated by experts aim to achieve energy efficiency in the digital management sector.

As already discussed, e-waste management has become an environmental and public health threat. The UN has recognised this fact and formulated policies and guidelines for scientific management of the e-waste across the countries. The governments also formulated required policy and legal framework to be adopted by the implementing agencies. The challenge however, is efficient implementation of these rules and regulations on the ground. Ultimately, only scientific recycling and waste disposal systems will work in reducing environmental and public health risks of digitalisation. The developed countries are a step forward in this respect compared to the developing countries where the administrative laxities make it difficult for strict implementation of the e-waste disposal rules and regulations.

Conclusion

The technologies discussed above in the digital world are driving an unprecedented surge in data generation and consumption. On the other hand, technologists often assert that their innovations enable cleaner and more efficient operations through energy savings. Experts in the digital economy echo these claims, emphasising the potential for increased efficiency and sustainability through technological advancement. They

argue that promoting the digital economy would lead to reduced carbon emissions by low carbon technology innovations. Several events in the technological history in the world, have proved that contrary to the expectations, energy efficient measures always lead to increased demand for more fuel or energy due to increased usage. And the digital field is no exception as digital technologies and their proclaimed energy gains have always been negated by increased use of energy (Pitron, 2023).

Today, there are claims and counter claims pertaining to the environmental impacts of the ICT sector in the world. For instance, the Global e-Sustainability Initiative (GeSI)---an initiative of the global digital players in the private sector predicted that the ICT industry's carbon footprint will reach 1.25 gigatons of carbon emissions by 2030 accounting for 1.97 per cent of global emissions. At the same time, the organisation also claimed in a report called SMARTer 2020 that the ICT interventions will reduce the greenhouse gas emissions by 16.5 per cent (Wang et al, 2023). This is a very significant claim at this juncture. Interestingly, the global environmental monitoring institutions like the UN Framework Convention on Climate Change (UNFCCC) began to take these claims as true and are emphasising ICT interventions to achieve global environmental objectives. Terms like Green IT are being popularised these days in the digital sector. But some academics and independent experts criticised these claims terming them over-optimistic, representing the lobby groups like GeSI. They also cautioned the global environmental institutions and the governments not to use these claims in their policy making as the aspect of digital waste was not considered in their reports making them one sided or biased towards the ICT serving their business interests (Pitron, 2023).

Apart from these claims and counterclaims, the impacts of digitalisation on environmental pollution have yet to be fully explored by scientific studies. At present, the entire story of environmental pollution is being told by the digital institutions and their associations. One aspect is certain that digitalisation has led to more energy consumption in manufacturing of the devices, the data storage and consumption. The world's most powerful companies like Amazon, Netflix, Oracle, LinkedIn, Twitter and Abode consume coal- based global electricity in the range of 13 to 36 per cent. Further, about 30 per cent of the world's electricity still comes from coal (Pitron, 2023). Pollution threats of e-waste recycling and unscientific disposal are yet to be explored deeply across the world. At present, this issue is mostly ignored in the context of benefits of digitalisation.

Today, digitalisation is irreversible, as it is intertwined with the development process itself. In this context, our efforts must be focussed on effective management of its negative effects especially, energy consumption and pollution issues. Innovative technologies and business models could reduce the burden on energy. On the pollution front, proper educational measures and strict implementation of the e-waste rules and regulations would mitigate the problems. As the problems of each country are different, each country should formulate its own strategies based on local conditions. Further,

digitalisation should be developed in a planned and controlled manner so that its adverse effects are minimised. Ultimately, the goal should be promoting environmentally sustainable digitalisation, not negating the digitalisation itself.

References

- Alves, Bruna. (2024). Global e-waste generation outlook 2022-2030, May 3, <https://www.statista.com>
- Carr, Nicholas. (2023). Data Centers, *Britanica*, November 22.
- Ericsson. (2019). 5G Consumer Potential, *Consumer and Industry Lab Report*, May.
- ION 24/7 Services, 5 Ways to Reduce Energy in Business IT Infrastructure, ion247.com
- Monika and Kishore, Jugal. (2010). E-Waste Management: As a Challenge of Public Health in India, *Indian Journal of Community Medicine*, July, 35(3), 382-385.
- Pitron, Guillaume. (2023). *The Dark Cloud*, B Jacobsohn translator, Scribe, (Original work published 2022). pp.9-14.
- Public Information Bureau, December 14, 2023, pib.gov.in
- Shenoy, Jaideep. (2019, March, 02). India's e-waste to touch 5.2 MMTs by 2020:ASSOCHAM-EY study, *Times of India*, <https://timesofindia.indiatimes.com/city/mangalore>
- Sonal Gupta. (2023, March 31). *ed*, indianepress.com
- UN Environment Programme, Sustainable Digitalization, unep.org
- Wang, H, et al. (2023). Breaking through ingrained beliefs:revisiting the impact of the digital economy on carbon emissions, *Humanities and Social Sciences Communications*, September, 23, *Nature*, Article No 609, nature.com.
- WHO. (2023). Electronic Waste, October 18, in WHO, who.int

Investigating General Public's Perspective on Air Pollution Causes: A Study of Lucknow City's Residential, Commercial and Industrial Areas

Nagarlok
ISSN-0027-7584
56(4), 451-471
October-December, 2024
@ 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.6>

Suleman*

Abstract

Air pollution is a critical global concern, posing substantial health risks and environmental degradation, and public perceptions of its causes can vary significantly based on location and socio-economic factors. This study focuses on the diverse perceptions of air pollution causes among residents in different areas of Lucknow City, including residential, commercial, and industrial zones. For this purpose, the exploratory research design was applied and primary data was collected through a structured questionnaire on a sample of 523 respondents taken through the purposive sampling technique.

The results revealed that Lucknow's air quality is uneven; commercial and industrial areas have higher pollution levels, while residential areas are better. However, the overall AQI remains a concern. The paper highlights the importance of localised approaches in combating air pollution and enhancing urban environmental health.

Keywords

Air Pollution, Residential areas, Commercial- cum- residential areas and Industrial- cum- residential areas.

Introduction

Air pollution is a critical global issue impacting human health, with urban air commonly containing pollutants like particulate matter (PM), nitrogen oxides (NO), sulphur

* Suleman, Senior Research Fellow Department of Geography, Khwaja Moinuddin Chishti Language University, Lucknow, Uttar Pradesh, India.
Email: ksuleman198@gmail.com

oxides (SO), carbon monoxide (CO), and volatile organic compounds (VOCs) (World Health Organisation, 2022). Fine particles, such as $PM_{2.5}$, are particularly concerning due to their ability to penetrate deep into the respiratory system, leading to diseases like respiratory and cardiovascular ailments, lung cancer, and adverse birth outcomes (Anderson et al., 2012; Cohen et al., 2017). Chronic conditions such as asthma, COPD, and heart disease can arise from long-term exposure, while acute exposure can exacerbate existing health issues, resulting in increased hospital admissions (Dominici et al., 2006). Additionally, air pollution affects children, the elderly, and individuals with pre-existing conditions more severely (WHO, 2022). The broader societal impacts include reduced quality of life, economic burdens on healthcare systems, decreased labour productivity, environmental degradation, and contributions to climate change (Wang et al., 2017).

Public perception plays a crucial role in the effectiveness of air quality control measures. Awareness and understanding of air pollution's health impacts can significantly influence public behaviour and support for regulatory policies. For instance, when individuals recognise the health risks associated with poor air quality, they are more likely to adopt measures to reduce pollution, such as reducing car usage, adopting cleaner technologies, and supporting policy initiatives aimed at improving air quality. Effective communication strategies are essential to raise awareness and foster a sense of urgency among the public and policymakers (Liu X et al., 2016).

Furthermore, public perception affects policy effectiveness. Policies that align with public concerns and have strong community support are more likely to succeed. Engaging the public in air quality monitoring and reporting can enhance transparency and accountability, fostering trust in regulatory agencies. This engagement ensures that the diverse needs and priorities of different community groups are considered, leading to more effective and equitable policies. (Fiorino D, 2018; Brunt H et al., 2017).

In Lucknow, a city classified as non-attainment due to its high pollution levels, air quality challenges are significant. Lucknow's severe air quality issues have gained international attention, ranking the city among the top 15 most polluted globally, according to the World Air Quality Report 2019 (IQAir, 2019).

Studies by Bojjagani S et al., (2023) identify major pollution sources, including vehicular exhaust, resuspended road dust, cooking fuel emissions, waste burning, diesel generator exhaust, secondary aerosols, and construction activities, particularly affecting $PM_{2.5}$ levels in residential areas. Kumar & Dwivedi, (2023) observed elevated levels of $PM_{2.5}$, PM_{10} , SO, and NO during Diwali, attributing these spikes to firecracker emissions. Srivastava & Shukla, (2021) highlighted the critical role of vehicular emissions, especially from motorcycles, in contributing to CO, HC, NO, and PM levels, recommending measures such as AVOID (avoiding unnecessary travel), SHIFT (shifting to cleaner transportation), and IMPROVE (improving vehicle efficiency), along with public awareness campaigns. Despite these efforts, Siddiqui A.A et al., (2019)

found that Lucknow often exceeds the National Ambient Air Quality Standards (NAAQS) for $PM_{2.5}$, PM_{10} and SPM. Given the severity of air pollution in Lucknow, understanding public perspectives across different localities is crucial for developing targeted interventions and improving air quality standards.

Objectives of the study

1. To analyse Lucknow's air quality using PM_{10} , SO_2 , NO_2 , and AQI measures in residential, commercial, and industrial zones.
2. To explore the most pressing reasons for air pollution from the perspective of general public living in different localities (residential areas, commercial -cum- residential areas & industrial-cum-residential areas) in Lucknow city.
3. To evaluate the association between the type of locality of respondents and the reasons for air pollution.

Justification and Need of the Study

Air pollution in Lucknow, is a complex issue, and tackling it effectively requires a multifaceted approach. Public perception plays a crucial role in shaping attitudes and behaviours. This study delves into how residents across Lucknow's distinct localities — residential areas, commercial-residential zones, and industrial-residential neighbourhoods — perceive the most pressing causes of air pollution. By exploring these diverse viewpoints, we can gain valuable insights into the public's understanding of the problem. These insights will be instrumental in crafting targeted communication strategies and community engagement initiatives that resonate with residents in each area. By fostering a shared understanding of air pollution's causes within Lucknow's diverse communities, we can empower residents to become active participants in improving the city's air quality.

Literature Review

Tvinnereim et al., (2017) found that citizens primarily linked glacier melt and sea-level rise to global warming, while smog was seen as a result of air pollution. They associated health impacts and pollution from vehicles or industries with both air pollution and global warming. Ramírez et al., (2017) reported that 80 per cent of respondents considered their local air quality to be poor or fair, with 65 per cent identifying particulate matter as the primary pollutant and 90 per cent acknowledging its health risks. Unlike other studies that highlight age and economic status, this study found that city size significantly influenced perceptions, with mining and infrastructure seen as major pollutants in smaller towns and road traffic in larger cities. Liao X et al., (2015) pinpointed motor vehicles (78.5%), waste burning (56.3%), and industrial facilities (53.7%) as the top sources of air pollution. In contrast, Shi, X., He, F (2012) found that residents in coal mining areas attributed pollution mainly to coal processing

rather than the mining itself. This differentiation highlights how the perception of pollution sources can vary based on local industrial activities.

Prasad & Sanyal (2016) observed that the air quality in Lucknow deteriorates significantly during Diwali festivities due to firecracker emissions. Similarly, Saxena P et al., (2022) noted that firecracker use during cultural celebrations releases a wide range of hazardous pollutants into the air. Saini & Kumar (2021) reported improvements in air quality during the COVID-19 lockdown, which led to a significant reduction in both coarse and fine pollutants due to decreased anthropogenic activities.

Fan S et al., (2017) found that worsening air quality heightened parental concern about their children's health, with motor vehicle emissions and passive smoke identified as major risk factors for respiratory illnesses. Stevens E et al., (2004) also emphasised traffic pollution as a significant cause and exacerbator of asthma. Yan Y (2016) reported that 72 per cent of Chinese respondents felt that air pollution had affected their health, with younger people showing more concern. Evans G. W et al., (1988) discovered that although residents were somewhat aware of air pollution and its health effects, their direct actions to mitigate exposure were limited. Awareness and personal beliefs about health effects were crucial in determining compliance with health advisories. Yazdanparast T et al., (2013) found that familiarity with the Pollutant Standards Index (PSI) was low among parents, with limited knowledge on daily air quality. Reyes-Angel J et al., (2022) noted widespread awareness of air quality alerts, but only a small percentage of parents modified their child's outdoor activities based on air quality perceptions. Ribeiro et al., (2015) found that while some parents were aware of passive smoking's health impacts, many were either unaware or underestimated its harm. Rosen J J et al., (2018) highlighted that parental perceptions of exposure to tobacco smoke varied based on visibility, odour, and proximity.

Prasad, & Sanyal, (2016) documented severe air pollution in Lucknow, exacerbated by vehicular traffic and seasonal variations. Mahendra H. N et al., (2023) reported a decrease in SO₂ levels but an increase in NO₂, impacting air quality. Lawrence and Fatima (2014) recorded PM₁₀ and PM_{2.5} levels surpassing WHO limits, with high AQI values and significant health impacts in urban areas. Zhan C et al., (2023) scrutinised the escalating air pollution in urban areas due to insufficient attention to environmental concerns. Apte and Salvi (2016) identified indoor tobacco smoking, construction materials, cooking and heating fuels, incense, mosquito repellents, pesticides, cleaning chemicals, and artificial fragrances as key sources of household air pollution.

Kim B et al., (2020) emphasised the importance of education in shaping public opposition to coal-fired power plants. Almetwally AA (2020) reviewed the causes and sources of air pollution, offering solutions for mitigating its effects. Ukaogo P.O et al., (2020) explored pollution causes and effects and suggested solutions for creating a sustainable environment.

The World Air Quality Report (IQAir, 2019) noted severe pollution levels in Indian cities, with temporary improvements observed during lockdowns. Prabhu et al., (2019) noted significant air quality degradation from firecracker use during Diwali. Prior research has highlighted the importance of understanding public perception towards air quality for effective environmental policy (Saksena, 2011). Studies like Sekar et al., (2023) demonstrated how significant air quality improvements can positively influence public perception, showcasing the potential impact of regulations. However, research by Qian et al., (2016) emphasized that factors like age and occupation can influence knowledge levels, suggesting the need for targeted communication strategies in policy development.

Research Methodology

The study used a cross-sectional survey design to capture general public perspectives in Lucknow between December 2023 and January 2024. An exploratory approach was adopted, with data collected through online and physical questionnaires from 523 participants selected via purposive sampling. Initially, 1500 individuals were approached, resulting in a 34.9 per cent response rate after data cleaning.

Data analysis included frequency analysis for demographics, exploratory factor analysis to identify key pollution causes, and chi-square tests to examine relationships between pollution reasons and locality. SPSS version 25 was used for primary data, while secondary data from Lucknow's air quality measures was analysed with MS Excel 16.

Data Analysis and Interpretation

Demographic Profile of General Public

Table 1 presents the demographic profile of the general public surveyed, highlighting key variables such as age, gender, type of housing, locality, religion, education, employment, and income. The majority of respondents were females aged 31–40 years, living in nuclear families and residential areas.

Age		Frequency	Per cent
Valid	21-30 years	104	19.9
	31-40 years	315	60.2
	41-50 years	52	9.9
	Above 50 years	52	9.9
	Total	523	100.0
Gender		Frequency	Per cent
Valid	Male	171	32.7
	Female	352	67.3
	Total	523	100.0

Type of house		Frequency	Per cent
Valid	Flat/Apartment	206	39.4
	Terraced House	132	25.2
	Semi-detached house	66	12.6
	Detached house	65	12.4
	Bungalow	34	6.5
	Other	20	3.8
	Total	523	100.0
Type of constituency		Frequency	Per cent
Valid	Lucknow North	211	40.3
	Lucknow East	104	19.9
	Lucknow West	104	19.9
	Lucknow Central	52	9.9
	Lucknow Cant	52	9.9
	Total	523	100.0
Type of locality		Frequency	Per cent
Valid	Residential	314	60.0
	Commercial- cum- Residential	157	30.1
	Industrial -cum- Residential	52	9.9
	Total	523	100.0
Religion		Frequency	Per cent
Valid	Hindu	319	61.0
	Muslim	155	29.6
	Christian	35	6.7
	Sikh	5	1.0
	Others	9	1.7
	Total	523	100.0
Type of family		Frequency	Per cent
Valid	Nuclear	407	77.8
	Joint	116	22.2
	Total	523	100.0
Marital Status		Frequency	Per cent
Valid	Single	107	20.5
	Married with kids	259	49.5
	Married with no kids	157	30.0
	Total	523	100.0
Educational Qualification		Frequency	Percent

	Illiterate	181	34.60%
	Primary School certificate	130	24.90%
	Middle School certificate	174	33.30%
	High School Certificate	18	3.40%
	Intermediate or post-high school diploma	14	2.70%
	Graduate or Postgraduate	3	0.60%
	Professional or honours	3	0.60%
	Total	523	100.00%
Current Employment Status		Frequency	Per cent
	Unemployed	98	18.73
	Employed	425	81.26
	Total	523	100.0
Gross Monthly Income of family (Rs)		Frequency	Per cent
Valid	Less than Rs. 25000	9	1.7
	Rs. 25,001 to Rs. 50,000	62	11.9
	Rs. 50,001 to Rs. 75,000	162	31.0
	Rs. 75,001 to Rs. 100,000	217	41.5
	More than Rs. 100,000	73	14.0
	Total	523	100.0
Family history of Respiratory diseases		Frequency	Per cent
Valid	Yes	63	12.0
	No	460	88.0
	Total	523	100.0
If yes then from whose side		Frequency	Per cent
Valid	Maternal	36	6.9
	Paternal	18	3.4
	Both	9	1.7
	Total	63	12.0

Source: Self-generated and compiled by the author with the help of primary data analysis of the study

The study's demographic profile as presented in Table 1 shows a diverse population: 60.2 per cent are aged 31-40 years, and 67.3 per cent are female. Housing types include 39.4 per cent in flats/apartments and 25.2 per cent in terraced houses, with fewer in semi-detached (12.6%) and detached houses (12.4%). The highest representation is from Lucknow North (40.3%), followed by Lucknow East and West (19.9% each). Residential areas dominate (60%), with commercial-residential (30.1%) and industrial-residential (9.9%) areas less common. Religiously, 61 per cent are Hindu, 29.6 per cent Muslim, with smaller percentages of Christians, Sikhs, and others. Most families are nuclear (77.8%), and 49.5 per cent are married with children. Educationally, 34.6 per cent are illiterate, and 81.26 per cent are employed. Income varies, with 41.5 Per cent earning Rs. 75,001-100,000 monthly. Health-wise, 12 per cent have a history of respiratory diseases, mainly on the maternal side (6.9%).

Month-wise Comparison of the Level of Air Pollution in the Residential, Commercial and Industrial Areas in Lucknow in 2023

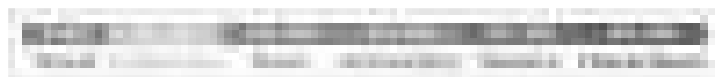
Table 2 presents a monthly comparison of air quality across different areas of Lucknow categorised as residential, commercial, and industrial for the year 2023. The data includes levels of PM₁₀, SO₂, NO₂, and AQI, showing significantly higher pollution during winter months and relatively cleaner air during monsoon months, especially in residential areas.

Location	Category	Measure - Micrograms per cubic meter (µg/m³)			
		PM ₁₀	SO ₂	NO ₂	AQI
January					
Hazratganj (Nagar Nigam)	Commercial	261.19	12.70	48.01	211
Mahanagar	Residential	201.27	10.62	45.97	168
Aliganj	Residential	256.25	10.53	41.67	206
Talkatora	Industrial	251.28	10.57	43.81	201
Ansal T. C.	Commercial	225.61	11.56	43.18	184
Gomtinagar	Commercial	221.06	9.45	39.23	181
February					
Hazratganj (Nagar Nigam)	Commercial	244.61	11.82	41.46	196
Mahanagar	Residential	196.83	10.42	39.49	165
Aliganj	Residential	193.32	9.35	34.90	162
Talkatora	Industrial	184.25	13.06	40.76	156
Ansal T. C.	Commercial	194.55	11.35	37.64	163
Gomtinagar	Commercial	175.82	9.69	35.81	151
March					
Hazratganj (Nagar Nigam)	Commercial	226.98	11.64	30.46	185
Mahanagar	Residential	183.43	8.32	31.49	156

Location	Category	Measure - Micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)			
		PM ₁₀	SO ₂	NO ₂	AQI
Aliganj	Residential	134.39	7.80	25.40	123
Talkatora	Industrial	174.84	12.31	36.62	150
Ansal T. C.	Commercial	181.92	9.66	30.72	155
Gomtinagar	Commercial	131.78	9.93	32.57	121
April					
Hazratganj (Nagar Nigam)	Commercial	239.67	10.73	38.31	193
Mahanagar	Residential	196.76	7.66	26.05	165
Aliganj	Residential	135.37	6.24	20.43	124
Talkatora	Industrial	226.17	10.90	38.29	184
Ansal T. C.	Commercial	154.54	9.33	32.87	136
Gomtinagar	Commercial	143.63	9.28	29.34	129
May					
Hazratganj (Nagar Nigam)	Commercial	224.48	7.65	28.21	183
Mahanagar	Residential	198.56	5.89	24.06	166
Aliganj	Residential	181.26	6.50	22.70	154
Talkatora	Industrial	201.27	6.93	34.91	168
Ansal T. C.	Commercial	176.46	8.66	29.14	151
Gomtinagar	Commercial	133.24	7.22	25.11	122
June					
Hazratganj (Nagar Nigam)	Commercial	185.23	7.75	23.31	157
Mahanagar	Residential	179.94	9.07	24.06	153
Aliganj	Residential	133.36	5.33	19.91	122
Talkatora	Industrial	165.28	8.75	29.51	144
Ansal T. C.	Commercial	178.02	8.88	25.64	152
Gomtinagar	Commercial	123.66	6.65	18.97	116
July					
Hazratganj (Nagar Nigam)	Commercial	142.83	7.35	18.49	129
Mahanagar	Residential	154.40	8.53	15.20	136
Aliganj	Residential	85.39	6.40	15.23	85
Talkatora	Industrial	119.23	5.35	18.06	113
Ansal T. C.	Commercial	131.08	7.90	18.59	121
Gomtinagar	Commercial	63.01	5.46	10.10	63
August					
Hazratganj (Nagar Nigam)	Commercial	132.25	7.10	16.92	122
Mahanagar	Residential	157.39	7.44	16.42	138
Aliganj	Residential	107.27	6.82	17.30	105

Location	Category	Measure - Micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)			
		PM ₁₀	SO ₂	NO ₂	AQI
Talkatora	Industrial	107.12	6.10	22.37	105
Ansal T. C.	Commercial	100.87	8.82	17.82	101
Gomtinagar	Commercial	74.90	5.79	18.31	75
September					
Hazratganj (Nagar Nigam)	Commercial	118.77	6.55	19.84	113
Mahanagar	Residential	154.76	8.94	16.54	137
Aliganj	Residential	76.40	10.69	13.83	76
Talkatora	Industrial	92.09	6.70	20.82	92
Ansal T. C.	Commercial	121.41	8.39	20.80	114
Gomtinagar	Commercial	88.34	7.31	20.81	88
October					
Hazratganj (Nagar Nigam)	Commercial	175.38	9.00	22.58	150
Mahanagar	Residential	164.28	7.73	21.34	143
Aliganj	Residential	138.10	7.34	21.29	125
Talkatora	Industrial	151.74	7.50	22.10	134
Ansal T. C.	Commercial	152.23	7.33	20.86	135
Gomtinagar	Commercial	109.05	8.02	23.40	106
November					
Hazratganj (Nagar Nigam)	Commercial	213.73	9.62	26.23	176
Mahanagar	Residential	224.97	8.91	27.21	183
Aliganj	Residential	238.77	8.97	26.16	193
Talkatora	Industrial	181.73	9.47	27.15	154
Ansal T. C.	Commercial	198.09	8.80	29.98	165
Gomtinagar	Commercial	159.67	8.91	29.49	140
December					
Hazratganj (Nagar Nigam)	Commercial	236.05	9.08	31.19	191
Mahanagar	Residential	223.81	14.03	22.27	183
Aliganj	Residential	194.16	8.54	19.85	163
Talkatora	Industrial	220.03	8.33	32.36	180
Ansal T. C.	Commercial	215.38	12.79	20.13	177
Gomtinagar	Commercial	173.36	9.50	24.70	149

Source: Uttar Pradesh Control Board. Ambient Air Quality/Noise Data. http://www.uppcb.com/ambient_quality.htm, accessed on 24-03-2023



Source: <https://www.aqi.in/in/dashboard/india/uttar-pradesh/lucknow>, accessed on 24-03-2024

Analysis of the data presented in Table 2: The line diagram reveals that air pollution in Lucknow peaks during winter months (December–January) across all locations, with higher PM_{10} and AQI levels in commercial and industrial zones like Hazratganj and Talkatora. Residential areas such as Mahanagar and Aliganj show relatively better air quality, especially during the monsoon season (July–September), when pollutant levels are lowest.

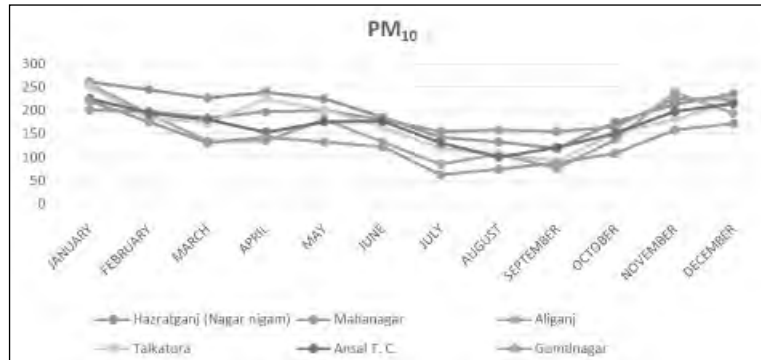


Figure 1: Level of PM_{10} in the Residential, Commercial and Industrial Areas in Lucknow in 2023

Source: Self-constructed with the help of secondary data available at <https://www.aqi.in/in/dashboard/india/uttar-pradesh/lucknow>.

Figure 1 shows that in Lucknow, PM_{10} pollution varies significantly: commercial areas like Hazratganj and Ansal T.C. experience high levels, ranging from “Moderate” to “Poor,” especially in winter. Residential areas such as Mahanagar and Aliganj typically have “Good” air quality. The industrial zone of Talkatora faces consistently high PM_{10} levels, often “Poor” to “Unhealthy.”

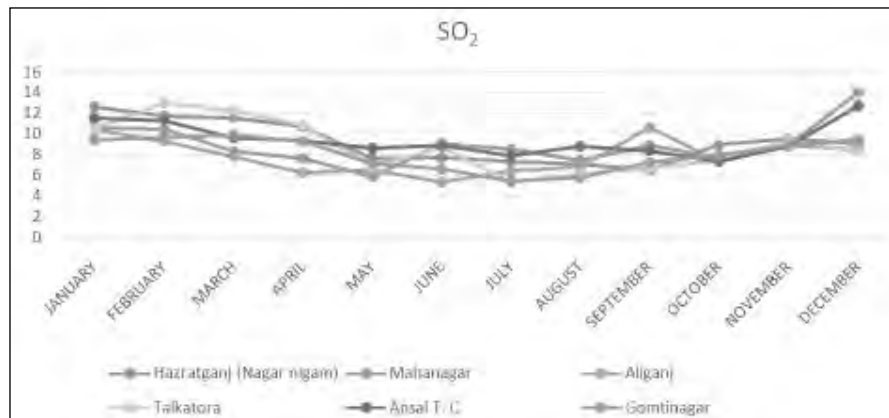


Figure 2: Level of SO_2 in the Residential, Commercial and Industrial Areas in Lucknow in 2023

Source: Self-constructed with the help of secondary data available at <https://www.aqi.in/in/dashboard/india/uttar-pradesh/lucknow>

It can be seen from the figure 2, SO_2 levels in Lucknow are generally low and consistent across all areas, with slight increases from spring to winter. Commercial areas like Hazratganj and Gomtinagar, as well as residential areas like Mahanagar and

Aliganj, show similar low SO_2 patterns. The industrial area of Talkatora has slightly higher SO_2 levels, but the difference is not significant. Overall, SO_2 levels are mostly in the “Good” range.

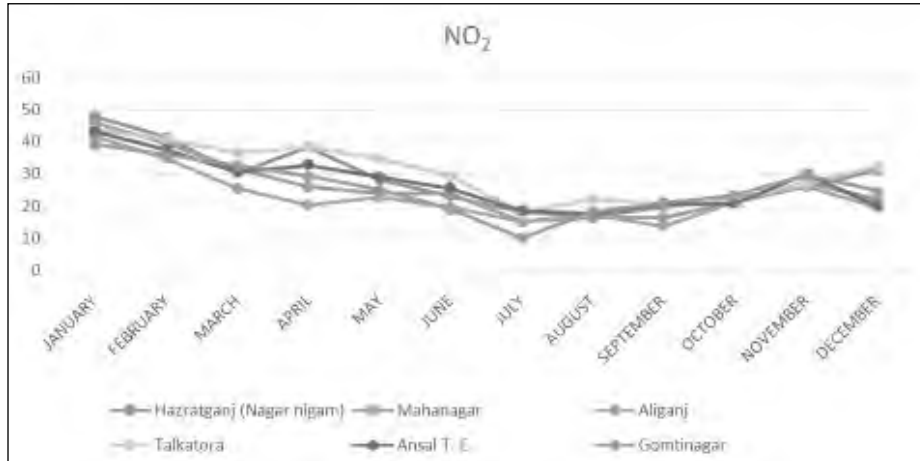


Figure 3: Level of NO_2 in the Residential, Commercial and Industrial Areas in Lucknow in 2023

Source: Self-constructed with the help of secondary data available at <https://www.aqi.in/in/dashboard/india/uttar-pradesh/lucknow>

Interpretation-- Figure 3 depicts that NO_2 levels in Lucknow fluctuate seasonally, peaking in winter. Residential areas like Mahanagar and Aliganj generally have lower NO_2 levels, while commercial hubs such as Hazratganj and Gomtinagar see higher pollution due to traffic and commercial activities. Industrial zones like Talkatora significantly impact overall NO_2 levels. Throughout the year, NO_2 concentrations are mostly “Good” to “Moderate” in warmer months and can reach “Poor” during colder months (October to February).

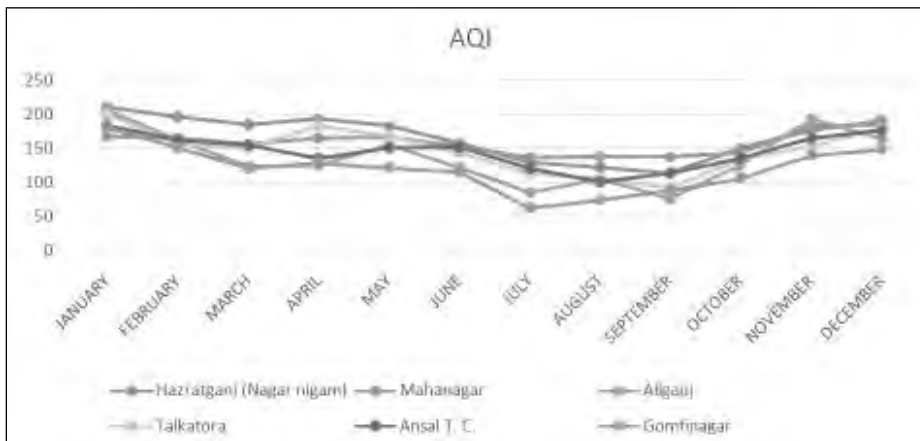


Figure 4: Level of AQI in the Residential, Commercial and Industrial Areas in Lucknow in 2023.

Source: Self-constructed with the help of secondary data available at <https://www.aqi.in/in/dashboard/india/uttar-pradesh/lucknow>

It can be said from the figure 4 that AQI levels in Lucknow are higher in winter (December and January) than in summer. Residential areas like Mahanagar and Aliganj have better air quality, while commercial hubs such as Hazratganj, Ansal T.C., and Gomtinagar face “Moderate” to “Poor” AQI levels. Industrial areas like Talkatora experience “Poor” to “Unhealthy” AQI levels year-round.

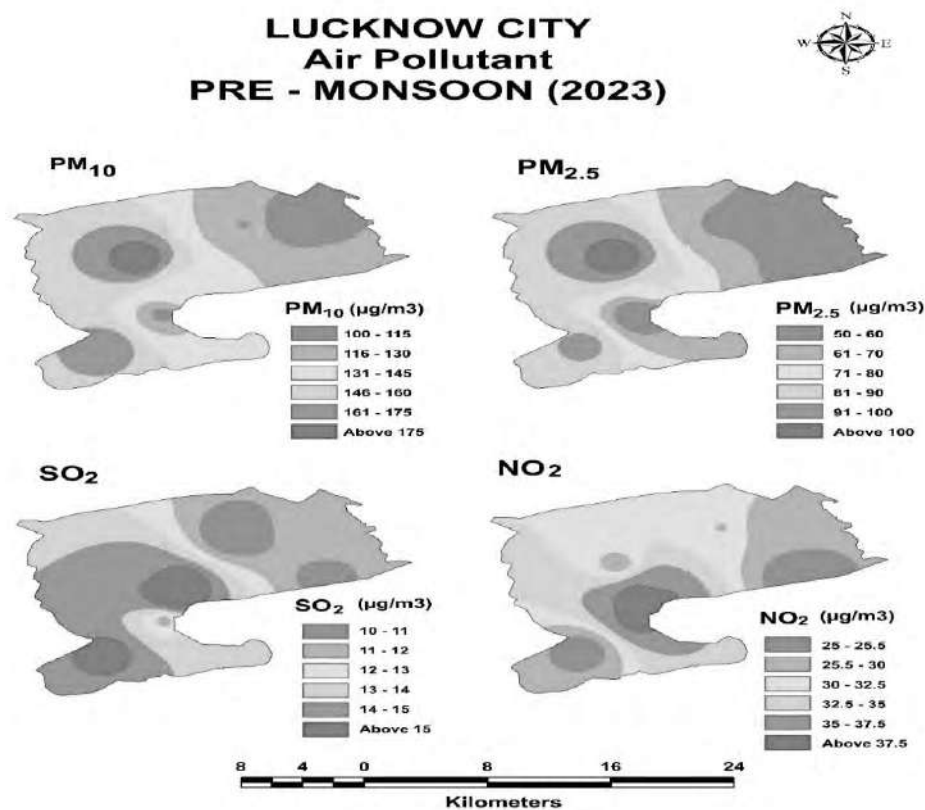


Figure 5: Map-1. Pre-Monsoon

Source: Self-constructed with the help of secondary data available at <https://www.aqi.in/in/dashboard/india/uttar-pradesh/lucknow>

Map-Based Analysis of Air Quality in Lucknow During the Monsoon Season, 2023

Figure 5 shows elevated PM₁₀ and PM_{2.5} levels in Lucknow during the pre-monsoon period of 2023, likely due to vehicular emissions, industrial activities, and construction dust. SO₂ and NO₂ levels are relatively lower, indicating less significant emissions from fossil fuel industries.

Figure 6 displays that post-monsoon air quality in Lucknow is affected by high PM₁₀ and PM_{2.5} levels, indicating harmful fine particulates. SO₂ and NO₂ levels are

lower, but localised hotspots point to specific emission sources such as industries and vehicular traffic.

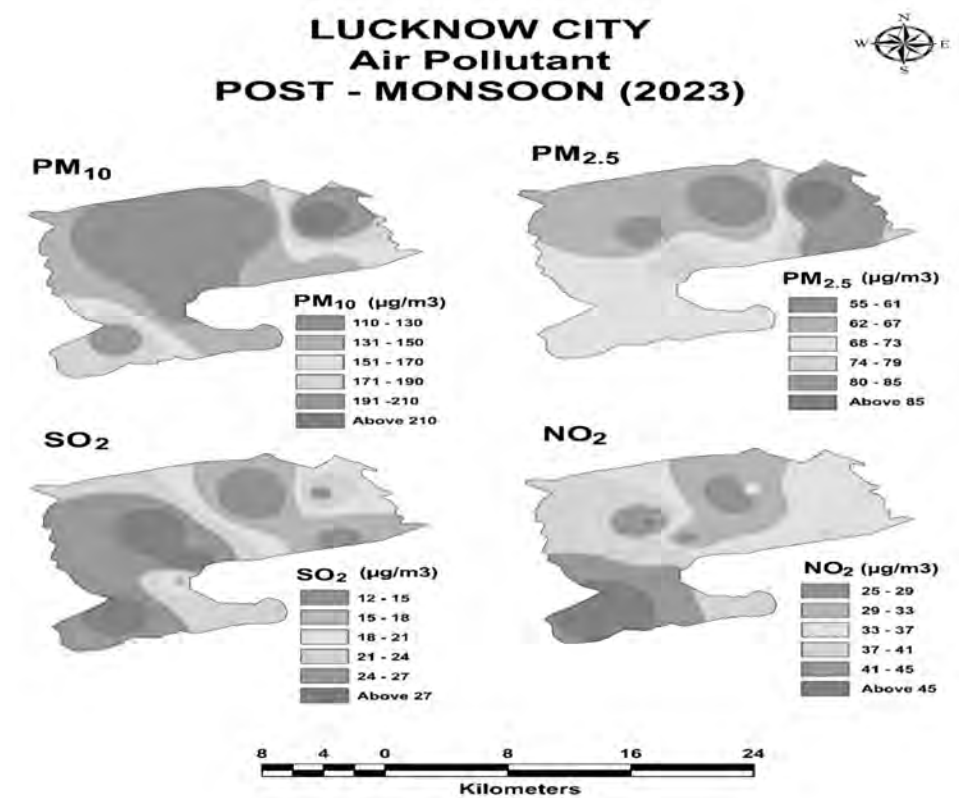


Figure 6: Map-2. Post-Monsoon

Source: Self-constructed with the help of secondary data available at <https://www.aqi.in/in/dashboard/india/uttar-pradesh/lucknow>

Factor Analysis

Identifying the most pressing reasons for air pollution from the perspective of general public living in residential areas, commercial-cum-residential areas and industrial-cum-residential areas.

For residential areas, the data is deemed adequate with a KMO measure of sampling adequacy of 0.508 and a significant correlation between variables (0.000), allowing for analysis to proceed. In commercial- cum- residential areas, the data is nearly adequate with a KMO measure of 0.483, also showing sufficient correlation (0.000) to continue the analysis. Similarly, for industrial-cum-residential areas, the data is nearly adequate with a KMO measure of 0.461 and enough correlation (0.000) to proceed with the analysis.

Table 3: Factor Analysis

Most pressing reasons for air pollution from the perspective of general public living in residential areas		
Component	% of Variance	Variables Covered
1	18.139	1. Decaying of micro-organisms; 2. Cigarettes, <i>hookahs</i> , and electronic cigarettes abound in cafes frequented by young people and minors; 3. Certain weather conditions, such as temperature inversions and stagnant air; and 4. Open burning of garbage waste.
Most pressing reasons for air pollution from the perspective of general public living in commercial- cum- residential areas.		
Component	% of Variance	Variables Covered
1	20.141	1. Loss of green spaces; 2. Inadequate urban waste management practices; 3. Vehicular emissions, particularly from older vehicles that may not meet modern emission standards; 4. Unauthorised and unregulated industrial units that operate without proper pollution control; and 5. Traffic Congestion
Most pressing reasons for air pollution from the perspective of general public living in industrial- cum- residential areas.		
Component	% of Variance	Variables Covered
1	20.465	1. Dust; 2. Loss of Green Spaces; and 3. Certain weather conditions, such as temperature inversions and stagnant air.

Source: Self-generated and compiled by the author with the help of primary data analysis of the study.

Table 3 shows that for the general public living in residential areas, component 1 accounts for the highest variance (18.139%) and is the most significant, with key variables highlighted for each component. For those in commercial- cum- residential areas, Component 1 explains the highest variance (20.141%) and is the most significant, with key variables listed. Similarly, for those in industrial- cum- residential areas, Component 1 explains the most variance (20.465%) and is the most significant, with key variables shown for each component.

Chi-Square Analysis

Association between the type of locality of respondents and the variables of reasons for air pollution have been summarised in Table 4.

Table 4: Summary of Chi-Square Analysis

Null Hypotheses (H_0)	Asymptotic Significance (2-sided)	Result (Retain/Reject)
1. There is no significant difference between the type of locality of respondents and the variable— Bonfires	1.000	Retain H_0 1
2. There is no significant difference between the type of locality of respondents and the variable— Open burning of garbage waste	0.959	Retain H_0 2
3. There is no significant difference between the type of locality of respondents and the variable— Spraying pesticides and fertilisers	0.041	Reject H_0 3
4. There is no significant difference between the type of locality of respondents and the variable— Volatile Organic Compounds (VOCs) found in paints, cleaners and personal care products such as perfume and deodorants.	0.065	Retain H_0 4
5. There is no significant difference between the type of locality of respondents and the variable— Decaying of micro-organisms.	0.139	Retain H_0 5
6. There is no significant difference between the type of locality of respondents and the variable— Cigarettes, <i>hookahs</i> , and electronic cigarettes abound in cafes frequented by young people and minors	0.958	Retain H_0 6
7. There is no significant difference between the type of locality of respondents and the variable— Vehicular emissions, particularly from older vehicles that may not meet modern emission standards	0.954	Retain H_0 7
8. There is no significant difference between the type of locality of respondents and the variable— Excavation, demolition, and construction activities	0.017	Reject H_0 8
9. There is no significant difference between the type of locality of respondents and the variable— Diesel Generators	0.000	Reject H_0 9
10. There is no significant difference between the type of locality of respondents and the variable— Inadequate urban waste management practices	0.307	Retain H_0 10

Null Hypotheses (H_0)	Asymptotic Significance (2-sided)	Result (Retain/Reject)
11. There is no significant difference between the type of locality of respondents and the variable— Traffic congestion	0.000	Reject H_0 11
12. There is no significant difference between the type of locality of respondents and the variable— Commercial and industrial activities	0.000	Reject H_0 12
13. There is no significant difference between the type of locality of respondents and the variable-- Fire crackers	0.000	Reject H_0 13
14. There is no significant difference between the type of locality of respondents and the variable— Certain weather conditions, such as temperature inversions and stagnant air	0.199	Retain H_0 14
15. There is no significant difference between the type of locality of respondents and the variable— Dust	0.008	Reject H_0 15
16. There is no significant difference between the type of locality of respondents and the variable— Loss of Green Spaces	0.002	Reject H_0 16
17. There is no significant difference between the type of locality of respondents and the variable— Unauthorised and unregulated industrial units that operate without proper pollution control	0.551	Retain H_0 17

Source: Self-generated and compiled by the author with the help of primary data analysis of the study

Conclusion and Discussion

Lucknow's air quality varies significantly, with higher levels of PM_{10} , NO_2 , and occasionally SO_2 found in commercial and industrial zones, especially during winter. Residential areas generally fare better, but the overall AQI remains poor due to fluctuating levels citywide. The study examined public perceptions of air pollution across different localities: residential, commercial-cum-residential, and industrial-cum-residential areas. In residential areas, key concerns included the decay of micro-organisms and open burning of garbage waste, highlighting a need for better waste management. The presence of smoking products in cafes frequented by young people and minors also indicated a need for stricter indoor smoking regulations.

In commercial- cum- residential areas, the loss of green spaces, inadequate urban waste management, and vehicular emissions were identified as major contributors to air pollution. These factors emphasise the need for policies addressing transportation

emissions and urban waste management. In industrial-cum-residential areas, dust pollution, loss of green spaces, and certain weather conditions like temperature inversions were prominent issues. The proximity of residential areas to industrial sites exacerbates exposure to pollutants, necessitating stricter regulations on industrial emissions.

The study also found significant associations between the type of locality and several air pollution factors, including spraying pesticides and fertilizers, excavation, demolition and construction activities, diesel generators, traffic congestion, commercial and industrial activities, firecrackers, dust, and loss of green spaces. These findings suggest the need for targeted interventions and policies tailored to the unique challenges of different communities. For example, controlling traffic congestion might be crucial in commercial areas, while preserving green spaces could be prioritised in residential neighbourhoods.

Suggestions

To improve air quality in Lucknow, targeted measures are essential: enhancing waste management practices in residential areas, enforcing stricter regulations on industrial emissions, preserving green spaces, and implementing traffic management strategies in commercial zones. Additionally, public awareness campaigns should focus on reducing the use of indoor smoking products and promoting cleaner transportation options to address the unique challenges faced by different localities.

References

- Almetwally AA, Bin-Jumah M, Allam AA. (2020). Ambient air pollution and its influence on human health and welfare: an overview. *Environmental Science and Pollution Research International*, 2020 Jul; 27(20):24815-24830. doi: 10.1007/s11356-020-09042-2. Epub. PMID: 32363462.
- Anderson JO, Thundiyil JG, Stolbach A. (2012). Clearing the air: a review of the effects of particulate matter air pollution on human health. *J Med Toxicol*; 8(2):166-75. doi: 10.1007/s13181-011-0203-1. PMID: 22194192; PMCID: PMC3550231.
- Apte K, & Salvi S. (2016). Household air pollution and its effects on health. F1000. Res. Oct 28; 5: F1000 Faculty Rev-2593. doi: 10.12688/f1000research.7552.1. PMID: 27853506; PMCID: PMC5089137.
- Bojjagani, S., Mahanta, S. K., Prasad, H. O., Khan, A. H., & Kisku, G. C. (2023). Source apportionment and analysis of spatial representativeness of fine particle pollution for an urban residential area in Lucknow, India. *Environmental Engineering Science*, 40(12), 678-688.
- Brunt H, Barnes J, Jones SJ, Longhurst JWS, Scally G, Hayes E. (2017). Air pollution, deprivation and health: understanding relationships to add value to local air quality management policy and practice in Wales, UK. *J Public Health (Oxf)*. Sep 1;39(3):485-497. doi: 10.1093/pubmed/fdw084. PMID: 27613763.
- Cohen, A. J., Brauer, M., Burnett, R., Anderson, H. R., Frostad, J., Estep, K. (2017). Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an

- analysis of data from the Global Burden of Diseases Study 2015. *The Lancet*, 389(10082), 1907-1918. <https://doi.org/https://doi.org/10.1016/S0140-6736>
- Dominici F, Peng RD, Bell ML, Pham L, McDermott A, Zeger SL, Samet JM. (2006). Fine particulate air pollution and hospital admission for cardiovascular and respiratory diseases. *JAMA*. 8; 295(10):1127-34. doi: 10.1001/jama.295.10.1127. PMID: 16522832; PMCID: PMC3543154.
- Evans, G. W., Colome, S. D., & Shearer, D. F. (1988). Psychological reactions to air pollution. *Environmental research*, 45(1), 1-15. [https://doi.org/10.1016/S0013-9351\(88\)80002-1](https://doi.org/10.1016/S0013-9351(88)80002-1)
- Fan, S., Yuan, Z., Liao, X., Tu, H., Lan, G., Maddock, J. E., & Lu, Y. (2017). International perspectives: Study of Parents' Perception of Air Pollution and Its Effect on Their Children's Respiratory Health in Nanchang, China. *Journal of Environmental Health*, 79(7), E1-E9. <https://www.jstor.org/stable/26330632>
- Fiorino, D. (2018). *Can Democracy Handle Climate Change?* Polity Books ISBN: 13: 978-1-5095-2396-2.
- IQAir, (2019). World Air Quality Report, <https://www.iqair.com/world-most-polluted-cities/world-air-quality-report-2019-en.pdf>
- Kim B, Yoon EJ, Kim S, Lee DK. (2020). The Effects of Risk Perceptions Related to Particulate Matter on Outdoor Activity Satisfaction in South Korea. *International Journal of Environmental Research Public Health*, 2; 17(5):1613. doi: 10.3390/ijerph17051613. PMID: 32131520; PMCID: PMC7084646.
- Kumar, S., & Dwivedi, S. K. (2023). Assessment of air quality in Lucknow, India during the festival of Diwali for four successive years amid the COVID-19 pandemic lockdown. *Physics and Chemistry of the Earth, Parts A/B/C*, 131, 103439.
- Lawrence A, & Fatima N. (2014). Urban air pollution & its assessment in Lucknow City--the second largest city of North India. *Science of the Total Environment*. 2014 Aug 1;488-489:447-55. doi: 10.1016/j.scitotenv.2013.10.106. Epub 2013 Dec 5. PMID: 24315412.
- Liao, X., H. Tu, J.E. Maddock, S. Fan, G. Lan, Y. Wu, Z.K. Yuan, and Y. Lu. (2015). Residents' perception of air quality, pollution sources, and air pollution control in Nanchang, China. *Atmospheric Pollution Research* 6: 835-841. <https://doi.org/10.5094/APR.2015.092>.
- Liu, X., H. Zhu, Y. Hu, S. Feng, Y. Chu, Y. Wu, C. Wang, Y. Zhang, et al. (2016). Public's health risk awareness on urban air pollution in Chinese megacities: The cases of Shanghai, Wuhan and Nanchang. *International Journal of Environmental Research and Public Health*. <https://doi.org/10.3390/ijerph13090845>.
- Mahendra, H. N., Mallikarjunaswamy, S., Kumar, D. M., Kumari, S., Kashyap, S., Fulwani, S., & Chatterjee, A. (2023). Assessment and Prediction of Air Quality Level Using ARIMA Model: A Case Study of Surat City, Gujarat State, India. *Nature Environment & Pollution Technology*, 22(1). DOI:10.46488/NEPT.2023.v22i01.018
- Prabhu V, Prakash J, Soni A, Madhwal S, Shridhar V. (2019). Atmospheric aerosols and inhalable particle number count during Diwali in Dehradun City and Environment Interactions 2:100006. DOI:10.1016/j.cacint.2019.100006
- Prasad, D., & Sanyal, S. (2016). A Study of Air Quality and its Effect on Health: A Geographical Perspective of Lucknow city. *Space and Culture, India*, 4(1), 51-64. <https://doi.org/10.20896/saci.v4i1.164>

- Qian, X., Xu, G. & Li, L. (2016). Knowledge and perceptions of air pollution in Ningbo, China. *BMC Public Health* 16, 1138. <https://doi.org/10.1186/s12889-016-3788-0>
- Ramírez, O., Mura, I., & Franco, J. F. (2017). How do people understand urban air pollution? Exploring citizens' perception on air quality, its causes, and impacts in Colombian cities. *Open Journal of Air Pollution*, 6(1), 1-17. DOI: 10.4236/ojap.2017.61001
- Reyes-Angel, J., Han, Y. Y., Forno, E., Celedón, J. C., & Rosser, F. J. (2022). Parental knowledge and usage of air quality in childhood asthma management. *Frontiers in Pediatrics*, 10, 966372. <https://doi.org/10.3389/fped.2022.966372>
- Ribeiro, F. A. D. C., Moraes, M. K. R. D., Caixeta, J. C. D. M., Silva, J. N. D., Lima, A. S., Parreira, S. L. S., & Fernandes, V. L. S. (2015). Perception of parents about secondhand smoke on the health of their children: An ethnographic study. *Revista Paulista de Pediatria*, 33(4), 394-399. <https://doi.org/10.1016/j.rpped.2015.02.003>
- Rosen LJ, Lev E, Guttman N, Tillinger E, Rosenblat S, Zucker DM, Myers V. (2018). Parental Perceptions and Misconceptions of Child Tobacco Smoke Exposure. *Nicotine Tob Res.* Sep 25;20 (11):1369-1377. doi: 10.1093/ntr/ntx169. PMID: 29059387.
- Saini, D. K., & Kumar, M. (2021). Respiratory health effect of ambient air pollutants on road-side vendors in industrial city Gajraula, Uttar Pradesh, India. *Plant Archives*, Vol. 21, No. 2, pp. 697-703, DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2021.v21.no2.108>
- Saksena, S. (2011). Public perceptions of urban air pollution risks. *Risk, hazards & crisis in public policy*, Wiley Online Library 2(1), 1-19. <https://doi.org/10.2202/1944-4079.1075>
- Sarath K. Guttikunda, K.A. Nishadh & Puja Jawahar. (2019). Air pollution knowledge assessments (APnA) for 20 Indian cities, *Urban Climate*, Volume 27, Pages 124-141, ISSN 2212-0955, <https://doi.org/10.1016/j.uclim.2018.11.005>. (<https://www.sciencedirect.com/science/article/pii/S2212095518302402>)
- Saxena, P., Kumar, A., Mahanta, S. K., Sreekanth, B., Patel, D. K., Kumari, A., Khan, A. H., & Kisku, G. C. (2022). Chemical characterization of PM₁₀ and PM_{2.5} combusted firecracker particles during Diwali of Lucknow City, India: Air-quality deterioration and health implications. *Environmental Science and Pollution Research*. 10.1007/s11356-022-21906-3.
- Sekar, A., Jasna, R. S., Binoy, B. V., Mohan, P., & Varghese, G. K. (2023). Air quality change and public perception during the COVID-19 lockdown in India. *Gondwana Research*, 114, 15-29. <https://doi.org/10.1016/j.gr.2022.04.023>
- Shi, X., and He, F. (2012). The Environmental Pollution Perception of Residents in Coal Mining Areas: A Case Study in the Hancheng Mine Area, Shaanxi Province, China. *Environmental Management* 50, 505–513. <https://doi.org/10.1007/s00267-012-9920-8>.
- Siddiqui, A.A., Mumtaz, N., Izhar, T. (2019). Assessment of air quality of Lucknow city and proposing a model using MATLAB: A Review. *Journal of Emerging Technologies and Innovation Research*, Issue 06, Volume 02. <https://www.jetir.org/papers/JETIR1902470.pdf>
- Srivastava, S., & Shukla, A. K. (2021). Vehicular Emission Estimates of Various Air Pollutants in Residential Region of Lucknow. *International Research Journal of Engineering and Technology (IRJET)*, Issue 08, Volume 09. https://www.academia.edu/download/73195708/IRJET_V8I904.pdf

- Stevens E, Cullinan P, Colvile R. (2004). Urban air pollution and children's asthma: what do parents and health professionals think? *Pediatr Pulmonol*; 37(6):530-6. doi: 10.1002/ppul.20008. PMID: 15114554.
- Tvinnereim, E., Liu, X. & Jamelske, E.M. (2017). Public perceptions of air pollution and climate change: different manifestations, similar causes, and concerns. *Climatic Change* 140, 399–412. Springer, <https://doi.org/10.1007/s10584-016-1871-2>
- Ukaogo, P.O., Ewuzie, U. and Onwuka, C.V. (2020). Environmental Pollution: Causes, Effects, and the Remedies. In: Chowdhary, P., Raj, A., Verma, D. and Akhter, Y. Eds., *Microorganisms for Sustainable Environment and Health*, Elsevier, Amsterdam, 419-429. <https://doi.org/10.1016/B978-0-12-819001-2.00021-8>
- Wang, S., Zhou, C., Wang, Z., Feng, K., & Hubacek, K. (2017). The characteristics and drivers of fine particulate matter (PM_{2.5}) distribution in China. *Journal of Cleaner Production*, 142, 1800-1809.
- World Health Organization (WHO). (2022). Ambient (outdoor) air pollution, Factsheets available at [https://www.who.int/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health) retrieved on 27th January 2023.
- Yan, Y. (2016). Air pollution in China: A study of public perception. Unpublished master's thesis, Kansas State University, Manhattan, Kansas. <https://core.ac.uk/download/pdf/33382026.pdf>
- Yazdanparast T, Seyedmehdi SM, Khalilzadeh S, Salehpour S, Boloursaz MR, Baghaie N, Hassanzad M, Velayati AA. (2013). Knowledge and Practice of Asthmatic Children's Parents About Daily Air Quality. *Tanaffos*; 12(3):23-8. PMID: 25191470; PMCID: PMC4153250.
- Zhan, C., Xie, M., Lu, H., Liu, B., Wu, Z., Wang, T., Zhuang, B., Li, M., and Li, S. (2023). Impacts of urbanization on air quality and the related health risks in a city with complex *Atmospheric Chemistry and Physics*.23, 771–788, <https://doi.org/10.5194/acp-23-771-2023>, 2023.

Innovation, Sustainability and Citizen-Centricity through Smart Cities: Lessons for India

Nagarlok
ISSN-0027-7584
56(4), 472-487
October-December, 2024
@ 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.7>

Bhawna Gupta* and **Tanya Ahuja****

Abstract

Across the globe, smart cities have emerged as instruments for facilitating innovative and citizen-centric urban transformation with sustainable digital approaches being embodied in city planning, infrastructure and service-design. In India, Smart Cities Mission was initiated by the Government in 2015 with an ambitious endeavour to improve quality of life by employing ‘smart solutions’ in 100 selected cities by strengthening their socio-economic, physical and institutional pillars. This paper reviews some of the best global practices that can further metamorphose India’s smart cities into innovative, sustainable and citizen-centric urban spaces. This paper uses secondary data from research articles, government reports, and websites. Through descriptive analysis, it highlights the importance of policy transfers in addressing emerging urbanisation challenges and facilitating the effective implementation of Smart Cities.

Based on the review, the paper suggests ten lessons for India which include, among others, a bottom-up approach in policy and planning, employing collaborative-technology, strengthening local governments and making people ‘smart’ to nudge them to act as true ‘agents of change.’

Keywords

Best Practices, Citizen- Centricity, Innovation, Smart Cities, Sustainability.

Introduction

The Smart Cities Mission (SCM) has opened up a vista of opportunities for urban re-development and transformation. The mission encourages using ‘smart solutions’ to

** Tanya Ahuja, Research Scholar, Indian Institute of Management, Ahmedabad.
Email: phd23tanyaa@iima.ac.in

Corresponding author:

* Bhawna Gupta, Assistant Professor, Department of Public Administration, Panjab University, Chandigarh.
Email: bhawnag@pu.ac.in

propel economic growth and to ameliorate the quality of life of the citizens through comprehensive work on physical, institutional, economic and social pillars of the city. It aims to promote cities that provide core infrastructure and a clean environment through effective use of technology. Sustainability and inclusiveness are vital aspects for the creation of ‘replicable models’ which may act as lighthouses to other aspiring cities. While India hopes to transform its urban spaces, many countries around the world provide crucial Smart City lessons to learn from. Innovation through smart technology and effective governance, sustainability measures and citizen-centricity emerge as the pivotal aspects that can metamorphose Indian cities to combat the challenges of rapid urbanisation and become more environment-friendly, equitable and liveable.

Aim and Methodology

This study aims to compile some of the best practices from around the world that may guide India to transform its cities and towns into innovative, sustainable, and citizen-centric urban spaces. The paper adopts a qualitative approach to collate the elements of Smart City initiatives from around the world that can be applied to Indian urban spaces. The data for the study has been collected from secondary sources, viz. official government websites and reports of various governmental and non-governmental bodies, journal articles, newspaper reports, etc.

This paper has been divided into five sections. The first section explicates the crises brought about by urbanisation and the opportunities that have emerged with the digital revolution. Consequently, it traces the conceptual evolution of Smart Cities and the status of Smart Cities in India. Sections two, three and four highlight the successful Smart Cities initiatives around the globe in terms of innovation, sustainability and citizen-centricity, respectively. It describes how cities worldwide tackle urban problems using clean and collaborative technology. The final section highlights ten key findings of the study, providing vital lessons for India to adopt and apply to its own unique context.

Urbanisation and Digital Revolution

Converting the Urbanisation Crises into Opportunities

According to the World Economic Forum (2015), it is estimated that nearly 66 per cent of global population will live in urban areas by 2050. Narratives on urban transformation have been driven by the recognition of the opportunity as well as the need for radical change towards smart, sustainable, and resilient cities (Albino, Berardi and Dangelico 2015, Hölscher and Frantzeskaki 2021, Wolfram, Borgström and Farrelly 2019). Telecommunication, digital technologies, transport systems, trade liberalisation, etc. are ‘shrinking’ the world and making it ‘smaller’ in terms of the speed of information and material flows across the globe. Concomitantly, globalisation generates its own demand for expeditious social and economic interactions. This nudges people to move

towards bigger cities, with their benefits of “proximity, accessibility and productivity” (Algayerova, 2020).

While technology is seen as a boon for progressive urban transformation, that alone does not suffice for a city to become smart and sustainable. The government has a novel responsibility of involving and influencing key stakeholders to get things done, through interaction rather than through mere coercive direction and fear of penalisation (Colebatch, 2014). A participatory approach encourages policymakers and relevant stakeholders to join hands to distribute the burden of sustainable administration, build trust and identify the real needs of the community.

A Digital Revolution amidst Looming Uncertainties

Precarious events like the financial crisis of 2008, and the COVID-19 pandemic engendered enduring repercussions in already economically-weaker cities. The effects on vulnerable groups are especially strong in countries with exacerbating social and economic inequalities, which are also traditionally spatially segregated (Algayerova, 2020), making them vulnerable and raising concerns of equity and inclusiveness.

At the same time, the ‘fourth industrial revolution’ is transforming economic and social lives which are being affected by big data, cloud computing, the Internet of Things (IoT), Artificial Intelligence (AI), machine learning, high-speed internet, etc. (Kauf, 2020). This has engendered a ray of hope for countries to expeditiously transform their cities on lines of innovation, sustainability, and citizen-centricity.

Conceptual Evolution

The Odyssey of Smart Cities

Putatively, the phrase, ‘Smart Cities’ has its origin in the concept of Smart Growth that focused on an alternative paradigm to deal with detached housing, dependence on automobiles, urban sprawl and new policies for urban planning (Bollier, 1998; Bhattacharya, et al., 2015). It accentuated mixed land-use and compact design, newer transportation and housing alternatives and a feeling of community living. Portland, Oregon, is widely believed to be an example of Smart Growth (Harrison and Donnelly, 2011). A novel concept called ‘Intelligent Cities’ displaced it in the 1990s, emphasising how data and information technology could impact the functioning of cities (Bhattacharya et al., 2015). Some technology companies (IBM et al., 2009) adopted the phrase since 2005 (Harrison and Donnelly, 2011).

In 2008, the global economic crisis caused by extreme reductions in urban finances adversely impacted social welfare. Assistance to render urban public services was sought from the private sector (Paroutis, Bennett and Heracleous, 2014). Thus, the Smart City Model emerged, allowing an interface with the city as a network of complex information flow providing better infrastructure and services. This allowed cities to integrate operations and optimise efficiency in different sectors including buildings,

transportation, electrical and water distribution, and public safety. The ‘Smarter Cities’ trademark was officially registered to IBM, in 2011 (Bhattacharya et al., 2015).

Definitions and Components: What Makes a City ‘Smart?’

Caragliu, Del and Nijkamp (2011) term a city smart “when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with wise management of natural resources, through participatory governance.” Several key components emerge in the existing literature on smart cities as shown in Table 1.

Table 1: Focus Areas in Definitions of Smart City

Year	Author	Key Components
2000	Hall et al.	Monitoring, integration and planning for critical infrastructure, services and security.
2007	Giffinger et al.	Economy, people, governance, mobility, environment, and living; self-decisive, independent, and aware citizens.
2011	Harrison et al.	Physical, social, business and IT infrastructure for collective intelligence.
2010	Toppeta	ICT design and planning; speedy bureaucratic processes; innovative solutions; sustainability and livability.
2011	Caragliu et al.	Social and human capital, sustainable economic growth, high quality of life, communication infrastructure, wise management of natural resources, participatory governance.
2013	Dameri	ICT, logistic, energy production, citizen well-being, inclusion and participation, environmental quality, intelligent development.
2019	OECD	Digitalisation, stakeholders’ engagement, people’s well-being, inclusiveness, sustainability and resilience.

Source: Compiled by authors.

Smart cities are based on the utilisation of human, collective, and technological capital for the development of urban agglomerations (Angelidou 2014). Though scores of definitions and descriptions of what a smart city is, can be found in the existing literature, there is no unanimous consensus on a standard definition of a smart city (Nam and Pardo, 2011).

The evolution of the models of smart cities is reflective of the growing importance of governance, the shift to citizen-centric approaches (Dameri, 2013), and the key role assigned to stakeholders (Dameri, 2013, Leydesdorff and Deakin 2011, Lombardi et al. 2011). Center for Study of Science, Technology and Policy (CSTEP) in its review (brings out the degree of emphasis on various components of a Smart City in the existing literature (Bhattacharya et al., 2015). They observe that ‘equity’ does not get considerable recognition as an outcome of sustainable cities. This partially indicates a

lack of a responsive effort to include the marginalised and disadvantaged sections in planning of smart attributes of the city.

The Idiosyncratic Context of India

The Smart Cities Mission was launched by the Hon'ble Prime Minister on 25th June 2015. The primary objective of the Mission is to promote cities that provide basic infrastructure, ensure a clean and sustainable environment, and enhance the quality of life for citizens through the implementation of 'smart solutions'. The Mission aims at providing quality of life and driving economic growth through comprehensive work on physical, institutional, social and economic pillars. The focus is on sustainable and inclusive development by creation of replicable models which act as lighthouses to other aspiring cities. 100 cities have been selected to be developed as Smart Cities through a two-stage competition (Ministry of Housing and Urban Affairs, 2021).

According to Ministry of Housing and Urban Affairs (2021), our future in this century will be defined by three major trends: growing inequities, changing climate and the fourth Industrial Revolution. Therefore, there is a need to address structural causes of migration viz. agrarian crises caused by natural disasters, lack of job opportunities for rural people and ineffective land reforms. Some other concerns are the needs and rights of women, children and the marginalised sections of society. An ambitious government plan to upgrade India's cities must not jeopardise further marginalisation of the poor and minority communities during slum evictions (Chandran, 2017). The lack of capacities in our city administration as envisioned in the 74th Amendment Act, 1993, forms the rationale behind the creation of Special Purpose Vehicles (SPVs) (Joshi, 2016). Besides the lack of charismatic leadership, procedural and financial impediments hinder effective planning and implementation of projects. Public–Private Partnership (PPP), especially in the North-East States is minimal (Shukla, 2015).

Despite India's unique context, several cities around the world offer outstanding examples of innovative, sustainable, and citizen-centric initiatives that India can adapt to suit its own needs.

Innovations Ideation and Interaction

According to Organisation for Economic Co-operation and Development (OECD) (2005), innovation implies creating and applying new knowledge to contribute, in new ways, towards building a path for a sustainable future. It may involve new ways of governing, structuring partnerships, managing social relationships or new organisational practices. It is about trying and finding better ways for people to interact and thrive beyond mere scientific research and profit-oriented, private sector activities.

Jakarta, Indonesia, experiences severe annual flooding during the rainy season. To address this, researchers developed PetaJakarta, a real-time flood map that crowd-sources flood reports from Twitter. In Seoul, South Korea, the Sharing City Seoul

initiative encourages residents to make better use of the resources they already own. Services such as the local car-sharing company SoCar and websites like Billiji, which help neighbours share items, aim to offer alternatives to ownership—particularly for things that are rarely used. (Saunders and Baeck, 2015).

Smart Technology: An Example of London

New digital technologies have had a profound impact on the way London functions. The Congestion Charging Zone uses cameras and software to automatically recognise car number plates, helping to manage traffic effectively. The London Air Quality Network employs digital sensing equipment to monitor and map air pollution across the city. Additionally, Transport for London has planned the installation of sensors at road crossings to enhance pedestrian safety. London also aims to invest in Smart Grids, which will help streamline road maintenance and construction, making urban infrastructure more efficient and responsive. (Saunders and Baeck, 2015).

One of the prime underused assets is cars. Available data reveals that they remain idle for 96 per cent of their life (Bates and Leibling, 2012). This has a drastic impact on cities in terms of the amount of space that is dedicated to car parks. The United Kingdom has an estimated 8 to eleven million regulated parking spaces and further seventeen million unregulated ones (British Parking Association, 2013).

In Singapore, a city–state where housing is extremely dense and expensive, roads take up twelve per cent of the total land area, compared to fourteen per cent for housing (Budget Direct, 2019).

Strategic Sustainable City Planning

Lessons from Europe

Strategic urban planning aims to develop a collective vision of metropolitan dynamics through coordination among public and private efforts and participation of citizens and stakeholders. This is done by channelising resources to adapt to new situations and by improving the living standards of citizens. It provides a methodology to identify strengths and weaknesses, and to define the main strategies for local development (Paroutis, Bennett and Heracleous, 2017).

STCCEP (Systems Thinking for Comprehensive City Efficient Energy Planning) was delivered in partnership with San Sebastian (Spain), Bristol (United Kingdom) and Florence (Italy). An innovative European project, ‘systems thinking methodology’ using open-data sourcing was adopted to enhance efficiency. It focused on the application of smart city concepts through an integrated approach. It aims to learn from the prowess of one another in devising sustainable practices (Centre for Sustainable Energy, 2013).

The InSMART project was tested in the towns of Nottingham (United Kingdom), Trikala (Greece), Cesena (Italy), and Évora (Portugal). It aimed to optimise energy flows based on economic, environmental, and social criteria. The project paved the way

for the implementation of priority operations in urban energy planning, contributing to smarter, more sustainable cities. (CORDIS, 2014).

The PLEEC project targeted reduction in energy use in Europe. It contributed to the European Union's 20-20-20 targets. Tartu (Estonia), Jyväskylä (Finland), Turku (Finland), Santiago de Compostela (Spain), Eskilstuna (Sweden), and Stoke-on-Trent (United Kingdom) were involved. Based on an evidence-based strategic planning approach, and taking into account the local conditions, the Energy Efficiency Action Plans have also been developed to enforce endogenous urban development.

Gothenburg, Glasgow, Ghent, and Riga under the STEP-UP project targeted convergence of urban planning and energy. This would help cities enhance their Sustainable Energy Action Plans with convergence of the ICT and energy sectors (Groth, Fertner and Grosse, 2016).

Efforts to reduce carbon dioxide emissions were made as part of the TRANSFORM project, which was coordinated by Lyon (France), Vienna (Austria), and (Germany). It considered all pertinent energy flows and environmental factors using robust stakeholder procedures and data analytics, creating win-win commercial models for parties with initially divergent interests. (Van der Veen, 2016).

Sustainability Initiatives

In the city of Oslo, where Disruptive Technologies is based, any service that can be digitalised is being digitalised. The city is advancing in areas such as circular waste management, green energy systems, and the testing of electric buses. It is also promoting zero-emission construction sites and the retrofitting of existing buildings with sensors and Building Management Systems (BMS) to enhance energy efficiency and sustainability. (Roth et al., 2021).

Emitting and Committing

By 2025, Copenhagen is expected to be the world's first carbon-neutral city, while Denmark has been committed to becoming fossil-fuel-free by 2050 (Birnbaum, 2019).

Sustainable transportation alone has eliminated more than a third of all fossil fuel usage in the transportation sector, reducing greenhouse gas emissions by ninety-thousand tons annually. The city makes wise use of GPS in buses, wireless data from mobile devices, and sensors in sewers and garbage cans. These innovations enable real-time assessment of the city's condition, allowing for continuous improvements to reduce traffic congestion, air pollution, and CO₂ emissions. (Law 2022).

Planning of eco-smart cities, that are completely vehicle-free is being focused and emphasised upon. For instance, in 2021, Singapore declared creation of such a city in Tengah, in the west of Singapore. It comprises five districts with 42,000 homes in a planned forest city, and facilitates safe zones for pedestrians and cyclists (Lai, 2021).

In Oslo, the capital of Norway, the transition to zero-emission cars is catching pace. They are allowed to run on bus lanes and park for free and enjoy reduced tolls. Oslo hopes to scrap non-electric vehicles by 2025. 70 per cent of cars purchased in 2020 were electric (Law, 2022).

Clean Energy, Green Spaces

Zurich has an ambitious goal of becoming a 2000-watt society by 2050. The Green City Zurich project aims to preserve and increase all green spaces. Allocation of funds by the government for energy efficiency, renewable sources, and raising the public awareness on sustainability becomes essential to fulfil these endeavours (Mombelli, 2016).

Sydney began the Sustainable Sydney 2030 initiative to reduce the city's carbon emissions by seventy per cent. This goal will be beneficial for its residents because the quality of breathing air will improve along with reviving dying ecosystems. In addition, Sydney envisions a Smart City for the future to help improve public transportation, bring its citizens together and overall make the city more sustainable (GreenMatch, 2018).

In 2009, the Amsterdam Smart City programme was launched to achieve the city's environmental goals, through cutting-edge technologies. According to the city's strategy, CO₂ emissions will be cut by forty per cent by 2025. By 2025, all non-electric vehicles will be phased out of Oslo, with more than seventy per cent cars purchased in 2020 being electric. Oslo seeks to expedite the switch to 'zero emissions' automobiles by allowing them to use bus lanes for free parking and lower fees. Copenhagen adopts an innovative approach to use technology to make the city more ecologically-friendly and improve the quality of life. Real-time data on traffic, air pollution, and CO₂ emissions is collected using mobile devices, GPS on buses, and sensors on sewers and garbage cans (*The CSR Journal*, 2022).

Citizen-Centricity: Towards Collaborative Governance

Many city governments are increasingly viewing the collaborative economy (also known as the sharing economy) as a valuable tool for tackling urban challenges. The term 'sharing city' has emerged to describe a more systematic approach for promoting the collaborative economy in cities (Saunders and Baeck, 2015). While Berlin, Amsterdam, Seoul and a network of 15 US cities are experimenting with various approaches, there is no consensus on a common definition or framework for a sharing city.

Sharehub, in Seoul, aims to promote public acceptance of the collaborative economy as part of the Sharing City Seoul initiative. It was launched in 2013, and facilitated large public engagements and education campaigns involving conferences, seminars, reports, etc.

Participatory Policymaking: Hearing What the Common-Man Has to Say

In Beijing, an app called, '*I love Beijing*' helps in reporting issues of broken streetlights and potholes to the city administration. Going a step ahead of reporting apps like *FixMyStreet* in the UK, it also includes a map of the informal food markets of the city. The residents may also include the opening times, new market and the types of goods, they sell, in the same app., The citizens of Reykjavik, Iceland, have, *Better Reykjavik* — a website, to propose, debate and vote on ideas for reforming the city. Monthly debates on popular issues are held by the city council. Nearly €1.9 million has been spent on developing more than 200 projects proposed by citizens by the city government. Likewise, in Paris, '*Madame Mayor, I have an idea*' is a participatory budgeting process, allowing citizens to suggest and vote on ideas for projects in Paris (Saunders and Baeck, 2015).

In Bangalore, a local NGO called the MOD Institute facilitated the development of a community vision for the Shanthingar neighbourhood. As part of this initiative, the organisation encouraged online debates among residents, fostering participatory dialogue about local issues. One key concern that emerged from these discussions was the prevalence of abandoned urban spaces. To address this, the MOD Institute developed user-friendly software that allowed residents to map these neglected areas using smartphones or SMS, enabling collective identification and potential revitalisation of these spaces.

Making better use of time, skills and everyday belongings

Smart City Zurich, launched in 2018, was aimed to bolster innovation and transformation of Zurich into a Smart City. Updated digital infrastructure, integrated public transportation, and 'smart participation,' — were some of its key areas of focus. This encourages participation of businesses and individuals in building Smart City Zurich (Saunders and Baeck, 2015).

- **Intelligent Streetlights (Glasgow):** The streetlights turn on and off as people walk through them at night. This helps save energy when the lights are not needed. (Griffiths n.d.).
- **Smart Bins (Barcelona):** These are used to optimise the route of waste-collection vans by signalling only those bins that are full. Ten per cent is estimated to be saved on waste disposal through these bins (Romualdo-Suzuki and Finkelstein, 2020).
- **Citywide Sensing (Santander):** Santander, in Spain, has over 12,000 sensors. From garnering data on parking spaces to air quality, sensors are used across the city. The pilot-project focused on the concept of city-wide sensing networks, and bringing about effective changes by gathering data on everyday activities and services (Newcombe, 2014).
- **Smart Buildings (London):** The Cognicity Challenge was initiated by the Canary Wharf group in 2014. It aimed to identify and pilot smart city technologies on its

estate. In addition to other technologies, it tested Demand Logic, aimed at helping businesses minimise electricity costs by intelligently monitoring electricity usage (Dunsby, 2014).

- **Traffic Management (Singapore):** Singapore's Intelligent Transport System includes electronic road pricing (ERP) and sensors attached to taxis that help the government map traffic conditions. ERP, alongside regulation, has helped reduce the number of journeys by private cars in Singapore (Land Transport Authority Singapore n.d.).

Lessons for India

The following lessons for India can be drawn from the best practices followed around the world:

- **Smart Technology for Better Livelihood:** Digital Technology, IoT, internet, etc. facilitate real-time data, which must be employed to find solutions for smart energy, transportation, data, infrastructure and mobility. London's example of the use of air quality networks, smart grids, regulated parking spaces, etc. shows the transformational power of technology. Like India, Singapore has extremely dense and expensive housing and road networks. Yet, through technology, it has taken commendable steps towards traffic management and is committed to be vehicle free soon.
- **Knowledge Organisation and Learning:** Evidence-based policies and programmes, which do not neglect stakeholders' opinions, need to be framed. Formalising mechanisms for collaboration and partnerships between cities, as well as establishing regional or international networks and repositories of smart cities, can significantly accelerate the transfer of policies and practices. These platforms would serve as valuable resources for collecting and disseminating case studies, best practices, and governance lessons, thereby enhancing the capacity of urban planners and policymakers to design and implement effective strategies for smart city development. (Li, et al. 2022).
- **S.M.A.R.T. Local Governance:** Local administration must not only adopt smart technology and plans but also be 'Simple, Moral, Accountable, Responsive and Transparent.' The credit for and burden of failure of programmes must be shared between the local administrators, the stakeholders and the citizens, and further actions must be taken collectively and responsibly.
- **Planning, Implementation and Monitoring:** Ministry of Housing and Urban Affairs (2022) promotes a perspective based on a demand and integration. It accentuates improvements in frameworks and designs for urban planning. By upgrading policy, providing infrastructure and technical guidance, carrying out pilot projects for 'learning-by-doing,' it helps mainstream innovations by testing technology solutions to metamorphose India's urban landscape. The 'Citizen

Outreach Campaign’ for demystifying urban planning, and revision of Town and Country Planning Acts recommended by NITI Aayog (NITI Aayog, 2021) can further guide smart cities.

- **Strengthening Local Leadership and Simplifying Procedures:** For re-engineering urban governance, people-oriented, responsible leaders, clear rules and regulations, and division of responsibilities and authority are needed. A dynamic organisational structure and extensive adoption of technology can enable public participation and inter-agency coordination. Moreover, steps for strengthening urban planning education system must be undertaken.
- **Inclusiveness and Equity:** Development must be collaborative and not imposed, taking along all sections, especially the marginalised and the slum-area masses. The needs of women, children, elderly, physically challenged, and socially and economically backward sections of society must be given due consideration while planning and implementing smart city projects.
- **Emphasising Quality of Life:** Public security and safety, better check on crimes, faster ways to commute, better public health and sanitation and social connectedness facilitated through smart technology and smart governance, can help improve the standards of living of people. Efficient intelligent energy networks, automation, optimised energy use, access to information and smart infrastructure help make the people smart and informed and can improve their quality of life.
- **Commitment to Environmental Conservation:** A healthy environment entails resource conservation and regeneration, clean energy and green spaces, and rational emission commitments. Commitments at global forums will be realised only by acting locally.
- **Socio-Economic Stability:** To ensure resilience, a healthy environment and socio-politico-economic sustainability are key prerequisites. The resilience of cities must be bolstered to improve adaptability and livability. By minimising inequality and injustice, social conflicts must be avoided and harmony and order must be promoted. While attempting to prevent wastage of resources (men, money, material), means to optimally utilise them must be adopted.
- **Smart People, not just Smart Technology:** Citizen-engagement and motivation for collaboration with the city administration in the co-design and co-creation of civic solutions increases contributions to address urban and social issues of common concern. The formidable challenge is not the installation of infrastructure or adoption of new technologies but the involvement of the public sphere in the civic life (Oliveira and Campolargo, 2015). Through education, dialogue and collaboration, the administration must take steps to make not only the city but also the people ‘smart.’

Table 2 summarises key international initiatives that offer valuable lessons and models from which India can learn to enhance its smart city and collaborative urban development strategies.

Table 2: At a Glance: Initiatives for India to Learn From

Innovation		Sustainability		Citizen-Centricity	
City/Place	Lesson/ Initiative	City/Place	Commitment	City/Place	Lesson/ Initiative
Jakarta, Indonesia	PetaJakarta,	Zurich, Switzerland	Preserving green spaces	Dubai, UAE	Fast Planning and Implementation
Seoul, South Korea	Sharing City, SoCar Car-pooling	Sydney, Australia	Sustainable Sydney 2030 initiative 70% emission cut by 2025	Boston, USA	Participatory Urbanism
London, UK	London 3D Mapping and Safe Transport for Pedestrians	Amsterdam, The Netherlands	40% emission cut by 2025	Seoul, South Korea	Sharehub
Barcelona, Spain	Smart Bins	Oslo, Norway	Phase out non-electric vehicles by 2025	Beijing, China	'I love Beijing' App
Glasgow, Scotland	Intelligent Streetlights	Copenhagen, Denmark	Real time data on air quality, mobile services and sensors	United Kingdom	FixMyStreet
Singapore	Traffic Management	Singapore City, Singapore	Vehicle-free city	Paris, France	Madam Mayor
Santander, Spain	City- wide sensing	Denmark	Fossil-free by 2050	Reykjabik, Iceland	Better Reykjabik website
London, UK	Smart buildings	Copenhagen, Denmark	Carbon-neutral by 2025	New York, USA	Women Entrepreneurs NYC

Source: Compiled by the authors.

Conclusion

Smart Cities, through ICT, are helping cities combat the challenges of rapid urbanisation, while creating newer opportunities for people, in terms of employment, quality of life and leisure. More recently, there has been a shift in the focus of Smart Cities from emphasis on mere technology to citizen-centric urban transformation. The Smart Cities Mission has been a crucial step for the development of India's major cities. The best practices and unique cases in innovation, sustainability, and citizen-centricity from all over the world can guide India to learn from the successes and failures of other countries, after eight years of its conception. This study finds that efficient use of smart technology, knowledge organisation, effective and responsible local administration, charismatic leadership and strategic planning, implementation and monitoring of programmes are crucial lessons for India to take back and work on. To make the people 'smart,' India must stay committed to achieving inclusiveness, equity, quality of life and environmental sustainability. Participation, dialogue, and stakeholders' engagement facilitated through technology and administered through innovative governance measures are crucial for India to light up the path of its urban spaces, and to make them inclusive, equitable, sustainable and truly smart.

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

References

- Albino, Vito, Umberto Berardi, and Rosa Maria Dangelico. (2015). Smart Cities: Definitions, Dimensions, Performance, and Initiatives. *Journal of Urban Technology*, Vol 22, No 1, pp 3-21. doi:10.1080/10630732.2014.942092
- Algayerova, Olga. (2020). "People-Smart Sustainable Cities," *UNECE*, https://unece.org/sites/default/files/2021-01/SSC%20nexus_web_opt_ENG_0.pdf.
- Angelidou, Margarita. (2014). "Smart City Policies: A Spatial Approach," *Cities*, Vol 41, No 1, <http://dx.doi.org/10.1016/j.cities.2014.06.007>.
- Bates, John and David Leibling. (2009). "Spaced Out: Perspectives on Parking Policy," *RAC Foundation*, <https://trid.trb.org/view/1225136>
- Bhattacharya, Shrimoyee, Sujaya Rathi, Sonali Anusree Patro, and Niepukhrie Tapa. (2015). "Reconceptualising smart cities: a reference framework for India." *CSTEP*, https://www.niti.gov.in/writereaddata/files/document_publication/CSTEP%20Report%20Smart%20Cities%20Framework.pdf
- Birnbaum, Michael. (2019, November 19). "What it takes to be carbon neutral — for a family, a city, a country," *Washington Post*. <https://www.washingtonpost.com/climate-solutions/2019/11/19/what-it-takes-be-carbon-neutral-family-city-country/>
- Bollier, David. (1998). *How Smart Growth Can Stop Sprawl: A Fledgling Citizen Movement Expands: A Briefing Guide for Funders 1998*, Washington: Essential Books.

- British Parking Association. (2013). "The size and shape of the UK parking profession," *Haywards Heath*, <http://www.britishparking.co.uk/write/documents/library/>.
- Budget Direct. (2019, October). "Why are cars so expensive in Singapore?" *Budget Direct*, <https://www.budgetdirect.com.sg/car-insurance/research/why-are-cars-so-expensive-in-singapore>.
- Caragliu, Andrea, Del Bo Chiara and Peter Nijkamp. (2011). "Smart Cities in Europe," *Journal of Urban Technology*, Vol 18, No 2, pp 65–82.
- Centre for Sustainable Energy. (2013). "STEPP: Systems Thinking for Efficient Energy Planning." London: Government Press, <https://www.cse.org.uk/projects/view/1244>.
- Chandran, Rina. (2017, June 12). "'No place for the poor' in India's Smart Cities, campaigners say," *Reuters*, <https://www.reuters.com/article/india-landrights-cities-idUSL8N1J90D0>
- Chaudhry, Shivani, Swapnil Saxena, and Deepak Kumar. (2018). "India's Smart Cities Mission: Smart for Whom? Cities for Whom?" *Housing and Land Rights Network*, https://www.hlrn.org.in/documents/Smart_Cities_Report_2018.pdf.
- Colebatch, Hal. (2014). "Making sense of governance," *Policy and Society*, Vol 33, No 4, pp 307-316, doi:10.1016/j.polsoc.2014.10.001.
- CORDIS. (2014). "Integrative Smart City Planning," *European Commission*, <https://cordis.europa.eu/project/id/314164>.
- Dameri, Renata Paola. (2013). "Searching for Smart City Definition: A Comprehensive Proposal," *International Journal of Computers and Technology*, Vol 11, No 5, pp 2544–2551.
- Dunsby, Megan. (2014, October 21). "Canary Wharf Group unveils smart city accelerator initiative," *Startups*, <https://startups.co.uk/news/canary-wharf-group-unveils-smart-city-accelerator-initiative/>
- Giffinger, Rudolf, Christian Fertner, Hans Kramar, and Evert Meijers. (2007). *Smart Cities: Ranking of European Medium-Sized Cities*, Vienna, Austria: Centre of Regional Science (SRF), Vienna University of Technology, http://www.smartcities.eu/download/smart_cities_final_report.pdf.
- GreenMatch. (2018). "Sustainable and Smart Cities Around the World," *Greenmatch*, <https://www.greenmatch.co.uk/blog/2017/04/sustainable-and-smart-cities-around-the-world>.
- Griffiths, Hannah. (2017). "The future of street lighting: The potential for new service development," *Future Cities Catapult*, <https://iotuk.org.uk/wp-content/uploads/2017/04/The-Future-of-Street-Lighting.pdf>
- Groth, Niels Boje, Christian Fertner, and Julianne Grosse. (2016). "Urban Energy Generation and the Role of Cities," *Journal of Settlements and Spatial Planning*, Vol 5, No 5, DOI: 10.19188/02JSSPSI052016.
- Hall, Robert E., B. Bowerman, J. Braverman, J. Taylor, H. Todosow, and U. Von Wimmersperg. (2000). "The vision of a smart city," *In Proceedings of the 2nd International Life Extension Technology Workshop*, Vol. 28, <http://www.osti.gov/bridge/servlets/purl/773961-oyxp82/webviewable/773961.pdf>.
- Harrison, Colin, and Ian Abbott Donnelly. (2011, September). "A theory of smart cities," *In Proceedings of the 55th Annual Meeting of the ISSS-2011, Hull, UK*.

- Hölscher, Katharina, and Niki Frantzeskaki. (2021). "Perspectives on urban transformation research: transformations in, of, and by cities." *Urban Transformations*, Vol 3, No 1, pp 1-14.
- IBM. (2009). "Smarter Cities: New cognitive approaches to long-standing challenges," *International Business Machines*, <http://www.ibm.com/smarterplanet/us/en/smartercities/article/newyork2009.html>.
- Joshi, Bhanu. (2016, June 28). "Smart Cities Mission: Flaws in a flagship programme." *The Hindu*, <https://www.thehindu.com/opinion/op-ed/Smart-Cities-Mission-Flaws-in-a-flagship-programme/article62116296.ece>.
- Kauf, Sabina. (2020). "Smart City in the era of the fourth industrial revolution," *Scientific Papers of the Silesian University of Technology*, https://managementpapers.polsl.pl/wp-content/uploads/2020/07/145_Kauf.pdf
- Lai, Olivia. (2021, July 13). "Smart Cities: Top 7 Smart Cities in the World and How They Do It," *Earth.org*, <https://earth.org/top-7-smart-cities-in-the-world/>.
- Land Transport Authority (n.d.). "Land Transport Authority (LTA)," Singapore City: Government of Singapore, <https://www.lta.gov.sg/content/ltagov/en.html>.
- Law, Marcus. (2022, September 20). "Top 10 sustainable smart cities helping make a better world," *Technology*, <https://technologymagazine.com/top10/top-10-sustainable-smart-cities-helping-make-a-better-world>.
- Leydesdorff, Loet, and Mark Deakin. (2011). "The triple-helix model of smart cities: A neo-evolutionary perspective." *Journal of Urban Technology*, Vol 18, No 2, pp 53-63.
- Li, Lili, Araz Taeihagh and Si Ying Tan. (2022). "What factors drive policy transfer in smart city development? Insights from a Delphi study," *Sustainable Cities and Society*, Vol 84.
- Lombardi, Patrizia, Silvia Giordano, Hend Farouh, and Y. Wael. (2011). "An analytic network model for Smart cities." In *Proceedings of the 11th International Symposium on the AHP*, pp 15-18.
- Ministry of Housing and Urban Affairs. (2021). "About the Mission: Smartcities," New Delhi: Government of India, <https://smartcities.gov.in/about-the-mission>.
- Ministry of Housing and Urban Affairs. (2022). "Sustainable Cities Integrated Approach Pilot (SCIAP)," *UN-Habitat India*, [https://www.unhabitat.org.in/projects/sustainable-cities-integrated-approach-pilot-\(sciap\)](https://www.unhabitat.org.in/projects/sustainable-cities-integrated-approach-pilot-(sciap)).
- Mombelli, Armando. (2016, February 15). "2,000-watt society: when the future becomes a reality," *SWI Swissinfo.ch*, https://www.swissinfo.ch/eng/politics/energy-efficiency_2000-watt-society-when-the-future-becomes-a-reality/41958718.
- Nam, Taewoo, and Theresa A. Pardo. (2011, June). "Conceptualising smart city with dimensions of technology, people, and institutions," In *Proceedings of the 12th annual international digital government research conference: digital government innovation in challenging times*, pp 282-291, <https://dl.acm.org/doi/pdf/10.1145/2037556.2037602>.
- Newcombe, Tod. (2014, April 28). "Santander: The Smartest Smart City," *Government Technology*, <https://www.govtech.com/data/santander-the-smartest-smart-city.html>.
- NITI Aayog. (2021). "Reforms in Urban Planning Capacity in India." New Delhi: Government of India, <https://www.niti.gov.in/sites/default/files/2021-09/UrbanPlanningCapacity-in-India-16092021.pdf>.

- OECD. (2005). "Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data," Paris: Oslo Publishing, https://www.oecd-ilibrary.org/science-and-technology/oslo-manual_9789264013100-en.
- OECD. (2019). "Enhancing the Contribution of Digitalisation to the Smart Cities of the Future," Paris: Oslo Publishing, <https://www.oecd.org/cfe/regionaldevelopment/Smart-Cities-FINAL.pdf>.
- Oliveira, Álvaro, and Margarida Campolargo. (2015, January). "From smart cities to human smart cities," In *2015 48th Hawaii International Conference on System Sciences*, IEEE, pp. 2336-2344, doi: 10.1109/HICSS.2015.281.
- Paroutis, Sotirios, Mark Bennett, and Loizos Heracleous. (2014). "A strategic view on smart city technology: The case of IBM Smarter Cities during a recession," *Technological Forecasting and Social Change*, Vol 89, pp 262-272, https://warwick.ac.uk/fac/soc/wbs/subjects/sib/people/sotirios_profile/paroutis_bennett_heracleous_13_tfsc.pdf.
- Paroutis, Sotirios, Mark Bennett, and Loizos Heracleous. (2017). "The making of a smart city: best practices across Europe Empowering Smart Solutions for Better Cities." https://smart-cities-marketplace.ec.europa.eu/sites/default/files/2021-04/the_making_of_a_smart_city_-_best_practices_across_europe.pdf.
- Romualdo-Suzuki, Larissa, and Anthony Finkelstein. (2020). "Data as Infrastructure for Smart Cities: Linking Data Platforms to Business Strategies" *New York: Cornell University*, <https://arxiv.org/ftp/arxiv/papers/2005/2005.11414.pdf>.
- Roth, Anders, Jenny von Bahr, Henrik Klooe, and Tomas Wisell. (2021). "Zero-emission vehicles and zones in Nordic cities-Promotion, instruments and effects." *DiVA Portal*, <https://www.diva-portal.org/smash/get/diva2:1549443/FULLTEXT01.pdf>.
- Saunders, Tom, and Peter Baeck. (2015). "Rethinking smart cities from the ground up." *Nesta*, https://media.nesta.org.uk/documents/rethinking_smart_cities_from_the_ground_up_2015.pdf
- Shukla, Pallavi. (2015). "Smart Cities in India: A Report," *The Energy and Resources Institute (TERI)*, http://terienviis.nic.in/WriteReadData/links/Smart%20Cities%20in%20India_Report_pagewise-5937837909069130880.pdf
- The CSR Journal. (2022, May 18). "Top Five Smart Cities Promoting Global Sustainability," *The CSR Journal*, <https://thecsrjournal.in/smart-cities-promoting-global-sustainability/>.
- Toppeta, Donato. (2010). "The Smart City Vision: How Innovation and ICT Can Build Smart, 'Livable', Sustainable Cities," *The Innovation Knowledge Foundation*. http://www.thinkinovation.org/file/research/23/en/Top_peta_Report_005_2010.pdf
- Van der Veen, Emma. (2016, May 16). "Transform," *Amsterdam Smart City*, <https://amsterdamsmartcity.com/updates/project/transform>.
- Wolfram, Marc, Sara Borgström, and Megan Farrelly. (2019). "Urban Transformative Capacity: From Concept to Practice," *Ambio*, Vol 48, No 5, pp 437-448. <https://link.springer.com/content/pdf/10.1007/s13280-019-01169-y.pdf>
- World Economic Forum. (2015, October 25). "Can we build cities that anticipate the future?" *World Economic Forum*, <https://www.weforum.org/agenda/2015/10/can-we-build-cities-that-anticipate-the-future/>.

Mushrooming of Unauthorised Colonies in Delhi : A Case Study of Sangam Vihar

Nagarlok
ISSN-0027-7584
56(4), 488-508
October-December, 2024
@ 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.8>

Ashish Kumar^{*}, Soma Arora^{} and Anand Prakash^{***}**

Abstract

For decades, about one-third of Delhi's population has lived in unauthorised colonies, lacking basic services, social infrastructure, and even recognition in the city's master plans. These colonies are not a feasible option for the city's long-term growth as they are disaster-prone due to a lack of varied municipal facilities and structural faults. The Supreme Court of India has also stated that the proliferation of unlawful colonies across the country is a threat to urban development. Hence, it is critical to thoroughly research these formal but legal, unplanned yet well-developed settlements since they are a solid reality today that cannot be wished away. The objective of the present research paper is to understand the causes, consequences, and extent of the proliferation of unauthorised colonies (UACs) in Sangam Vihar and to understand the efforts made in terms of regularising the UACs by present and previous government and regulatory bodies. The research is exploratory in nature and uses three separate data gathering techniques: document analysis, thematic narrative analysis, and a survey. This study primarily focuses on interviewing, documenting, and analysing the responses of inhabitants of Sangam Vihar, which is one of the largest unauthorised colony of Asia as a whole.

Keywords

Urban Housing, Unauthorised Colonies, Living Conditions, Sangam Vihar, Regulatory bodies.

^{**} Dr. Soma Arora, Professor-PG, School of Leadership and Management, Manav Rachna International Institute of Research and Studies MRIIRS, Faridabad, Haryana.
Email: somaarora.slm@mriu.edu.in

^{***} Professor Anand Prakash, Professor Emeritus, Manav Rachna International Institute of Research and Studies MRIIRS, Faridabad Haryana.
Email: anandp0001@yahoo

Corresponding author:

^{*} Ashish Kumar, Research Scholar, School of Leadership and Management, Manav Rachna International Institute of Research and Studies MRIIRS, Faridabad, Haryana.
Email: ashishkumar.sbss@mriu.edu.in

Introduction

For decades, about thirty per cent of Delhi's population has been living in unauthorised colonies, lacking basic utilities, social infrastructure, and even recognition in the city's master plans. With India's partition in 1947, a large number of migrants had to be accommodated in the national capital in a short period of time. These were mostly accommodated in the form of unplanned settlements (colonies) in Delhi, as well as villages on the outskirts of the city. In those early years, the good availability of services, expanding markets, and growing demand for labour attracted many individuals to Delhi in search of work." However, the persistent shortage of affordable housing in Indian cities like Delhi and Mumbai has driven low-income groups towards such informal settlements, as economic barriers limit access to formal housing options (Gandhi, 2012). The Delhi Development Authority, DDA, was tasked with planning the development of Delhi, one of the key components of which was to provide planned homes to Delhi residents. However, the gap between planned development and people's demands became obvious over time, as planned development could not keep up with Delhi's growing population. In total disdain for the existing rules and norms, a number of informal settlements sprang up around Delhi. These "spontaneous communities" could no longer be ignored as the large number of people living in them began to express themselves and became recognised as a substantial political constituency. Similar trends had been observed in metropolitan fringes like Seoul, where informal settlements emerged in response to rapid urbanisation and inadequate housing supply over decades (Han et al., 2017). These communities have been undergoing developed throughout these years and have metamorphosed into what we today know as 'Unauthorised Colonies'(UACs). According to Shahana Sheikh's (2014) analysis, these colonies fall under the category of "unplanned settlement types designated by the Government of National Capital Territory of Delhi (GNCTD)," and they have grown either on non-agricultural land that has not yet been designated as residential or on agricultural land that has been illegally divided, completely disregarding the guidelines of the Delhi Master Plans. M.N Ganju (2012) stated that these colonies don't have a single definition. Instead, the absence of even the most basic municipal facilities in such colonies makes them distinctive. Additionally, these communities have grown entirely through the efforts of average citizens, with no assistance from the government.

The Urban Development Department's Annual Plan 2014–2015 (Volume II) lists the various habitats and colonies found in the National Capital Territory of Delhi:

1. J.J. Clusters
2. J.J Resettlement Colonies
3. Slums Rehabilitation Colonies
4. Regularized-Unauthorized Colonies
5. Approved/ Planned Colonies

6. Unauthorised Colonies (UACs)
7. Walled city/ Notified Slum Areas

Unauthorised colonies are one of the seven categories of “unplanned developments” listed on the website of the Delhi Urban Development Department. Shahana Sheikh and Subhadra Banda, (2014) stated that more than 30 per cent of Delhi’s population resides in what the government has categorised as unauthorised colonies. As per Artika Shukla (2016) analysis, these settlements give off an overall sense of poverty and unhealthy living conditions. As inexpensive, authorised housing in Delhi has become a dream, more individuals are gradually investing in real estate in these locations. These colonies are home to more than 35 lakh people. An additional 30 lakh individuals are thought to reside in Delhi’s six lakh *Jhuggis*, which are dispersed among 1200 JJ Clusters. This basically equates to more than 55 per cent of Delhi inhabitants living in residences other than what are referred to as “regularised colonies.”

Need for the Study

The estimates place the ‘unauthorised’ populace of Delhi at around 60 per cent. Unauthorised constructions abound in several sections of South Delhi, including Lajpat Nagar, Sangam Vihar and Sainik Farms. The vast majority of Delhi’s approximately three million private automobiles are parked on public property at night. It is considered that the majority of public buildings beyond the Lutyen’s zone are in violation of construction codes and regulations. The bulk of commercial structures are also in violation of standard governing open spaces and parking. Keeping all of this in mind, it is critical to research these formal but legal, unplanned yet well-developed settlements thoroughly since they are a solid reality today that cannot be wished away. The inhabitants of these colonies are in the millions, and it is now the state’s responsibility to assess their needs and arrange for a realistic solution. Sangam Vihar is one of Asia’s largest unauthorised colonies. This study is primarily focused on interviewing, documenting, and analysing the responses of inhabitants of Sangam Vihar.

Objectives of the Study

1. To understand causes, extent of the proliferation of unauthorised colonies in Sangam Vihar and potential municipal deprivations faced by the residents of these colonies.
2. To understand the efforts made in terms of regularising the UACs by present and previous government and regulatory bodies.

Research Method

The exploratory nature of the study uses three separate data gathering techniques: document analysis, thematic narrative analysis, and survey.

Survey

For the purpose of the survey, a total of 80 people were surveyed. A semi-structured interview with open-ended questions was conducted. The questionnaire was written in Hindi since the majority of the residents were more comfortable answering questions in Hindi. The door-to-door survey took 30 days to complete. The survey included questions about the respondents' demographic details such as area density, male female ratio, educational level, income status, and source of livelihood.

Document Analysis

The documents have been analysed from the following sources such as

- A. Public documents (newspaper)
- B. Research articles from journals
- C. Reports from policy think tanks

Thematic Narrative Analysis: The Thematic Narrative Analysis (TNA) has been used to summarise the results of the causes of the proliferation of UACs, and the municipal deprivations experienced by the residents of these UACs. Thematic narrative analysis draws upon qualitative traditions that value participants' lived experiences and interpretative depth (Eisner, 1991).

Research Site

Area details are given in the Table below:

Table 1: Research Site : Sangam Vihar

Area	8.46 km ²
Population	208471
Population Density	24642 people per km ²
Male Population	112168
Female Population	96303

Source: Ministry of Health and Family Welfare, India 2020

As shown in Table 1, the locality, Sangam Vihar falls in South Delhi district situated in NCT of Delhi state, with a population of 208471 people. The male and female populations are 112168 and 96303 respectively. The size of the area is about 8.46 square kilometres. The Sangam Vihar colony has been designated by Delhi's National Capital Territory as an unauthorised colony. Construction workers, daily wage labourers, drivers, vegetable vendors, and manufacturing employees make up the majority of the population in these colonies. The majority of the locals are employed as temporary, contractual workers by labour contractors in the Okhla industrial area. The majority of the residential requirements of the lower and middle classes are met by

these colonies. In Sangam Vihar colony, there are approximately 189041 households. The colony came up on the agricultural land during 1970's & 80's. Communities from East of Kailash, Nehru Place, Govindpuri, Kailash Colony, Raj Nagar, and Alaknanda have been resettled here over the past several years. The colony is located near the Delhi-Haryana border.



Figure 1: A political map of Delhi and location of research site

Source: Maps of India

As shown in Figure 1, Sangam Vihar is located in South Delhi, an area that has seen rapid and unplanned urbanisation. Many of the residents of these colonies lost their employment as a result of being displaced, thus, finding other means of support became extremely difficult. Even many years later today, the neighbourhood still has trouble getting access to basic services like clean water, sanitation waste disposal, and adequate street lighting, etc.



Figure 2: Geographic Location of Sangam Vihar

Source: Google Maps

As shown in Figure 2, Sangam Vihar lies on the southern edge of Delhi, near the Delhi-Haryana border, positioning it as a liminal zone between urban and peri-urban dynamics. It highlights its proximity to important landmarks like Tughlaqabad Fort and the Delhi-Haryana border, helping to understand how the settlement fits into the city's larger structure. These references provide a clear picture of its placement in relation to major roads, transport routes, and surrounding areas.

Sangam Vihar is one of the largest unauthorised colonies in Asia and has grown rapidly over the years. Its expansion has been shaped by migration patterns, mainly involving people who moved here after being displaced from other parts of Delhi due to redevelopment projects. Many of these residents work as construction workers, daily wage labourers, small business owners, and street vendors. With limited planning and government support, the colony developed in an unregulated manner, leading to high population density and severe infrastructure challenges.

Since Sangam Vihar is located near the Delhi-Haryana border, it acts as a transition zone between urban and semi-urban areas. Many residents commute to nearby industrial and commercial hubs such as Okhla and Nehru Place for work. Despite being in Delhi's National Capital Territory (NCT), the colony lacks many basic amenities, such as proper water supply, sanitation, and public transport.

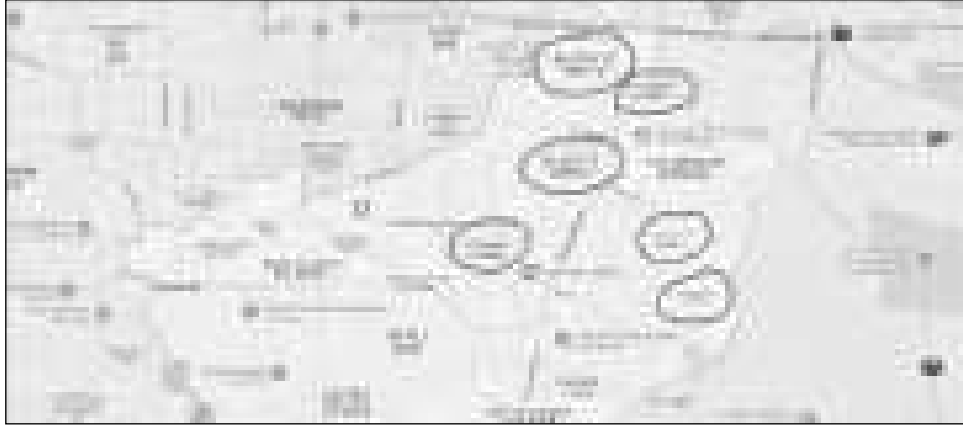


Figure 3: Administrative Boundaries and Blocks of Sangam Vihar

Source: Google Maps, Annotated by the Authors.

The data were collected from six major blocks in Sangam Vihar C, D, E, G, H, and K based on criteria such as population density, infrastructure, and occupational diversity, as depicted in Figure 3. These blocks were selected based on their population density, occupational patterns, infrastructure conditions, and access to public services.

Blocks C, D, and E have higher population density and house a diverse range of occupations, including labourers, small business owners, and street vendors. Given their central location, these blocks provide insight into the economic vibrancy and daily challenges of densely populated sections.

Block G and H – Characterised by severe infrastructure deficits, these blocks face acute shortages of clean water supply and inadequate sanitation. They depict the typical challenges of unauthorised colonies, where residents struggle with access to essential services.

Block K – This block is situated on the edge of Sangam Vihar, close to the Delhi-Haryana border. It represents the urban-rural transition and helps in understanding the challenges of newly developed sections of the colony in terms of accessibility, infrastructure, and socio-economic integration.

By focusing on these blocks, the study aims to capture variations in living conditions, employment patterns, and access to basic services within the settlement.

Sampling techniques

Data about Sangam Vihar's residents was gathered using the incidental sampling approach.

Data Analysis and Results

Data analysis and results have been segregated into three categories:

1. In accordance with the research objectives, survey data has been analysed using the simple statistical techniques, such as percentages to understand the demographic details of the Sangam Vihar colony.
2. The objective of the research is to examine the efforts made to regularise the colony by the government and regulatory bodies. For the same, a detailed document analysis has been done making use of various reports, research articles, and news articles available till date.
3. Narrative analysis has been utilised to present the various themes related to the causes for proliferation and municipal deprivation faced by residents of Sangam Vihar.

Survey Findings

Table 2: Demographic Survey of Sangam Vihar

Variable	Respondents	Number	Percentage
Sex	Male	48	60%
	Female	32	40%
Educational Status	Matriculation	27	33.75%
	Undergraduate	37	46.25%
	Graduate	16	20%
Economic Status	Below poverty Line	32	40%
	Middle income group	48	60%
	High income group	0	0
Employment	Service professional	29	36.25%
	business/self employed	23	28.75%
	Student	8	10%
	Unemployed	20	25%

Source: Based on a Survey.

As shown in Table 2, 60 per cent of respondents were males and 40 per cent were females. Among the female group of participants, 18 of the 32 respondents held a degree equivalent to class X, 9 held a degree equivalent to class XII, and just two held a degree equivalent to graduation. Out of 48 male respondents, 13 held a degree equivalent to class X, 13 held a degree corresponding to class XII, and five held a degree equivalent to graduation.

There were numerous instances of dropouts among both male and female respondents. Women often left education to focus on household responsibilities, while men dropped out to support their families financially. Despite their lack of formal

education, both male and female individuals had acquired the specific skills required for their respective jobs.

In terms of income, 60 per cent of the population falls into the medium income band, with yearly earnings ranging from Rs. 5 lakhs to 30 lakhs. Both men and women, were salaried employees of the private sector. 33 per cent of the population was classified as below poverty line, with an annual income ranging from Rs. 1.20 to 1.80 lakhs. The vast majority of men employed in the unorganised sector, worked as shopkeepers, auto mechanics, carpenters, plumbers, electricians, daily wage labourers, fruit and vegetable sellers, construction workers, cleaners, and so on. Females from this strata were either housewives, or worked as factory workers, househelps and as cooks, etc. This income strata highlighted a distinct skill set which could not be acquired at a school, college, or training institute, but from experience and personal work with trained and skilled individuals. The remaining seven per cent of the population belonged to the higher income category, with an annual income of more than 30,000 lakhs. These people owned the land and received monthly or annual rent payments from tenants.

36.25 per cent of the people in these colonies were self-employed, with the majority working as shop owners, plumbers, carpenters, cooks, cleaners, florists, and so on, while 28.75 per cent worked as service professionals like clerks, office assistants, school teachers, mechanics, hair stylists, nurses, bankers, and so on. It was startling to learn that almost 25 per cent of the whole sample was unemployed, while 10 per cent were students.

Document Analysis

The documents have been analysed from the following sources such as

- D. Public documents (newspaper)
- E. Research articles from journals
- F. Reports from policy think tanks

Documents selected	Analysis
“Delhi’s Unauthorised Colonies: An Issue Only for the Election Season?” Ajith & Katarai, <i>The Quint</i> , 2022.	To get a mental picture of the extent of proliferation of UACs in Sangam Vihar
“Planned Illegalities Housing and the ‘Failure’ of Planning in Delhi: 1947-2010, Bhan, EPW 2013	To understand the three major waves of “regularisation” in Delhi’s history
Regularising Delhi’s unauthorized colonies, Centre for Policy Research, Banda, & Sheikh, 2014	Actions by the GNCTD regarding regularisation of UACs

Documents selected	Analysis
Regularising Unauthorised colonies in Delhi: Well intended but not enough, India Housing Report Nagpal, Singh & Sharma, 2021	To understand regularization efforts undertaken under “PM – UDAY” scheme
Urban Policy Failure in Delhi: A Case of Unauthorised Colonies: Urban India, Vol 39 (II) July-December 2019	To understand the political impediments, and institutions involved in the regulation of UACs

1. Major regularisation waves in history of Delhi: In Delhi’s history, three main waves of “regularisation” have occurred. As part of the initial Master Plan, 102 colonies were regularised in the first wave in 1962. The second wave occurred in 1975, when 567 unauthorised colonies were regularised. In 2009, about a decade and a half after applying for regularisation, 733 of these colonies were regularised as part of the third major wave of regularisation . The Government of Delhi invited applications from RWAs of UACs in 2004 to submit the layout of the colonies and sought for regularisation. Following that, in 2008, before the assembly elections, 1,218 UACs were awarded ‘Provisional Regularisation Certificates (PRC),’ and 895 were regularised. It was later assumed that this was done for political purposes. PRCs appear to have had little or no impact on full regularisation or service supply (Bhan, 2013).

2. PM-UDAY and regularisation of UACs in Delhi : The political parties in Delhi have made the regularisation of UACs an electoral issue every time. The Union government announced the PM-UDAY (Prime Minister - Unauthorized Colonies in Delhi Awas Adhikar Yojana) initiative, which would grant property ownership or transfer/mortgage rights to inhabitants of illegal colonies in Delhi through the Delhi Development Authority (DDA). The scheme’s debut and implementation coincided with the run-up to the 2020 Delhi state elections. Around 4,37,255 PM-UDAY registrations were made on the platform till October 2021, with 87,275 applications submitted. Thirty applications were disposed of out of 717. However, there is no information as to what happened to the rest of the registrations.

The residents of UACs were cajoled with the prospect of regularisation, which coincided with elections almost every time. The regularisation programme PM-UDAY initiative took centre stage in the run-up to the Delhi state elections in February 2020. Despite the desirable option to secure full ownership rights, evidence shows a lacklustre reaction. Notwithstanding its good intentions, the PM-UDAY initiative has fallen short of combining strategies and directives for basic infrastructure services. These needs were non-negotiable, particularly in the event of a global health pandemic. To ensure the efficient absorption of UACs into

urban development mainstreaming, the PM-UDAY must be coordinated with the impending Delhi Master Plan 2041 (Nagpal, Singh and Sharma, 2021).

3. **Extent of proliferation in Sangam Vihar :** To get a sense of the complexity of the task at hand, the authors have attempted to superimpose the image of Lodhi Garden, a 90-acre posh urban park in Delhi, over satellite imagery of Sangam Vihar, one of India's largest unauthorised colonies. Sangam Vihar can hold a total of 12 Lodhi Gardens, demonstrating the immense scale of the unauthorised community. The image effectively captures the spatial inequities faced by residents of unauthorised colonies, residing in high-density urban clusters with inadequate urban infrastructure (Ajith & Kataria, 2022).

The uncertainty around regularisation remains, despite delimitation in 2008 that defined the current constituency boundaries, as shown in Figure 4. The current boundaries of the Sangam Vihar constituency were established in 2008 as part of the execution of the recommendations of the Delimitation Commission of India, which was established in 2002. The residents are sceptical of the regularisation's fate, and most fear that it will be a damp squib, like the provisional regularisation certificates provided to colonies prior to the 2008 assembly elections.

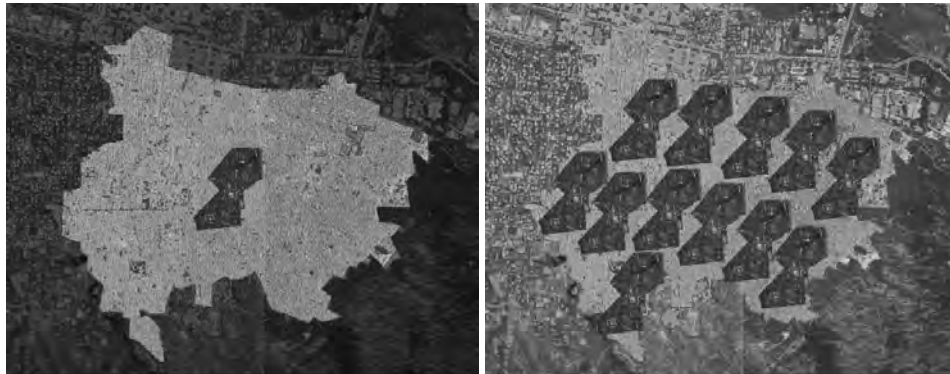


Figure 4: Extent of Proliferation in Sangam Vihar

Source: Ajith and Kumar, 2022, *The Quint*

4. **Politicisation of regulation of UACs in Delhi elections:** The sporadic nature of policy announcements and changes has been a special feature of the problem of UACs in Delhi, and this can be attributed to the political aspects of the matter—as election dates approach, work in this context accelerates and then slows down due to multiple institutional constraints.

As shown in Table 3, apart from the political impediments, another impediment in improving the conditions of UACs in Delhi, is the multiplicity of institutions involved in the regulation of these housing units such as Local body, GNCTD¹, and DDA² (Prabhakar, Agarwal, & Rangan 2019).

Table 3 : Political Angle of Policy Formulation for UACs

1976: Introduction of first policy of regularisation	6th Lok Sabha elections in 1977
2004: Ministry of Urban Development, and Government of India issued guidelines for regularisation of UACs	14th Lok Sabha elections during April-May, 2004
2008: Regulations for regularisation introduced in 2008	15th Lok Sabha elections in 2009

Source: Prabhakar, Agarwal, & Rangan, 2019, *Urban India*

- 5. Actions by the GNCTD regarding regularisation of UACs:** Table 3 summarises the actions taken by the GNCTD regarding the regularisation of UACs. This was a sequence of processes that included revising the official land records and retracting the notification of purchase. No sincere regularisation drive has taken place since 1993 (Banda, & Sheikh, 2014).

The data presented in Table 4 outlines the major milestones in the Government of National Capital Territory of Delhi's (GNCTD) efforts to regularise unauthorised colonies. These efforts span from the early waves of regularisation in 1962 and 1975 to more structured processes in 2007, 2008–09, and 2012.

Table 4: Actions by the GNCTD regarding regularisation of UACs

First wave of regularisation: 1962	102 colonies were regularised
Second wave of regularisation: 1975	567 unauthorised colonies were regularised
2007	1639 UACs applied for regularisation
Third wave of regularisation: 2008-2009	1218 UACs received PRCs
2012	895 UACs found “eligible for regularisation” 312 UACs which were on private land stood regularised with effect from September, 2012 583 UACs partly or fully on public land were supposed to be regularised from the date of recovery of cost of public land.

Source: Banda & Sheikh, 2014, Centre for Policy Research

Narrative Analysis

A hybrid approach of inductive and deductive coding ensured both grounded theory emergence and thematic validation (Fereday & Muir-Cochrane, 2006). The analysis produced the following themes on causes for living in UACs

- (i) **Migration for livelihood :** According to the majority of the responses, the primary reason for persons living in UACs to migrate to Delhi and purchase a plot in an unauthorised colony was to earn a livelihood.

“I moved from Uttar Pradesh in 1996 to earn my living because I didn’t have any source of income in my own state,” said one of the residents during an informal discussion.

- (ii) **Affordability:** All of the participants agreed that they acquired plots in UACs because these were affordable and they got value for money based on their income.

“I acquired this land in 2008 using a Power of Attorney from a property agent that did not contain a full registration, and this is why our colonies were deprived of basic municipal services. I chose this plot since it was easily accessible, affordable, and the process for obtaining these plots was simple.”, said another resident.

- (iii) **Better educational facilities:** A vast majority of the respondents stated that social constraints, and poor educational and career possibilities were also major drivers of migration to and settlement in UACs;.

- (iv) **Property owner, politicians and bureaucracy nexus:** The involvement and vested interests of property owners/brokers, politicians, and bureaucrats were mentioned as the most common reasons why residents of Sangam Vihar did not choose DDA flats. A corrupt system also marred the process of obtaining a DDA flat.

“The broker would seek the same amount to book a DDA unit as I paid to buy a house in the colony. After the broker’s booking, the purchase price was to be paid to the owner separately. I paid 10,000 rupees per square yard for the flat that I acquired in the colony. I am satisfied with the price because it was reasonable for the time when I acquired the land in the year 2000,” said a buyer.

The analysis produced the following themes on deprivations faced by residents

- (i) **Physical and Social infrastructure:** Some of the respondents expressed that there were plots with no setbacks, plots that touched the walls on three sides of different plots, no provision for ventilation or fresh air, different typologies coexisting, room sizes that were extremely small, and basements that were sometimes used for industrial activities.

“The establishment of unauthorised colonies is completely flawed. Electricity is putting a significant pressure on the physical infrastructure, with an increase in electric meter connections leading to an increase in transformer demand. Because there are no building height constraints, builders have built towers up to G+4 storeys without getting permission or following any structure-related regulations.

There were only a few government primary and secondary schools. A few government-run dispensaries in addition to private clinics were operational.

- (ii) **Water Supply & Electricity:** Lack of Delhi Jal Board water supply was another challenge that these residents had to deal with. Most of these residents purchase water from tankers or rely on their own personal water pumps. Almost 45 per cent of the houses surveyed claimed to have their own privately installed pumps, although more than 55 per cent acknowledged at least occasionally purchasing water from tankers at higher prices. Residents were reliant on BSES/DESU for electricity. Electricity was often carried via dangerously exposed, barbed wires, which made these colonies even more vulnerable to mishappenings.
- (iii) **Drainage and Public utility:** The respondents stated that while municipal water services and public borewells were available, drainage facilities were limited. There were sewage lines that were not closed. The blockage of rain water throughout the wet season exacerbated the problem. The majority of the respondents who were interviewed for the study were living in very difficult circumstances in their leased homes. The rooms in their accommodations were very small, and the majority of them lacked a kitchen and bathroom. Since there were no municipally anchored sewage lines, the sanitation conditions were pitiful in these colonies. People were using the open fields as toilets because most of the dwellings lacked toilet facilities. The administration did not provide a facility to clean up or collect trash from the neighbourhoods. Due to the absence of facilities, these areas became a landfill.
- (iv) **Property Ownership rights:** Another issue that bothered the residents of the colonies was the question of property ownership. Residents were unable to borrow against their property.
- (v) **Increased crime and conflicts:** The regular conflicts and crime rates in the colonies, as well as the use of abusive language, had made life more difficult for families and children. Due to increased unemployment, people continued to roam indiscriminately in the colonies, causing havoc. These colonies struggle to survive as a result of their primary concern for the protection of women and children from local goons.
- “After sunset, it becomes really difficult to go with children and families because there are numerous groups that just start a fight without any reason and will use offensive language,”* residents were quoted as saying.
- (vi) **Maladministration:** Residents cited further issues against the administration, claiming that the administration would unduly seize the roadways. Because the roads were already quite narrow and traffic congestion was regular, the unnecessary seizure of roads by the police administration had worsened the problem.

Summary of Findings

a. Demographics

The majority of the female respondents had a degree equivalent to class X, and among males, few held a degree equivalent to class X, and a few others held a degree

corresponding to class XII. Only a very few people had passed out of class XII. Numerous incidences of dropouts were seen in both male and female groups of respondents, with later compelled to concentrate on household responsibilities and males to earn a living for the family. Despite their lack of formal education, both groups of males and females possessed the particular set of skills necessary for the jobs.

The majority of people in these colonies were self-employed, working as shop owners, plumbers, carpenters, cooks, cleaners, florists, and so on, while a few others worked as service professionals such as clerks, office assistants, school teachers, mechanics, hair stylists, nurses, bankers, and so on.

Almost over 20 per cent of the population was jobless, whereas 10 per cent were students.

b. Deprivation faced

The residents of Sangam Vihar UAC experienced the following municipal deficiencies:

- (i) The absence of social infrastructure including public parks, community centres, schools, and clinics;
- (ii) There were no standards for how many floors a structure should have or how to construct it so that it is disaster-ready or meets the building standards;
- (iii) The government did provide electricity across the entire settlement, but it did not conforming to standards. The bulk of these people rely on their own personal water pumps or tanker deliveries of water; and
- (iv) The safety of women and children from local goons was a major concern of these communities.

c. Efforts made by the regulatory bodies

In response to the increasing number of unauthorised colony structures, the government has consistently implemented laws to regularise them and provide basic amenities to colony inhabitants. From 1977 through 1993, the government was periodically involved in the process of regularising these colonies. In 2008, shortly before the elections, a list of 1218 colonies were awarded “Provisional Regularisation Certificates”. It was later stated in 2012 that 895 of the aforementioned colonies were determined to be “suitable for regularisation” but not actually regularised. Furthermore, this was a sequence of processes that included revising the official land records and retracting the notification of purchase. Even now, this process is not complete. Recent news reports indicate partial progress with over 10,000 ownership rights granted under PM-UDAY in 2021 (*Hindustan Times*, 2021). The process of regularising colonies like Sangam Vihar has often been stalled, and final approvals from central authorities are still awaited. (Ghosh, 2021). As a result, no sincere regularisation drive has taken place since 2008.

Moreover, there appears to be a lack of understanding, capacity, and desire in dealing with stakeholders. Despite their best intentions, policymakers appear to have

forgotten about the bulk of UACs, which are frequently low-income settlements populated by individuals with poor education and technological skills. Apart from the application price, the fact that applications may only be made online on an English-only portal, rather than a bilingual form, effectively eliminates many locals from participating. Furthermore, while the majority of inhabitants have mobile phones, mandatory procedures such as creating or providing an email account complicate matters. Typical issues include insufficient and defective property documents, as well as many claims for the same property. Acknowledging the heterogeneity of UACs necessitates engagement with various stakeholders who play active roles in this settlement. Categorisation of settlements remains a fundamental step in designing targeted policy responses (Mukhopadhyay et al., 2015). The Delhi Master Plan 2041 offers a partial solution for UACs but lacks actionable frameworks for immediate relief (Matam, 2021).

d. Causes for residing in UACs

Following were the main grounds given by the inhabitants for residing in these colonies:

1. Affordability and availability of cheap housing was the major reason for people to buy or rent homes in UACs
2. The tedious process of acquiring DDA flats, coupled with corruption in DDA flat delivery was another reason pushing people to buy homes in UACs.
3. As most of the people living in UACs were working as factory workers hence they had a locational advantage.
4. Civic amenities were also scarce in authorised plots and they cost more than the plots in UACs with almost the same civic amenities.

Discussion

One key factor for the proliferation of unplanned settlements in Delhi was the city's exponential population growth since Independence. People continued to move to Delhi since the city served as a hub for all economic, educational, and job possibilities for individuals from all across the country. This puts further strain on an already limited resource: land, which was later fragmented and improperly subdivided further down the line. Nevertheless, most people in Delhi chose to settle and add to the city's population.

The study's findings were consistent with Dupont's assertion that since Delhi's urban density increased from 7,225 pp km in 1961 to 14,667 pp km in 2011 owing to new migrants, the city's planned growth has fallen well short of its objectives. Dupont, V. (2008) This produced a massive unmet need for housing, which these colonies addressed as a low-cost choice. The same was echoed in the survey responses, when respondents cited affordability and quick availability as reasons for choosing UACs. According to Bakan and Linden, the establishment of unauthorised colonies in a city was a response to the lack of affordable formal housing. (Bankan & Linden, 1992-97).

The study's findings were consistent with Shahana Sheikh's contention that the inability of the government to provide appropriate, affordable housing to the residents of Delhi on time was the single most critical factor for the emergence of unauthorised colonies. The single developer of affordable public housing in Delhi, the Delhi Development Authority, has continuously fallen short of the ever-increasing demand, driving the working class to seek alternatives unlawfully. Furthermore, as highlighted by Kritika Narula in her working paper has opined that the plot sizes and quality of services offered in DDA-developed apartments in Delhi have fallen well short of people's expectations coupled with political patronage which has further worsened the problem (Narula, 2009). This was one of the primary reasons why medium and lower income people have decided to invest in structurally solid and liveable houses in unauthorised colonies at the same prices.

The most common motivations for migrating were for better educational possibilities, career prospects, marriage, and new markets (Ganju, 2012). This combined with the city's rising urbanisation and massive expenditures in infrastructure and ongoing works, attracted a large number of employees to Delhi. The same arguments were represented in the study, when respondents stated numerous reasons for their migration, such as earning a living, discrimination based on caste, better education, and expanding markets, among others.

Undoubtedly these housing structures provide inexpensive accommodation to the migrant population of Delhi NCR, but we must also remember that these housing structures are not a feasible option for the city's long-term growth. These colonies are disaster-prone due to a lack of different municipal facilities and structural faults. The Supreme Court of India has also stated that the proliferation of unlawful colonies across the country is a threat to urban development.

Another concern is the scarcity of job prospects in both rural, and semi-urban areas. The more we can expand industry in these areas, the less people will go to cities. Until the courts decide to investigate these two concerns, we may continue to compile a list of illegal colonies, accuse the mafia, politicians, and everyone else under the sun, and the situation will worsen.

Politicians and the land mafia have long fostered illegal settlements, resulting in Delhi becoming a city of slums, illegal colonies, and ghettos. In order to secure their support, the Delhi administration has formally regularised several 'illegal' colonies in various sections of the city. These challenges in Delhi reflect a broader tension between urban informality and formal planning. The persistence of unauthorised colonies like Sangam Vihar highlights the failure of urban governance to provide affordable housing and basic infrastructure (Ahluwalia et al., 2014; Bardhan, 2009). Despite initiatives like PM-UDAY, political expediency often overrides sustainable planning (Nagpal, 2021; Matam, 2021). These settlements remain excluded from Smart City benefits and SDG 11 targets, deepening inequality (Abdel-Razek, 2021; Doyle & Stiglitz, 2014; Manoj Kumar et al., 2018). Addressing this requires integrated governance and

participatory urban redevelopment (Meuleman, 2021; Jain & Rohracher, 2022). As Giuliodori et al. (2023) argue, achieving sustainable and inclusive development requires harmonising smart governance and long-term policy planning, in line with SDG 11. Smart governance is essential to aligning unauthorised colonies with sustainable urban frameworks, especially under the context of SDG 11, which calls for inclusive and safe cities (Abdel-Razek, 2021).

Suggestions

- (i) The function of the DDA as the exclusive authority for land planning and development in Delhi has to be discussed and explored in order to build a new institutional structure, since the DDA has failed miserably in meeting the demands of the city's growing population. Jain and Rohracher (2022) emphasise that true infrastructure transformation depends on assessing local governance capacity and inclusive redevelopment planning. As a result, the supply side of the land equation must be enhanced by enabling private developers to engage in the land market, which had hitherto been solely DDA's domain. As a result, the DDA's function should eventually be reduced to planning and monitoring, and it should serve as a facilitator rather than being the only executor of land development. While Babić et al., (2022) argue that smaller cities face compounded governance challenges due to scale, the case of Delhi demonstrates that even large metropolises struggle to coordinate among multiple planning bodies, highlighting the universal difficulty of effective urban governance.
- (ii) There is a need for a framework under which civic amenities and basic municipal services could be provided to these colonies in order to ensure the required standards of sanitation, public health, and safety in these areas, as there are more than 1208471 people residing in Sangam Vihar UAC and many others in various other UACs in Delhi.
- (iii) As it has been plainly evident that the current regulations have been excessively lax in this regard, it is proposed that the existing political patronage and nexus of politicians and builders be dismantled to make the DDA plots allocation less cumbersome and more prompt. Any laxity or corruption by law enforcement authorities should be investigated thoroughly. Moreover, cases involving illicit property transactions, other land-related conflicts, should be resolved rapidly by creating Fast Track courts for land matters. This will also aid in the establishment of a rule-of-law ethos in Delhi. As urban spaces continue to expand, ensuring sustainable governance is critical, a challenge also identified by Bibri (2021) in the context of managing urban growth within the Sustainable Development Goals framework

Conclusion

In conclusion, this study offers a nuanced examination of the causes and challenges faced by people residing in unauthorised colonies in Delhi. The narrative analysis has

unveiled a multifaceted picture, emphasising migration for livelihood, affordability, and the intricate nexus involving property owners, politicians, and bureaucracy as primary reasons for choosing these settlements. The deprivations faced by residents, ranging from inadequate physical and social infrastructure to issues with water supply, electricity, and property ownership rights, underscore the urgent need for comprehensive interventions. While regulatory efforts have been made, the study reveals persistent challenges and a digital divide in the regularisation process. The broader context of Delhi's urban development crisis, characterised by exponential population growth and inadequate planned growth, reinforces the urgency of re-evaluating existing policies and engaging with the root causes of illegal settlements. The suggestions outlined, including a redefined role for the Delhi Development Authority, private sector involvement, and the establishment of a framework for civic amenities, aim to guide policymakers in formulating effective strategies to address the complex issues associated with unauthorised colonies, promoting sustainable and inclusive urban development in the national capital. India's urban revolution under SDG 11 calls for the urgent inclusion of informal colonies into mainstream planning frameworks (Muttana & Singam, 2023). As Mallick et al., (2023) recommend, urban resilience frameworks like the Pressure and Release (PAR) approach should be adapted to Indian cities to anticipate and address future infrastructural vulnerabilities. Integrating governance into SDG strategies must be a priority for urban areas to promote sustainable and equitable development (Biermann et al., 2014).

References

- Abdel-Razek, S. A. (2021). Governance and SDGs in smart cities context. In *Smart Cities and the UN SDGs* (pp. 61-70). Elsevier.
- Ahluwalia, I. J., Kanbur, R., & Mohanty, P. K. (Eds.). (2014). *Urbanisation in India: Challenges, opportunities and the way forward*.
- Ajith, A., & Kataria, R. (2022). Delhi's Unauthorised Colonies: An Issue Only for the Election Season? *The Quint*. <https://www.thequint.com/author/1640884/aditya-ajith-and-ritu-kataria>
- Babić, A., Sokolić, D., & Antonić, J. J. (2022). Development of smart governance in Croatian cities - the size of a city as a determinant of smart governance. *Ekonomski vjesnik/Econviews - Review of Contemporary Business, Entrepreneurship and Economic Issues*.
- Bakan, R.-J., & van der Linden, J. (1992). *Land Delivery for Low Income Groups in Third World Cities*. Aldershot: Avebury.
- Banda, S., & Sheikh, S. (2014). Regularizing Unauthorized Colonies in Delhi: The Thin Line between Legitimate and Illegal.
- Bardhan, P. (2009). India and China: Governance issues and development. *The Journal of Asian Studies*, 68(2), 347-357.
- Bhan, G. (2013). Planned illegalities: housing and the 'failure' of planning in Delhi: 1947-2010. *Economic and Political Weekly*, 58-70.

- Bibri, S. E. (2021). Data-driven smart sustainable cities of the future: an evidence synthesis approach to a comprehensive state-of-the-art literature review. *Sustainable Futures*. <https://doi.org/10.1016/j.sftr.2021.100047>
- Biermann, F., Stevens, C., Bernstein, S., Gupta, A., & Kabiri, N. (2014). Integrating governance into the sustainable development goals (No. 3). UNU-IAS.
- Dupont, V. (2008). Slum Demolitions in Delhi since the 1990s: An Appraisal. *Economic and Political Weekly*, 43(49), 75-81. Retrieved from <https://www.epw.in/journal/2008/49/special-articles/slum-demolitions-delhi-1990s-appraisal.html>
- Doyle, M., & Stiglitz, J. (2014). Eliminating Extreme Inequality: A Sustainable Development Goal, 2015–2030. *Ethics & International Affairs*, 28, 5-13. <https://doi.org/10.1017/S0892679414000021>
- Eisner, E. W. (1991). *The enlightened eye: Qualitative inquiry and the enhancement of educational practice*. Toronto: Collier Macmillan Canada.
- Fereday, J., & Muir-Cochrane, E. (2006). Demonstrating rigor using thematic analysis: A hybrid approach of inductive and deductive coding and theme development. *International Journal of Qualitative Methods*, 5(1).
- Gandhi, S. (2012). Economics of affordable housing in Indian cities: The case of Mumbai. *Environment and Urbanization Asia*, 3(1), 221-235.
- Ganju, M. A. (1998). Note on Village Planning and Architecture by MN Ashish Ganju. Available at: <https://oa.mg/work/2883623740>
- Ghosh, S. (2021). Regularisation of illegal colonies awaits Centre's nod. *The Hindu*. <https://journal.ijramt.com/index.php/ijramt/article/view/2506>
- Giuliodori, A., Berrone, P., & Ricart, J. E. (2023). Where smart meets sustainability: the role of smart governance in achieving the sustainable development goals in cities. *Brq Business Research Quarterly*, 27–44. <https://doi.org/10.1177/23409444221091281>
- Han, Y., Song, Y., Burnette, L., & Lammers, D. (2017). Spatiotemporal Analysis of the Formation of Informal Settlements in a Metropolitan Fringe: Seoul (1950–2015). *Sustainability*, 9, 1190. <https://doi.org/10.3390/su9071190>
- Jain, M., & Rohrer, H. (2022). Assessing transformative change of infrastructures in urban area redevelopments. *Cities*. <https://doi.org/10.1016/j.cities.2022.103573>
- Kataria, A. A., & R. (2022). Delhi's unauthorized colonies: An issue only for the election season? *The Quint*.
- Mallick, S. K., Das, P., Maity, B., Rudra, S., Pramanik, M., Pradhan, B., & Sahana, M. (2023). Understanding future urban growth, urban resilience, and sustainable development of small cities using the prediction-adaptation-resilience (PAR) approach. *Sustainable Cities and Society*. <https://doi.org/10.1016/j.scs.2021.103196>
- Matam, A. (2021). Delhi master plan 2041: A half-step forward for unauthorized colonies – but more is needed. *Scroll.in*.
- Meuleman, L. (2021). Public Administration and Governance for the SDGs: Navigating between Change and Stability. *Sustainability*, 13, 5914. <https://doi.org/10.3390/su13115914>
- Mukhopadhyay, P., et al. (2015). Categorisation of settlement in Delhi, Centre for Policy Research. Available at: <https://cprindia.org/people/subhadra-banda/>

- Muttana, R. R., & Singam, S. M. (2023). India in the Urban Revolution through the lens of sustainable development goal 11, *International Journal of Recent Advances in Multidisciplinary Topics*.
- Nagpal, S. (2021). Regularising Unauthorised Colonies in Delhi: Well-Intended but Not Enough. *India Housing Report*. Available at: <https://indiahousingreport.in/author/sukrit-nagpal/>
- Narula, K. (2009). Analysis of the Housing Delivery Mechanism & DDA's Role in It. *Centre for Civil Society*. Retrieved from <https://www.readkong.com/page/analysis-of-the-housing-delivery-mechanism-dda-s-role-in-6476389>
- Ownership rights for over 10,000 residents of unauthorized colonies in Delhi (2021). *Hindustan Times*.
- Prabhakar, P., Agarwal, A., & Rangan, D. (2019). Urban policy failure in Delhi: A case of unauthorized colonies. *Urban India*, 39(2), 1–15.
- Shukla, A. (2016). Unauthorised colonies in South Delhi: Causes, impact and way forward Dissertation, Lal Bahadur Shastri National Academy of Administration (LBSNAA), Mussoorie.

Endnotes

1. The Government of Delhi, officially the Government of the National Capital Territory of Delhi (GNCTD) is the governing body of the Union Territory of Delhi.
2. The Delhi Development Authority (DDA) was created in 1957 under the provisions of the Delhi Development Act “to promote and secure the development of Delhi”. The DDA is responsible for planning, development and construction of Housing Projects, Commercial Lands, Land Management, Land Disposal, Land Pooling, Land Costing etc.

Spatial Organisation and Economic Impact of Manufacturing Sectors in Ludhiana: A Cluster Analysis

Nagarlok
ISSN-0027-7584
56(4), 509-525
October-December, 2024
@ 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.9>

Mostafizur Rahman^{*} and Sandeep Dua^{}**

Abstract

Ludhiana, a key industrial hub in India, boasts diverse and thriving manufacturing sectors. Understanding the spatial organisation of these sectors is crucial for optimising industrial planning and boosting economic growth. The authors have used locational quotient analysis and cluster analysis, based on registration data from Udyam Aadhar portal of Government of India including interviews with local stakeholders. The authors found that micro and small manufacturing enterprises dominate in Ludhiana both in terms of number of units and number of employees. Hosiery-knitwear manufacturing, bicycle parts manufacturing, and metal fastener manufacturing are prominent sectors in Ludhiana. The spatial concentration of hosiery and knitwear manufacturing is towards the northeast of Ludhiana, while bicycle parts and metal fastener manufacturing is concentrated in the southeastern part of the city. The backward linkages of all these sectors are stronger than their forward linkages, with most backward linkages located within the clusters. The hosiery and knitwear manufacturing sector has the highest number of shared infrastructures. These findings highlight the importance of localised industrial clusters in Ludhiana's economic landscape and underscore the need for targeted policies to support these critical sectors.

Keywords

Industrial clusters, Spatial organisation, Manufacturing sector, Ludhiana.

Introduction

According to the National Sample Survey (NSS) 73rd round conducted during 2015-16, India had a total of 633.88 lakh Micro, Small, and Medium Enterprises (MSMEs). Data

^{**} Sandeep Dua, Professor, Department of Architecture, Guru Nanak Dev University, Amritsar, India.
Email: duasandeep18@rediffmail.com

Corresponding author:

^{*} Mostafizur Rahman, Research Scholar, Department of Architecture, Guru Nanak Dev University, Amritsar.
Email: mostafizurs@gmail.com

from the Ministry of Micro, Small, and Medium Enterprises, Government of India, reveals that the manufacturing sector constituted 31 per cent of these enterprises and contributed to 32 per cent of overall employment generation, providing jobs to 360.41 lakh individuals. Notably, majority of MSMEs are Micro and Small-scale Enterprises (MSEs) and are predominantly proprietary in nature. Undoubtedly, the MSME sector is integral to India's economic growth and employment generation.

MSEs (Micro and Small Enterprises) often exist in clusters to foster a conducive environment for their development, innovation, and competitiveness. These clusters facilitate growth by enabling shared resources, exchanging knowledge, and providing easier access to markets. (Vicente 2018). Recognising this, policymakers and stakeholders are increasingly focused on assessing spatial organisation of micro and small-scale manufacturing enterprise clusters.

According to the 3rd Small Scale Industries (SSI) Census of India there were 1,223 registered SSI clusters producing 321 products and 819 unregistered SSI clusters covering 250 products across the country (Hashim, 2010). One such major cluster in North India is located in Ludhiana. Nicknamed as "The Manchester of India" for its textile and garment production, Ludhiana is an industrial hub in northern India. The city contributes 48.8 per cent of the microenterprises in the Punjab state and attracts labour from various parts of Northern India, particularly Bihar, Madhya Pradesh, Rajasthan, and Uttar Pradesh (Mehra, 2017). The focal point of industrial activities in Ludhiana predominantly resides in the eastern sector, largely due to the Amritsar-Ambala railway line, which poses a significant physical demarcation (Tewari, 1998). However, despite Ludhiana's prominence as a manufacturing hub for micro and small enterprises, there is a notable gap in empirical research concerning the identification of dominant manufacturing sectors, their spatial organisation, and their linkages with ancillary activities.

Literature Review

Industrial Clusters

The spatial concentration of people and economic activities was initially elucidated by Alfred Marshall in his work "*Principles of Economics*" in 1890 (Marshall, 2013). Marshall employed the concept of economies of scale to explicate the clustering of economic activities and defined the industrial district as a region where numerous specialised branches of industry are seamlessly integrated into an organic whole (Marshall, 1919). Michael E. Porter defines industrial clusters as geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in the related industries, and associated institutions in a particular field that not only compete but also cooperate (Porter, 1990). Becattini's definition of industrial cluster arguably comes closer to delineating an organically developed cluster, stating that for an industrial district to thrive, a population of small firms must merge with local residents possessing social and cultural characteristics conducive to a bottom-up

industrialisation process (Becattini, Bellandi & De Propis L 2009). As outlined by these scholars, some common attributes of industrial clusters that define spatial organisation are, geographic concentration, networks and interconnectedness, supporting institutions and infrastructures.

Regional and Local Concentration of Industries

Many researchers explained that regional concentration of industry can be used to identify industrial cluster growth. This is measured by the location quotient (LQ) which describes the industrial growth in a particular region (Carroll, Reid & Smith 2008; Billings & Johnson 2012; Morrissey 2016; Ergen 2018; Niyimbanira, Eggink & Nishimwe-Niyimbanira 2020; Pominova, Gabe & Crawley 2021). Locational quotient analysis can be done using number of units (establishments) or number of employees generated. The establishment based method of analysis provides insights into the physical presence and distribution of industries, reflecting the diversity of economic activities within the region (Billings & Johnson, 2012).

The LQ (Location Quotient) value represents the ratio of an industry's activity proportion in a region of interest to its proportion in a reference region. An $LQ > 1$ indicates a higher industry concentration, suggesting specialisation or comparative advantage. An $LQ < 1$ suggests a lower concentration, indicating potential areas for diversification or investment. An $LQ = 1$ indicates similar industry concentration in both regions. (Niyimbanira et al., 2020).

Local concentration of manufacturing within a city can be identified through the mapping of units and determining hotspots of different types of industries. The units of analysis can be wards or zones. The number of industrial units or employees within a ward can vary significantly from one ward to another.

Backward and Forward Linkages

Research by Hefner and Guimaraes examines the significance of backward and forward linkages in manufacturing location decisions. Their study reveals that both types of linkages play a significant role, with backward linkages showing greater statistical significance and exerting a larger impact on the probability of locating within a specific region (Hefner & Guimaraes, 1994).

By mapping the locations of primary industries, suppliers, and downstream activities, researchers can identify spatial patterns, hotspots, and potential areas of concentration within a cluster. This analysis enables policymakers and stakeholders to discern spatial dependencies, accessibility issues, and opportunities for spatial optimisation and infrastructure development.

Recent Studies on Industrial Clusters of Ludhiana

Recent literature about industrial activities in Ludhiana reveals a multifaceted impact on firm performance, influenced by various drivers including the micro-foundations

of clustering and their interconnectedness (Kamaldeep, Shergill & Mehta, 2021). Gupta and Saini (2019) observed that garment production units in Ludhiana and Tirupur primarily operate as small and medium enterprises (SMEs), often relying on informal labour networks and exhibiting limited technological integration. Ray and Miglani (2022) found evidence of certain clusters that enhance inter-firm division of labour, competitiveness, and global market penetration. Ray and Sharma (2022) proposed a policy framework grounded in cluster economics to leverage CSR funds for impactful sustainability projects (Ray & Sharma, 2022). Kumar and Randhawa (2020) noted Ludhiana's core as the primary economic growth pole, yet facing challenges of inadequate infrastructure amidst urbanisation. Rahman (2022) highlighted the presence of ancillary workers in industrial areas, underscoring the need for planned regularisation to mitigate the growth constraints of low-cost services. Kaur et al., (2021) emphasised the urgent need to address pollution in *Buddha Nullah*, Ludhiana, highlighting its degradation.

Research Gap

While theoretical literature extensively discusses the spatial organisation of the industrial clusters, focusing on factors like geographic concentration, networks and interconnectedness, supporting institutions and infrastructures. empirical research on the spatial organisation of manufacturing sector in Ludhiana remains lacking. Hence, this study aims to identify the significant manufacturing activities prevalent in the Punjab region of India, specifically focusing on Ludhiana city. It seeks to ascertain their concentration, identify common institutions and infrastructure, and analyse their specialisation, and interconnections with ancillary activities.

Methodology

The methodology employed in this study involved a multi-step approach to analyse the geographic concentration and industrial linkages within Ludhiana's manufacturing sector. The research began with a Locational Quotient (LQ) analysis using data from the 2023 Udyam Aadhar registration portal, with Punjab serving as the reference region. This analysis aimed to identify the primary industries in Ludhiana, revealing sectors that were highly concentrated in the city with $LQ > 1$. Following the LQ analysis, a ward-wise spatial analysis was conducted by mapping the location data of these manufacturing units across Ludhiana's 95 wards. This mapping allowed for the identification of specific hotspots within the city, highlighting concentration patterns of prominent manufacturing sectors. This spatial analysis provided a visual representation of the industrial landscape in Ludhiana, illustrating the areas with significant industrial activity.

To further understand the industrial ecosystem, the study examined the network of backward and forward linkages within the identified manufacturing sectors. This analysis involved identifying and mapping key ancillary activities, such as raw

material suppliers, transporters, and retailers. The strength and spatial distribution of these linkages were visually represented to illustrate the interconnectedness of manufacturing activities across different wards, emphasizing the role of these linkages in supporting the primary manufacturing sectors.

In addition to the spatial and linkage analysis, the study sought to understand the availability and effectiveness of common industrial infrastructure through a series of stakeholder interviews. These interviews were conducted with key industry representatives and local manufacturers from the three identified sectors. Specifically, the study included interviews with two members each from the Knitwear and Apparel Manufacturing Association, Ludhiana, representatives from the Bahadur ke Textile Knitwear Manufacturers Association, the United Cycle and Parts Manufacturers Association, Ludhiana, and the Fasteners Manufacturers Association of India. The interviews also encompassed discussions with 11 knitwear and hosiery manufacturers, eight bicycle parts manufacturers, and eight metal fastener manufacturers, as well as four workers from each of these sectors.

These stakeholders provided valuable insights into the types of ancillary activities associated with particular manufacturing sectors and their locations. Stakeholders' interviews also revealed about availability and adequacy of common industrial infrastructure, including fire stations, electric substations, common effluent treatment plants, transport hubs, training institutions, and dispensaries. A semi-structured interview format was used to allow for the collection of both quantitative data, such as the number of institutions and infrastructure facilities, and qualitative insights regarding operational challenges and the effectiveness of these facilities.

To ensure the accuracy and reliability of the data collected through the interviews, a validation process was undertaken by cross-referencing the information with secondary sources, including Google Maps and government websites.

Study Area: Ludhiana

Ludhiana, the largest city in Punjab in terms of both area and population, is located within Ludhiana district (Figure 1). Strategically positioned, it is the most centrally located of the 20 districts in the state. Belonging to the Malwa region of Punjab, Ludhiana is located between north latitude 30°34' and 31°01' and east longitude 75°18' and 76°20'. It is strategically situated along the Amritsar-Delhi G.T. Road (NH-1) and the Amritsar-Ambala railway line, serving as vital transportation arteries within the state.

Situated on a ridge of *Buddha Nullah*, which once served as a riverbed of the River Satluj, Ludhiana's urban expanse was historically confined to the south of *Buddha Nullah*. Covering an area of 159.37 sq.km, Ludhiana Municipal Corporation is divided into 95 wards. According to data from worldpopulationreview.com, as of the projected figures for 2024, Ludhiana's population was estimated to reach 1,988,438 individuals,

with males comprising 54 per cent and females 46 per cent of the population. These statistics are derived from the latest revision of the UN World Urbanisation Prospects. Other than this, the labour participation in hosiery and knitwear manufacturing is 44 per cent from Uttar Pradesh, 42 per cent from Bihar, 12 per cent from Himachal Pradesh. In the cycle parts cluster, the labour participation is 69 per cent from Uttar Pradesh, 18 per cent from Bihar and 12 per cent from Himachal Pradesh (Mehra & Singh, 2013).

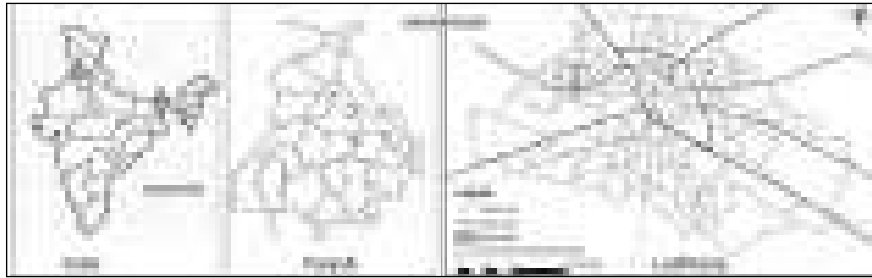


Figure 1: Location of Ludhiana

Source: Base Map: ESRI Online GIS Data; Map prepared by the authors.

The industrial concentration in Ludhiana is predominantly located in the eastern part of the city, as outlined in the 2031 Master Plan (Fig. 2). To accommodate manufacturing activities, the Master Plan designates two distinct categories of land use: mixed-use and industrial. The areas with a mixed land-use character are further divided into two specific categories: commercial mix and industrial mix. The industrial mix category is intended for areas where industrial activities may coexist with residential development. Currently, the majority of manufacturing units are situated within the industrial and industrial mixed-use zones.

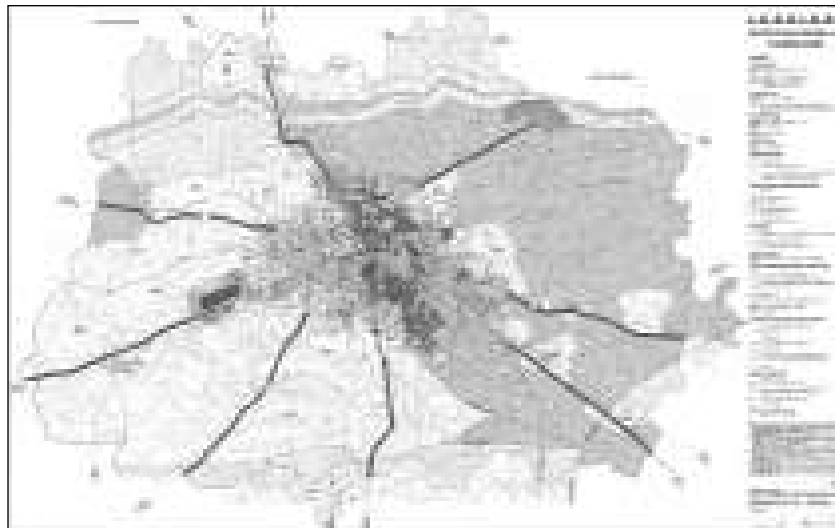


Figure 2: Master plan Ludhiana 2031

Source: Punjab Urban Development Authority.

Geographic Concentration

According to the 2023 Udyam Aadhar registration portal of the Government of India, Ludhiana saw the registration of 41,799 manufacturing units. Of these, 17,073 units were associated with textile manufacturing, and 10,729 units were involved in metal and machine parts manufacturing. Within the textile sector, 8,616 units specialised in hosiery and knitwear manufacturing. In the metal and machine parts sector, 1,784 units specialised in bicycle parts manufacturing, and 1,349 units specialised in metal fasteners manufacturing.

Prominent Industries in Ludhiana

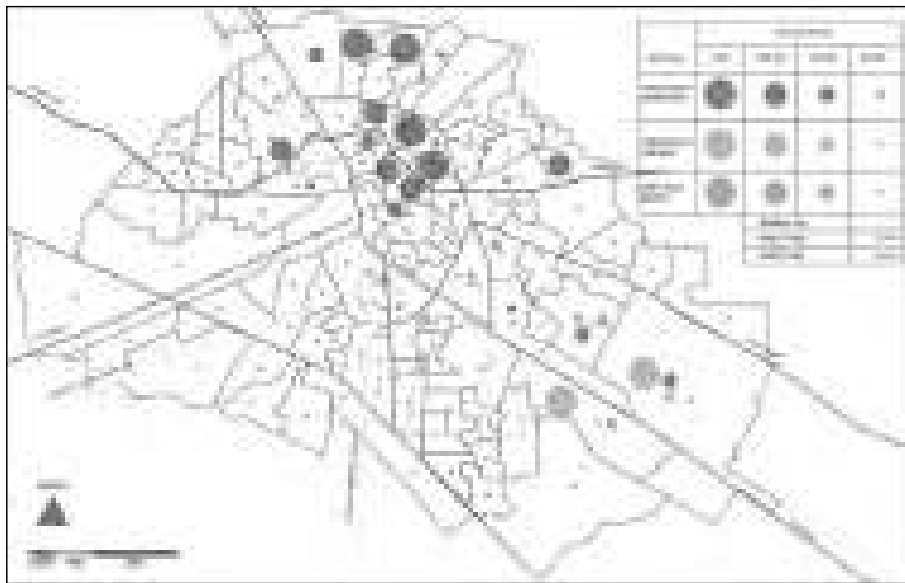
According to data from the Ministry of MSME (2023), a locational quotient analysis was conducted to identify prominent manufacturing sectors in Ludhiana using NIC classifications. Considering Punjab as the reference region, three manufacturing categories in Ludhiana had locational quotient values greater than 1: knitwear and hosiery with LQ 2.562, metal fasteners with LQ 2.0, and bicycle parts with LQ 2.416 (Table 1). These sectors are highly concentrated in Ludhiana. However, a micro-level analysis is necessary to pinpoint the specific hotspots and understand the linkages of these activities within the city.

Table 1: Locational quotient analysis of major manufacturing sector in Ludhiana (NIC based)

5 Digit NIC	Description of Industry	Units in Ludhiana	Units in Punjab	Units in a particular NIC in Ludhiana / Total manufacturing units in Ludhiana (A)	Units in a particular NIC in Punjab / Total manufacturing units in Punjab (B)	Location Quotient (A/B)
14309	Manufacture of apparel including knitwear and hosiery	3408	3599	0.082	0.032	2.562
25991	Manufacture of metal fasteners	1349	1794	0.032	0.016	2.0
30923	Manufacture of bicycle and cycle parts	1338	1458	0.032	0.013	2.461
	Total manufacturing units	41799	110934			

Source: Ministry of MSME, Government of India, Udyam Registration Database. Retrieved from <https://udyamregistration.gov.in> on August 2023.

Ludhiana comprises total 95 wards. Location data of manufacturing units has been meticulously gathered from the Udyog Aadhar Portal of the Government of India. The data was segregated ward-wise and mapped to show concentration of prominent industries in Ludhiana (Figure 3). Notably, the production of wearing apparel, knitwear, and hosiery is prominently located in the north-eastern part of the city. Conversely, the manufacturing of metal products and cycle parts exhibits a concentrated presence towards the south-western region.



Source: Authors' own analysis based on data from Udyog Aadhaar Registration Database (Ministry of MSME, Govl).

Network and Interconnectedness

Industrial clusters are closely intertwined with the strength and nature of backward and forward linkages in manufacturing activities. A cluster exhibits strong linkages with ancillary activities, serving as effective indicators for defining a manufacturing

cluster within a local area. In Ludhiana, the dominant industrial activities have been identified to establish connections with various ancillary sectors including raw material suppliers, transportation, retail and wholesale units (Table 2). Linkages have been mapped and visually represented to understand their distribution across different wards of Ludhiana.

Table 2: Backward and forward linkages of major manufacturing units in Ludhiana

Sector	Backward linkages	Forward linkages
Hosiery and knitwear	Yarn production	Transporter
	Manufacturing of dye	Retailer
	Dyeing of textile	Exporter
	Printing of textile	
	Embroidery	
	Manufacturing of textile related machinery	
Cycle and cycle parts	Chemical additives	Transporter
	Steel wire suppliers	Retailer
	Plastic, textile fiber, rubber, leather suppliers	Exporter
	Sheet metal suppliers	
	Metal fasteners	
Metal fastener	Steel wire suppliers	Transporter
	Sheet metal suppliers	Retailer

Source: Stakeholders' interview, 2023.

Hosiery and Knitwear Backward-Forward Linkages

The hosiery and knitwear manufacturing cluster demonstrates robust backward linkages with ancillary industries, notably machinery production resulting in the establishment of machinery manufacturers and suppliers (Tewari, 1999). Furthermore, an ancillary dyeing sector has surfaced in Ludhiana. Sub-contracting knitting firms play a pivotal role in the cluster's value chain by supporting knitting units grappling with time constraints in fulfilling orders, particularly those involved in bulk orders or exports.

The final product is distributed both domestically, reaching various regions of the country, and internationally, through exportation outside India. In the domestic market, forward linkages are facilitated by intermediate agents, wholesalers, and retailers. Additionally, the cluster has witnessed the emergence of numerous clothing brands, further reinforcing forward ties to the manufacturing units.

The mapped linkages between manufacturing and ancillary activities of hosiery and knitwear show stronger backward linkage than the forward linkage (Figure 4). Also, the spatial spread of the industrial cluster is far beyond the concentration of hosiery

and knitwear manufacturing units. The cluster includes wards with wholesale markets, transportation wards and some of the wards which have machinery manufacturing units at the south.

The backward linkages in the hosiery and knitwear manufacturing sector at Ludhiana exhibit a higher dependency on minor roads. This is due to the clustering of manufacturing units in close proximity, where they consist of mixed forms of units specialised in different activities within the same textile manufacturing process. These minor roads facilitate the efficient movement of raw materials and semi-finished goods between these closely situated units. On the other hand, major roads and railway lines have a more significant impact on the forward linkages. Finished products in the hosiery and knitwear sector tend to be shipped over longer distances, making proximity to these major transportation infrastructures crucial for efficient distribution and market access.



Figure 4: Backward and forward linkages of hosiery and knitwear manufacturing in Ludhiana

Source: Authors' own analysis based on data from Udyog Aadhaar Registration Database (Ministry of MSME, GoI).

Bicycle and Bicycle Parts Manufacturing Backward Forward Linkages

The bicycle and bicycle parts manufacturing sector in Ludhiana has significant backward linkages with industries supplying chemical additives, steel wire, plastic or leather fibres, sheet metal, and metal fasteners, all crucial for production. Chemical additives enhance durability, steel wire forms structural components, plastic and leather fibres are used in seats and grips, sheet metal for parts like fenders, and metal fasteners for assembly. These linkages ensure a steady supply of essential materials, maintaining production efficiency. Additionally, the sector has forward linkages with transporters

and wholesale retail markets, facilitating distribution to retailers and consumers. Spatial analysis shows stronger backward linkages, critical for the industry's concentration in Ludhiana. (Figure 5)

The majority of cycle and its parts manufacturing units are concentrated near Gill Road, Dhandari Kalan, and Giaspura. Backward linkages within this sector primarily rely on minor roads for the movement of raw materials and semi-finished products. However, when it comes to forward linkages, Transport Nagar, the Dhandari Kalan railway goods yard, and major highways leading to Delhi, Amritsar, Firozpur, and Chandigarh play crucial roles in facilitating the distribution of finished goods to wider markets.

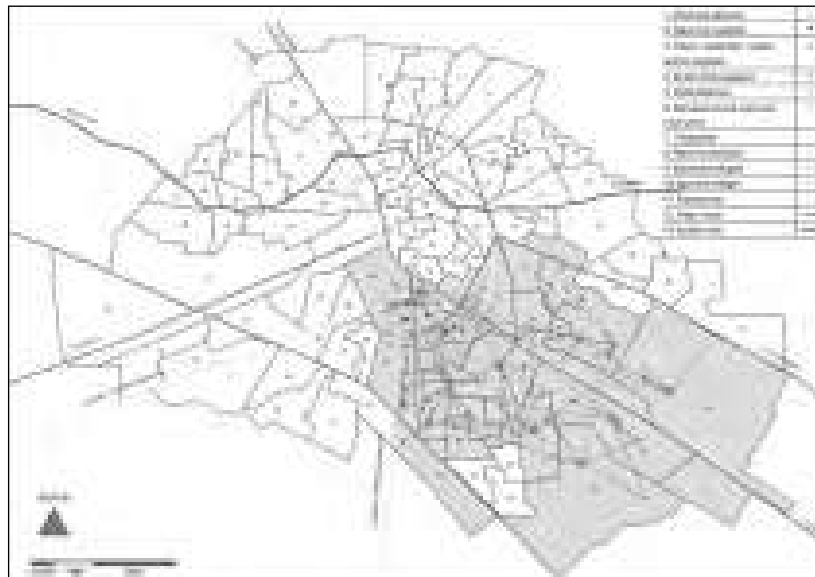


Figure 5: Backward and forward linkages of bicycle and bicycle parts manufacturing in Ludhiana

Source: Authors' own analysis based on data from Udyog Aadhaar Registration Database (Ministry of MSME, Govt.).

Backward and Forward Linkages of Metal Fastener Manufacturing

The metal fastener manufacturing industry in Ludhiana exhibits robust backward linkages with suppliers of steel wire and sheet metal, while also demonstrating forward linkages with transporters, wholesale markets, and retail outlets. These linkages are integral to the functioning and success of the industry, driven by specific reasons.

Backward linkages with steel wire suppliers are essential as steel wire serves as the primary raw material for manufacturing metal fasteners such as nuts, bolts, screws, and rivets. Sheet metal suppliers provide additional materials necessary for certain types of fasteners or for manufacturing components used in fastener production. On the other hand, forward linkages with transporters are vital for the distribution of finished metal

fasteners from manufacturing facilities to wholesalers, retailers, and ultimately to end consumers. Also, wholesale markets serve as key hubs for bulk purchases by retailers and industrial consumers, while retail outlets cater to individual customers and small-scale buyers.

Backward and forward linkages of metal fastener manufacturing have been shown in Figure 6 with black lines showing backward and pink lines showing forward linkages. The highlighted wards show concentration of fastener industry and the spatial analysis also reveals that the backward linkage is stronger and significant than the forward linkage of the industry.

Forward linkages for fastener manufacturing are closely connected with the railway goods yard at Dhandari Kalan and Transport Nagar, located at the junction of Chandigarh Road and Delhi Road. These connections facilitate the efficient transportation of finished products to broader markets.

In contrast, backward linkages are primarily concentrated among the micro and small-scale units within the manufacturing cluster. However, there is a significant physical barrier that disrupts the linkages between metal fastener manufacturing and its ancillary activities located in Focal Point, Giaspura, and Dhandari Kalan. This barrier hinders the seamless flow of materials and coordination between these interconnected activities.



Figure 6: Backward and forward linkages of metal fastener manufacturing in Ludhiana

Source: Authors' own analysis based on data from Udyog Aadhaar Registration Database (Ministry of MSME, Govt.).

The overall findings indicate that Ludhiana's manufacturing sector exhibits stronger backward linkages compared to forward linkages, supporting the theoretical proposition. Internal linkages show that primary manufacturing and ancillary activities are concentrated within the clusters, with communication and material flow optimised through their mixed existence within these clusters. (Fig. 7)

Forward linkages, on the other hand, are primarily facilitated by major highways leading to Amritsar, Delhi, Chandigarh, and Firozpur. The Railway Goods Yard and Transport Nagar serve as key transport hubs where goods are transferred from smaller vehicles to larger trucks and trains, enabling efficient distribution to broader markets.

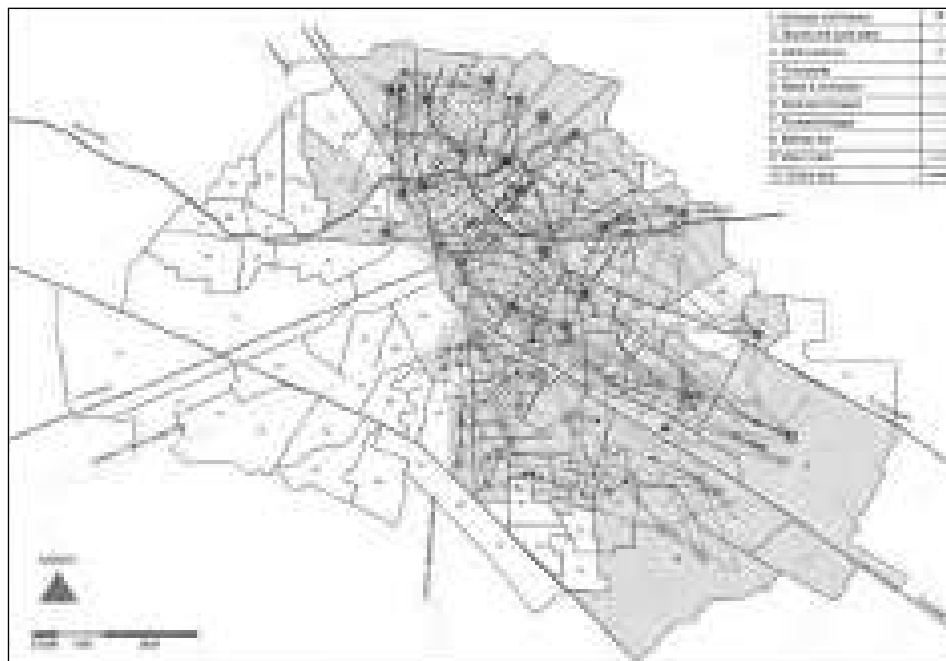


Figure 7: Collective backward and forward linkages of major manufacturing sectors in Ludhiana

Source: Authors' own analysis based on data from Udyog Aadhaar Registration Database (Ministry of MSME, GoI).

Common Industrial Institutions and Infrastructure

Common industrial institutions and infrastructure are crucial for the growth of micro and small-scale manufacturing enterprises (Table 3). In Ludhiana, these resources include industrial associations, training institutions, ESI dispensaries, export promotion councils, and key infrastructure like fire stations, electric substations, Common Effluent Treatment Plants (CETPs) and transport hubs.

The hosiery and knitwear cluster stands out with five industry associations, compared to two each for cycle and metal fastener clusters. Four citywide Industrial Training Institutes provide ample skill development opportunities. An export promotion council

benefits the hosiery cluster, enhancing global competitiveness. ESI dispensaries are numerous in the hosiery cluster, ensuring accessible healthcare. Each cluster has at least one fire station, but the hosiery cluster has fewer electric substations. Transport hubs are accessible to all clusters, facilitating efficient logistics. Environmental sustainability is highlighted in the hosiery cluster with two CETPs, unlike the other clusters. Overall, the hosiery and knitwear clusters benefit from the most extensive support, while bicycle and metal fastener clusters have moderate support.

Table 3: Common Industrial Infrastructure and Institutions in Ludhiana

Manufacturers	Common industrial institutions (numbers)	Common industrial infrastructure (numbers)
Hosiery and knitwear manufacturers	Industry associations – 5 Knitwear and apparel manufacturing association, Ludhiana, Federation of Knitwear textile and allied industries, Bahadur ke Textile Knitwear Manufactures Association, Bajwa Nagar Hosiery Association, Ludhiana Woolen Manufacturing Association, Hosiery Industrial Association Knitwear club Training institutions - 4 Export promotion council - 1 ESI dispensary 2	Fire stations 1 Electric sub stations 1 Common Effluent Treatment Plant - 2 Transport Hub -1
Bicycle manufacturers	Industry associations -2 United cycle and parts manufacturers association Ludhiana, Ludhiana wholesale cycle part dealers' association, Training institutions - 4 Export promotion council - 0 ESI dispensary 1	Fire stations 1 Electric sub stations – 2 Common Effluent Treatment Plant - 0 Transport Hub -1
Metal fasteners	Industry associations – 2 Fasteners manufacturers association of India, The Ludhiana Steel Fasteners Manufacturers Association Training institution - 4 Export Promotion Council – 0 ESI dispensary 2	Fire stations 1 Electric sub stations - 2 Common Effluent Treatment Plant – 0 Transport hub – 2

Source: Industrial Association Directory of Punjab & Stakeholders' interview 2023).

Discussion and Conclusion

Micro and small-scale enterprises play a vital role in the economy and employment landscape of India. Ludhiana stands out as a hub for such enterprises, making it a compelling case study for comprehending industrial concentration and the associated ancillary activities linked to micro and small-scale enterprises. The findings of this study illuminate the spatial configuration of manufacturing activities within Ludhiana, Punjab, India, offering valuable insights into the dynamics of industrial clusters in the region. By empirically examining the spatial organisation of manufacturing sectors in Ludhiana, a research gap is addressed, considering the city's significant industrial activities, which have been previously overlooked in the literature.

The study reveals the dominance of hosiery and knitwear manufacturing in Ludhiana, closely followed by bicycle manufacturing and metal fastener production, with high location quotient (LQ) values indicating substantial concentration within Ludhiana compared to other districts in Punjab. Such concentration signifies the presence of robust industrial clusters, essential for understanding the region's economic landscape. Spatial analysis demonstrates clear division between textile manufacturing (hosiery and knitwear) in the northeast wards and metal-based manufacturing (metal fasteners and bicycles) in the southeast wards of Ludhiana, highlighting spatial specialisation and efficient resource utilisation. The spatial distribution shows that textile activities are primarily concentrated along Budha Nala, while metal fastener and cycle parts manufacturers are situated near railway yards and key transport hubs.

The strength of backward linkages within Ludhiana's manufacturing clusters indicates robust interdependencies between primary manufacturing activities and ancillary support services, aligning with theoretical expectations and emphasising the importance of supply chain dynamics in cluster formation. Forward linkages, on the other hand, are primarily facilitated by major highways leading to Amritsar, Delhi, Chandigarh, and Firozpur. The Railway Goods Yard and Transport Nagar serve as key transport hubs where goods are transferred from smaller vehicles to larger trucks and trains, enabling efficient distribution to broader markets.

The presence of industrial associations and shared infrastructure facilities reflects a supportive ecosystem fostering collaboration, innovation, and collective problem-solving among industry players. Varying degrees of institutional support and infrastructure availability across different manufacturing clusters cater to the specific needs and dynamics of each sector. The hosiery and knitwear cluster in Ludhiana benefits from the most extensive support with five industry associations, ample training institutions, and specialised infrastructure like CETPs for environmental sustainability. The bicycle and metal fastener clusters have moderate support, each with two industry associations and access to key infrastructure, but lack dedicated export promotion councils and CETPs.

This study offers crucial insights for urban planning in Ludhiana by identifying the spatial concentration and specialisation of manufacturing activities, which can inform zoning regulations, infrastructure development, and resource allocation to support the growth and sustainability of micro and small-scale enterprises. By highlighting the strengths and gaps in institutional support and infrastructure across different manufacturing clusters, the study provides a basis for targeted interventions to enhance industrial efficiency, foster collaboration, and improve overall economic resilience in the region.

Acknowledgements

Authors here acknowledge GNDU for providing facility and opportunity.

References

- Becattini, G., Bellandi, M. & Propis L, De. (2009). *A Handbook of Industrial Districts*, Edward Elgar Publishing.
- Billings, S.B. & Johnson, E.B. (2012). 'The location quotient as an estimator of industrial concentration', *Regional Science and Urban Economics*, 42(4), 642–647.
- Carroll, M.C., Reid, N. & Smith, B.W. (2008). 'Location quotients versus spatial autocorrelation in identifying potential cluster regions', *The Annals of Regional Science*, 42(2), 449–463.
- Ergen, B. 2018. 'Periodical Manufacturing Industry Clustering Analysis in Yozgat Using The Location Quotient Method (2006-2016)', *Journal of Planning*.
- Hashim, S.R., (2010), *SME Clusters in India: Identifying Areas of Intervention for Inclusive Growth*, Institute for Studies in Industrial Development (ISID), New Delhi. Sponsored by the Planning Commission, Government of India.
- Hefner, F.L. & Guimaraes, P.P. (1994). 'Backward and Forward Linkages in Manufacturing Location Decisions Reconsidered', *Review of Regional Studies*, 24(3).
- Kamaldeep, K., Shergill, B.S. & Mehta, S. (2021). 'Micro-foundations of Cluster Development', *Challenges to Punjab Economy*, 1st edn.
- Kaur, J., Kaur, V., Pakade, Y.B. & Katnoria, J.K. (2021). 'A study on water quality monitoring of Buddha Nullah, Ludhiana, Punjab (India)', *Environmental Geochemistry and Health*, 43(7), 2699–2722.
- Marshall, A. (1919). *Industry and Trade*, Macmillan And Co.Limited.
- Marshall, A. (2013). *Principles of Economics*, Palgrave Macmillan UK, London.
- Mehra, S. (2017). 'A Financial Analysis of Ludhiana's Migrant Labour', *Social Change*, 47(1), 81–93.
- Mehra & Singh. (2013). 'Determinants and Factors Related to Migration of Labourers to Industries in Ludhiana, Punjab'.
- Ministry of MSME, Government of India. (2023). *District-wise Registered Enterprises Data*, obtained via Udyam Registration Portal, <https://udyamregistration.gov.in>, accessed on August 2023.
- Morrissey, K. (2016). 'A location quotient approach to producing regional production multipliers for the Irish economy', *Papers in Regional Science*, 95(3), 491–507.

- Niyimbanira, F., Eggink, M.E. & Nishimwe-Niyimbanira, R. (2020). 'The Identification of the Key Sub-Industries Among Coastal Metropolitan Cities of South Africa: An Application of the Location Quotient Technique', *International Journal of Economics and Finance Studies*, 50–70.
- Pominova, M., Gabe, T. & Crawley, A. (2021). 'The Pitfalls of Using Location Quotients to Identify Clusters and Represent Industry Specialization in Small Regions', *International Finance Discussion Paper*, 2021(1329), 1–25.
- Porter, M.E. (1990). *The Competitive Advantage of Nations*, Free Press, New York.
- Rahman, M. & Dua, S. (2022). 'Integrating Street Vendors In Industrial Area Planning of Ludhiana City: A Societal Enhancement Through Infrastructure Reform', *Journal of Positive School psychology*, 6(8), 1196–1203.
- Randhawa, A. & Kumar, Dr. A. (2020). 'Reviving the Urban Core: Ludhiana City, Punjab, India', *Urban Studies and Public Administration*, 3(3), p1.
- Ray, R.S. & Sharma, T. (2022). 'Towards Cluster-Based Sustainability and CSR Framework in Indian Small and Medium Enterprises—A Case Study on Garment Industry', pp. 67–81.
- Ray, S. & Miglani, S. (2022). 'The Role of Technology in Increasing Competitiveness: An Examination of the Indian Garment Clusters', *Foreign Trade Review*, 57(4), 408–428.
- Saini, H. & Gupta, L. (2019). 'Production Processes in Knitwear Export Units: A Comparison of Ludhiana and Tirupur', *Journal of National Development*, 32(2).
- Tewari, M. (1998). 'Intersectoral linkages and the role of the state in shaping the conditions of industrial accumulation: A study of Ludhiana's manufacturing industry,' *World Development*, 26(8), 1387–1411.
- Tewari, M. (1999). 'Successful Adjustment in Indian Industry: the Case of Ludhiana's Woolen Knitwear Cluster', *World Development*, 27(9), 1651–1671.
- Vicente, J. (2018). 'A Brief History of Cluster Theory', *Economics of Clusters*, pp. 5–20, Springer International Publishing, Cham.

Learnings from Past: Heritage Town of Saswad—Potentials and Challenges

Nagarlok
ISSN-0027-7584
56(4), 526-546
October-December, 2024
@ 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.10>

Ar. Vaidehi Lavand*

Abstract

Heritage and medieval town planning offer invaluable insights into how communities organised themselves in the past, reflecting social, economic, and cultural structures that can still be relevant today. The present paper begins with a discussion on the origin and evolution of the historic town of Saswad, a heritage town in Deccan region. The second part outlines the methodology devised to understand the cultural significance of Saswad, particularly in terms of its built heritage. Further discussions unfold various historical factors integral to the town's development processes, aiming to comprehend the town as a cultural resource. The concluding section scrutinises issues related to heritage preservation in Saswad, providing concise guidelines for formulating a comprehensive Conservation Policy. The study employs observation and visual analysis methods, mapping, and inventories to support the arguments developed in the process of research.

Keywords

Conservation Management, Heritage, Heritage Typology, Historic towns, Medieval Town planning.

Introduction

Saswad is a small-scale town well known for its history and context in the region. In the rapid phase of urbanisation, it still retains its character both in a tangible and intangible way. It has a population of 1,31,821 covering an administrative area of 2256 hectares, (22.56, square kilometres). It is located on state highway no. 36 on the Pune-Saswad-Neera Road.¹ A major proportion of the population is dependent upon agriculture and urbanisation has led to a change in occupational patterns, brought about by industrialisation. The Development Plan Report of 2008 describes about migration of people and major shifts in occupational trends in Saswad. There is an expansion on the western side of the town towards Pune given the natural barriers on north and south

* Dr. Ar. Vaidehi Lavand, Associate Professor, SMEF'S Brick School of Architecture, Pune.
Email: vaidehilavand@brick.edu.in, lavand.vaidehi@gmail.com

side of town. On north side, the terrain is high and there is no agricultural land. The Karha River is located on the south side and therefore there is no space for expansion of the town in that direction. Industrial development – Kirloskar Pneumatics Pvt. Ltd. Plant is coming on northwest side that is pulling major crowd for secondary and tertiary source of income. Many industries are appearing in the region. Dependence on Primary sector is tremendously diminishing. An upcoming airport near Saswad has now triggered development of the town as a satellite town of Pune (Fig. 1).

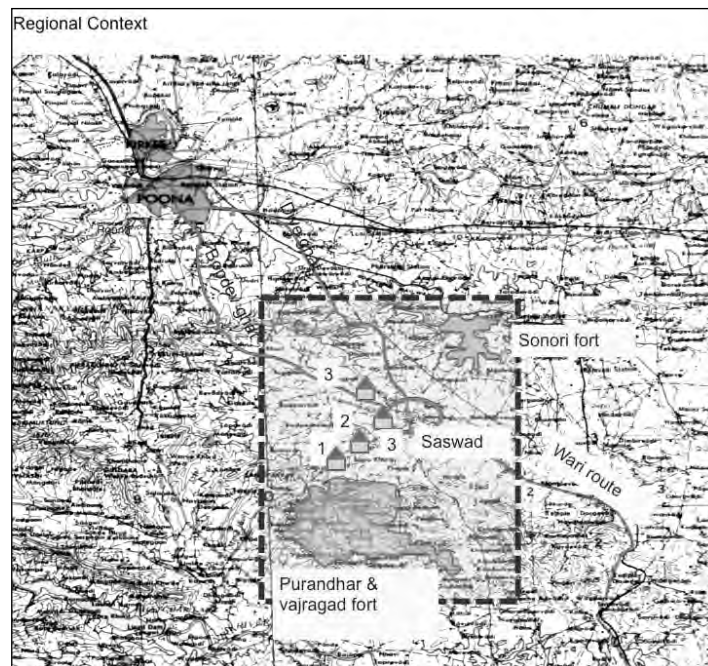


Figure 1: Regional context of Saswad map

Source: Author

Historic Town of Saswadⁱⁱ

Urbanisation significantly accelerated after colonisation in the historic medieval towns of Maharashtra, particularly around the Deccan Plateau. This marked the beginning of a transformation in the character of small settlements. Changes occurred on multiple levels, including the imposition of new town planning systems and the emergence of secondary occupational opportunities, both of which spurred migration from nearby villages.

Pune, which served as the capital of the Peshwas in the 18th century and later developed into a colonial administrative centre, is a notable example. It evolved into a city with dual identities—representing two distinct urban forms within one settlement.

Saswad, located near Pune and serving as a key link to southern India via the Dive and Bapdev Ghats, also experienced a significant transformation. It reflects the transition from a traditional village to an emerging urban centre.

Methodology

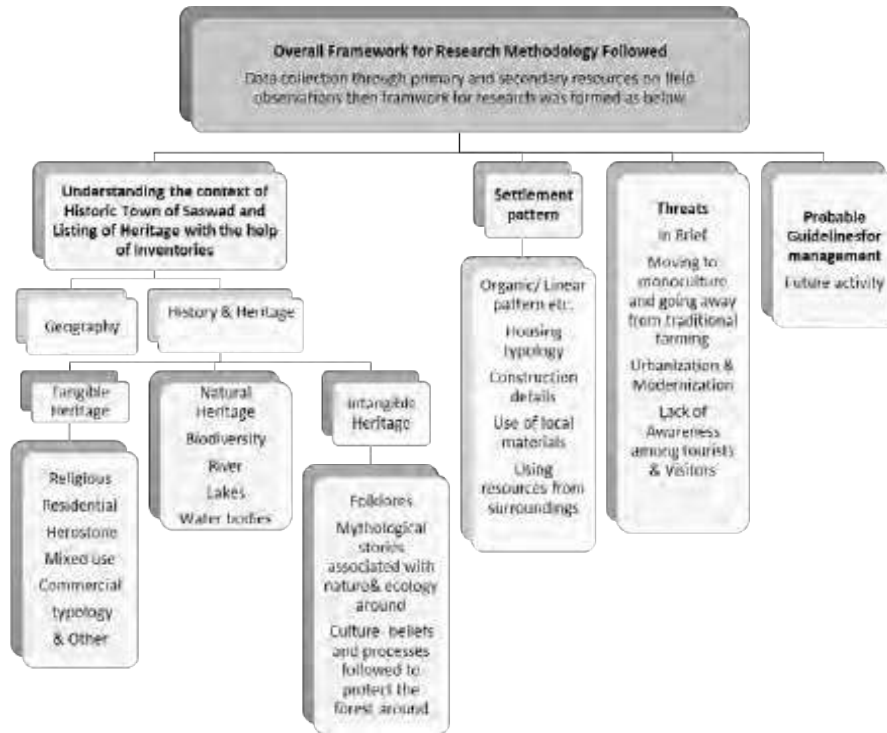


Figure 2: Flowchart for methodology followed

Source: Author

Flowchart 2 shows how the methodology framework was prepared to study the historic town of Saswad to identify tangible, intangible elements as heritage potential of a town. Historic town of Saswad, well - known medieval town in the Deccan flourished during the later Maratha period under the local philanthropist and minister, popularly known as *Sardar* Purandare, marks its presence in various ways. Numerous tangible and intangible historic elements define distinctive character of Saswad. Settlement of Saswad flourished at the confluence of two rivers Krha and Chambali. Various historical references and archaeological findings suggest that the town of Saswad, has roots going back to the Satavahana period. As per mythological stories, the name originated from seven banyan trees existed long back. Saswad demonstrates a typical Maratha style settlement in Deccan region. This consists of an old core area protected with remains of fortification wall which was intact few centuries back. Settlement has central axis connecting edge of the river and market street. Location of Purandare mansion, right at the middle of town is protected by very strong fortification wall surrounded with mansions of other ministers of Purandare family (Fig. 3). Various wards were evolved around this huge mansion as supporting agents and support system to the entire town. As the growth was very organic in nature, it reflected in the meandering roads developed around.



Figure 3: Purandare mansion

Source: Image by Abhishek Sukale

Pratyush Shankar rightly observed that it is not always landmarks that remain in your mind and memories associations, but there are many local symbols that contribute to placemaking (Shankar, 2012). Same is evident at Saswad where several layers of history are still evident in the form of its residential, mixed use and religious typology.

The meandering road pattern of the town reveals a settlement organically developed over time, with distinct areas such as *Shimpi Ali*, *Borate Ali*, *Jagtap Ali*, *Brahmin Ali*, and others, each named after the occupational communities that settled there. These neighbourhood divisions reflect the social and professional structure of the town, with each group occupying specific zones based on their trades and the period of their establishment. The alignment, location, and architectural character of the houses not only narrate the town's historical evolution but also embody the hierarchical, feudal organisation typical of medieval urban development. Shah(2012);Venkatrama, (1994).

Main axis of town connects both the important parts of town those are open market space at one end whereas riverside on the other. The Purandare Mansion (Fig. 3), a royal residence in the town, served as the architectural prototype for the construction of Shaniwarwada in Pune—the seat of power during the Peshwa rule. The Maratha town planning system that emerged was shaped by the political vision and administrative strategies of various Maratha ministers up to the early 19th century. This distinctive planning pattern reflected the socio-political hierarchy and spatial organisation characteristic of the Maratha era. (*Gazetteer of the Bombay Presidency Poona*,1954); Oak Pramod, 2011).

Architectural elements such as arches, merlons, and lime stucco serve as tangible evidence of the diverse influences that have shaped the town's architectural style. over several centuries. A confluence of Islamic, Gujarati, and Maratha structural and decorative traditions is prominently reflected in the built environment. These stylistic influences are not limited to individual buildings but are apparent at both the macro

level—in the overall town planning—and the micro level, in the architectural details and construction techniques. Together, they form a layered narrative of the town's cultural and historical evolution.

Data Base

Heritage Potential of Historic Settlement of Saswad

Further discussion on heritage potential of Saswad demarcates its character as an important medieval settlement still retaining character in the old *Gavthan* area. While understanding conflicts between old and new it is essential to know what is still existing there and why it is so important to know as a layer of architectural history and unique language it demonstrates. Various typologies of built heritage demonstrate architectural character of medieval settlement. Spatial organisation in residential, mixed use, religious, and commercial areas is identified and expressed in further discussion.

Residential Architecture

Various residential typologies and hierarchy of spaces could be observed at various locations in the old town. Cortile planning, housing patterns with front and backyard and mixed use pattern typology is prominently seen in different wards such as *Brahmin Ali*, *Jagtap Ali* and *Shimpi Ali*. Various houses act as support systems during Wari procession when lakhs of people proceed to Pandharpur during Wari (Varshiki, 2008; Saswad City Council, 2020; Sowani Avinash, 2011). Clear segregation in terms of different casts seen in various quarters of the town such as *Brahmin* predominantly located in Brahmin Ali with more than 30 cortile mansion typologies. Where as *Jagtap Ali* demonstrating front and backyard home and *Shimpi Ali* with mixed use typology with common walls in linear plots are visibly adorned with cast iron balconies and wooden brackets.

Public courtyards also called as *Phadacha Chowk* whereas private courtyard called as *Chowk* that was mainly used by women in the house (Fig. 4 and 5).

This Khajgicha Chowk is mainly surrounded by rooms for women and a puja room for worshipping family deities. Service area mainly consists of detached toilets and servants rooms usually located on the left side of *Wada* (Fig. 8) towards south. Out of these mansions, some are in a good condition and still in use but others are replaced with tall concrete apartments catering to the needs of the new generation.

Jagtap Ali consists of 98 houses with both front and backyards exhibiting identical features. The *Jagtaps* primarily worked as farmers. Over time, a distinctive architectural style emerged, featuring a unique flair for including the development of space hierarchy tailored to practical needs.

A protective compound wall encircles the house. The *Padvi* serves as a significant semi-open seating area, welcoming all guests at a public space within the house. The *Sopa*, a closed living area, functions as a seating area where outsiders are typically not

permitted to enter. The *Majghar*, a dark storage area, is primarily utilised by the women of the households. The *Swaympak Ghar*, situated at the rear, functions as the kitchen where cooking is predominantly done by the women. Facilities such as the water tank, toilet, and bath are separate from the main house. The *Parasbag*, or backyard open space, serves as an area for drying clothes and other activities.



Figure 4: Mapping for residential units still retaining its character in *Brahmin Ali*

Source: Author



Figure 5: Image showing internal courtyard of Bokil Wada

Source: Author

Primarily, construction relies on locally sourced materials. The ground floor is built with sturdy stone walls, while the first floor predominantly features flat brick walls. A composite structure is employed, combining load-bearing stone walls with timber-framed elements. Mansions exhibit an introverted layout in their planning.

In *Shimpi Ali* (Fig. 6, 7, 9 and 10) and other commercial *Alis*, approximately 140 mixed-use houses are observed, featuring shops with display platforms on the ground floor and residential areas on the first floor. The spatial arrangement typically begins with the *Padvi* area adjacent to the road, historically used for commercial purposes but still serves that function to some extent. The *Osari* functions as a seating area for visitors. Similar spatial hierarchy, including storage areas like *Majgharas*, kitchens primarily located at the rear, separate service areas, and backyards, is evident in all houses (Fig. 11). These houses employ comparable construction techniques and materials. However, they tend to be smaller in scale and feature an extroverted planning approach. The segregation and planning of *Saswad* distinctly illustrate the hierarchy of castes and classes. Various wards have emerged, and the architectural planning and character reflect the diverse communities that have settled in the town over time (Fig. 11 and 12).



Figure 6: Houses in Shimpi Ali
Source: Image by Rohan Bhosale



Figure 7: Layout of a house in Shimpi Ali
Source: Author



Figure 8: Documentation of one Wada changing its face and now major part of it is in dilapidated condition (Red dotted line is part of Wada which is in damaged condition), made by Vaidehi Lavand (Dotted line, appearing in the Plans on the left figure appearing in the elevation on right figure, is a part of Wada which is in damaged condition.)

Source: Author

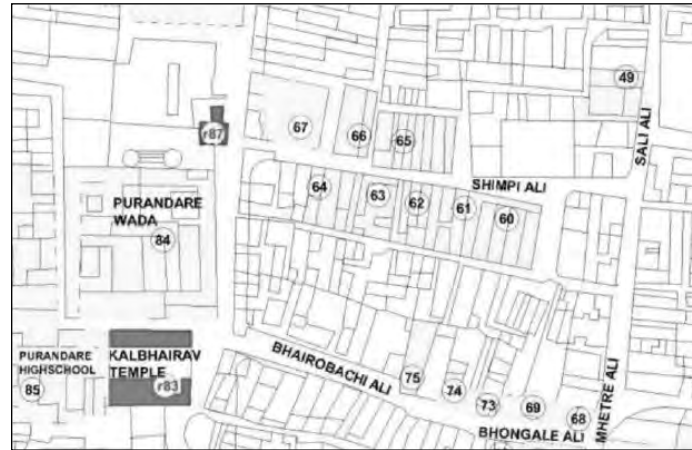


Figure 9: Layout Showing Houses in Shimpi Ali still retains their old character

Source: Author

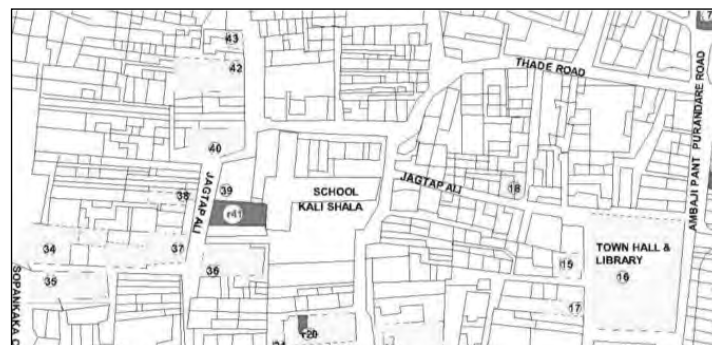


Figure 10: Layout of Jagtap Ali locating existing old houses retaining its old character

Source: Author

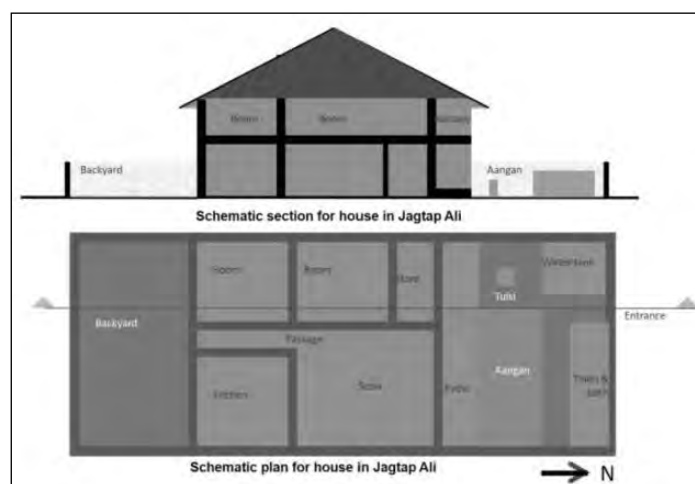


Figure 11: Plan and section of a Residence in Jagtap Ali

Source: Author



Figure 12: Front open space in a house at Jagtap Ali

Source: Author

Religious Architecture

Religious architecture encompasses the design and building of structures dedicated to worship sacred spaces, including churches, mosques, stupas, temples, and more. Human worship initially centred around natural elements such as the sun, moon, rain, and trees. Over time, this evolved into the worship of idols, leading to the creation of dedicated spaces within structures to house these idols—each representing specific deities and associated myths.

Mapping done by Vaidehi Lavand

The evolution from simple *menhirs* to elaborate temple complexes narrates the tales of temple origins, the magnificent periods of their construction, and the layers of history that have influenced the region (Fig. 13 and 14).

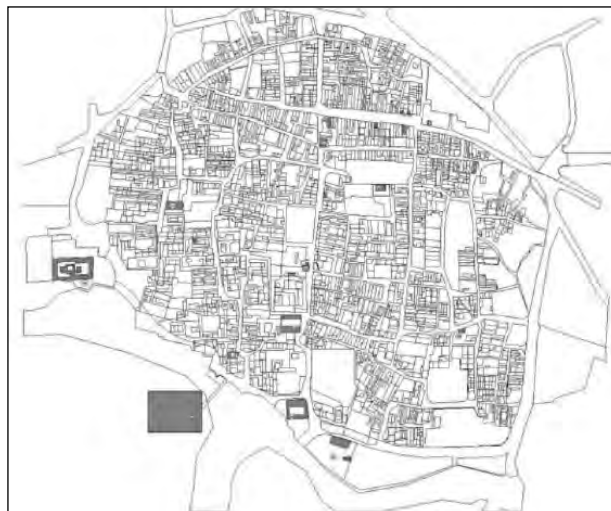


Figure 13: Mapping of religious typology at Saswad

Source: Author



Figure 14: Different communities residing in separate wards in Saswad

Source: Author

Total number of temples is 16 in Saswad

- 7 to 10 *samadhis*;
- 2 *dargahs*;
- Some of the important temples like Vateshwar, Siddheshwar temples are situated along Karha built during *Yadava* period;
- Sopandev temple near chambali/ Bhogavati river is from Dyaneshwar / Preshivaji period; and
- Sangameshwar temple which is on the confluence of Chambali and Karha rivers belongs to peshwa period.

From the 11th century onwards, the Deccan region faced political instability due to invasions from both northern and southern parts of India. An illustrative example from this period is the '*Sopandev's samadhi*' (Fig. 15), located alongside the riverside of Saswad, dating back to the 11th century, dedicated to Sopandev, brother of the saint Dnyaneshwar. Additionally, the *samadhi* of Baji Pasalkar, a minister during the Shivaji era in the 15th century, lies in the heart of the historic city of Saswad. Nearby temples such as the Shiva temple at 'Hiware' and the Shiva temple on Narayanpur road, known as 'Vateshwar', exemplify the 'Vesara style,' which incorporates elements from both the Nagar and Dravidian architectural styles. Scholars specialising in Indian temple architecture provide insightful critiques by analysing the characteristics of these locally emerged structures in depth. Throughout history, diverse empires have utilised religion and religious sites for both destruction and construction as part of their political

strategies. Similar examples of this phenomenon can also be observed in Saswad.



Figure 15: Kund at Sopandev Samadhi

Source: Image by Abhishek Sukale

Two categories of temples are noticeable in and around the vicinity of Saswad:

1. Individual Temples
2. Temple complexes

Individual temples could be further categorised as public and private temples. Other religious elements observed are *Samadhis*ⁱⁱⁱ, individual cults and many such examples. Illustrations other than Hindu temples are rarely found in the neighbourhood. This expresses the prevalence of Hindu community in and around town.

As per the survey conducted in historic core of Saswad, religious structures are listed and documented as the landmarks of the settlement. Important of those are mentioned is the list further. Some of the important are mentioned below-



Figure 16: View of Sangameshwar temple

Source: Image by Abhishek Sukale

List of Temples

1. Sangameshwar Temple (Fig. 16)
2. Ganpati Temple (Fig. 17)
3. Nagareshwar Temple
4. Shani Temple
5. Kalabhairav Temple (Fig. 18)
6. Karabai Temple
7. Munjaba Temple
8. Murlidhar Temple
9. Vateshwar Temple
10. Maruti Temple
11. Durga Temple

List of Samadhis

1. Sopandev Samadhi
2. Baji Pasalkar Samadhi
3. Godaji Jagtap Samadhi

Grading of heritage structures in town

Figure 17: Ganesha Temple

Source: Image by Abhishek Sukale



Figure 18: Kalbhairavnath Temple

Source: Image by Abhishek Sukale

Existing heritage sites could be categorised into specific ways after undergoing classification through specially designed inventories, taking into account criteria set forth by UNESCO World Heritage Sites and locally established guidelines such as those provided by INTACH grading.

1. Purandare Wada
2. Sangameshwar Temple
3. Vateshwar Temple
4. Tahsildar Kacheri
5. Kalbhairav temple
6. New *Shimpi Ali*
7. *Brahmin Ali* comprising big scale courtyard mansions
8. Wari in town – Cultural landscape
9. Karha river side – Natural Heritage

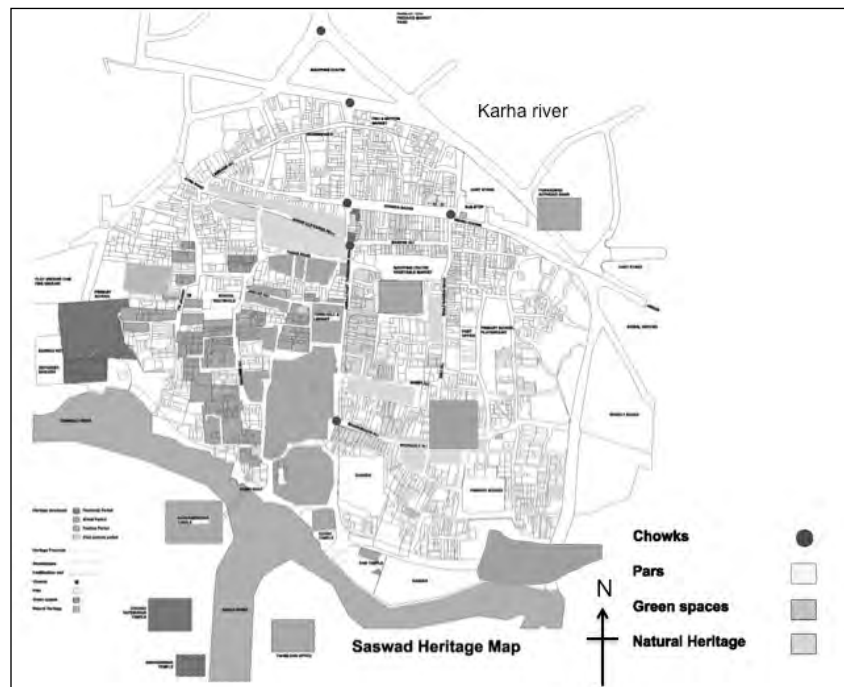
As mentioned by INTACH and based on a study conducted on the heritage core of Saswad, Heritage Grade-III comprises buildings and precincts important for the townscape, which evoke architectural, aesthetic, or sociological interest, though not to the same extent as those in Heritage Grade-II.(INTACH)(Lavand, 2018).

1. “Sopandev Temple
2. Godhaji Jagtap *samadhi*
3. Baji Pasalkar *samadhi*
4. *Pars* community seating areas in historic town
5. Samjai Temple in *Brahmin Ali*
6. Gansh Temple near Purandare Mansion” (Lavand, 2018)

Table 1: As per field work prepared by the author

Heritate Statistics (as per the survey made in the year 2008)		
A	Identified Heritage Structures	308 no
B	Heritage precincts	1 no
	Streetscapes	2 no
C	Traditional open spaces	9 no

Issues related to regulations for Gaathan and similar congested areas as specified in DP (referred in the year 2008)

**Figure 19:** Heritage map of Saswad Prepared

Source: Author

Old town has maximum population density but it is in one of the most neglected conditions at the moment. Gross density in core area is 684.66/hectare whereas Gross Density in new area is 24.71/hectare. These statistics show maximum population density could be seen in old core zone. Southern part of old town near Karha River is least developed as most of the commercial area has been encroached upon by the main Bazar Road. But this area has the maximum potential of being an important recreational and natural heritage. The proposed River Development Project includes maximum old mansions which are 300 to 350 years old and are architecturally rich. Temples having significant architectural character are Sangameshwar, Kalbhairav, Sopandev, Samjai,

Karhabai, and Ram Temple all of which are located in the old precinct area. Except for a cinema hall, there is no other recreational facilities in Saswad. Many Wadas are neglected and in dilapidated condition in old core. Due to these poor civic conditions, many families are forced to shift to Pune or in newly developing areas. Saswad is now fast developing as a suburb of Pune. It comes under Municipal Council C type. The infrastructural facilities include six primary schools, two high schools, and one higher educational Institute. As per *Development Plan Report*, Primary health centre dispensary and maternity home run by Municipal Council, and one private hospital—all of which are located in the vicinity of retail shops, Vegetable market, fish and mutton market to cater to the communities settled there. Table 1 depicts the heritage potential of Saswad.

Review of the Existing Byelaws

As per the existing byelaws, following points have been observed.

Upcoming buildings in the historic core area are proposed to have 12 m wide roads, hampering streetscape and heritage structures. In case of monuments, there is a need to frame suitable rules, while taking into account the architectural vocabulary developed over the period of time.

Rules have also been enforced for the front open spaces such as for the streets of 7.5m to less than 12m width, 1m set back is proposed; for the streets 12 m and above 1.5m whereas for the streets less than 7.5m in width no set back is required unless there is 4.5m clear distances of structural projections. For the streets of 4.5 m widths, a setback of 2.25m should be there from centreline of such lanes. Streets less than 4.5 m that shall be treated as lanes. Despite their narrowness from part of traffic circulation system widening should be proposed and normal setback mentioned above shall be applied. Balconies, cornices, weather sheds, roof projections shall be allowed in setback will not be considered in built over area. Built up area in *Gaothan* area shall not be more than 75 per cent. Maximum height of building shall be 2 storeys. In case of buildings with two story is to be constructed the built over area shall not be more than 60 per cent. No such specifications mentioned for use of specific materials for building construction in any part of the town. These basic points cover no much description related to the elements and vocabulary of new constructions and control over its character.

Discussion: Issues related to built heritage

Piecharts in Fig. 20 show the results of actual surveys. 48 per cent of the total houses in historic core are vacant and in a dilapidated state whereas 44 per cent houses are on rent. Only 8 per cent houses are in use by their actual owners.

The addition of new services such as electric fittings, sanitary pipes, and water tanks is often carried out with minimal regard for traditional construction techniques.

This negligence has led to several structural issues. For instance, the installation of water tanks and toilets has introduced significant dead loads, causing structural stress and, in some cases, visible damage.

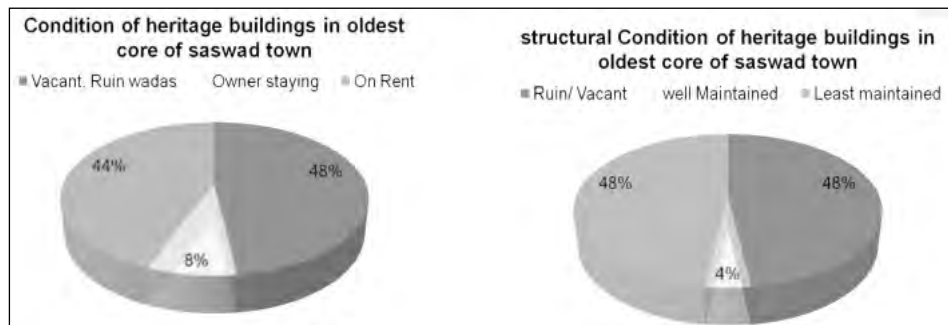


Figure 20: Condition of Heritage Structures in Saswad

Source: Author

Moreover, the construction of additional floors without a proper understanding of the building's structural capacity has further compromised the integrity of many structures. Various parts of these buildings are now in a state of disrepair and are not being utilised properly.

A major challenge is the loss of traditional craftsmanship. Skills related to working with materials like stone, lime, fine brickwork, and intricate wooden carvings are becoming increasingly rare. The use of modern materials, such as cement, is incompatible with older lime-based plasters, leading to problems like water seepage.

In addition, sanitary services are often installed haphazardly, creating issues at multiple levels of the structure. The continued deterioration of original materials underscores the urgent need for regular maintenance.

Lastly, debris and scrap materials from demolished sections of old structures are accumulating, creating unsightly and hazardous conditions in the surrounding areas.

Proposed Policies and Guidelines

The primary goals of policy formation are to safeguard and elevate the distinctive heritage essence of Saswad. This involves conserving noteworthy structures and architectural elements while ensuring that new designs align with Saswad's heritage identity. It is essential that alterations to existing buildings complement and enrich Saswad's heritage character. Policies would help in maintaining identity of Saswad as an important heritage town. New policies and guidelines will support and encourage pedestrian amenities by maintaining human-scaled development, connections to adjacent neighbourhoods, and a welcoming, interesting sidewalk environment. Those will help in encouraging the redevelopment and revitalisation of underutilised sites to enhance Saswad heritage character. Engaging residents, property owners, business

proprietors, and other interested parties in the evolution of Saswad requires the discussion and development of new guidelines pertaining to the town.

Changes in Legislations

While reviewing byelaws it was observed that there are a lot of lacunas in existing rules related to development of historic core of the town. After brainstorming related to the existing fabric of the town, few guidelines considering context should be made. First and foremost, revision should be done in FSI that can be restricted to 1.5 or less for the old historic core. Changes should be made in byelaws according to scale and proportions of existing heritage buildings. There is a need to form a Heritage Conservation Committee, to regulate any kind of alteration in the core area. There is an urgent need to stop reconstruction in the vicinity. Scale and proportions of upcoming structures and material technological aspects need to be controlled well. While considering issues related to road widening, there is a need to look for meticulous plan to redirect traffic from narrow lanes to avoid possible loss of the character of the built heritage.

Pedestrianisation of some parts of the core area can be a better solution to avoid unnecessary traffic. With a methodical approach to the core town there is a need to prepare inventories to listing of these important heritage structures. Entire precinct of old core town rather individual structure needs to be considered under conservation management plan. Indeed, tangible and intangible contribute to the heritage character of historic town of Saswad. With a holistic approach there is a need to have a relook at all the existing byelaws and regulations especially for the core town.

As an important part of our shared heritage, preserving the plurality of architectural expressions—each shaped by its own historical context—requires a dedicated set of guidelines and principles.

Maintaining the Historic Character of the Town

Concepts such as 15 min city, happy streets, eyes on street could be explored further in the context of core heritage towns. Study done by Pratyush Shankar on urban form, Jan Gehl opines that the urban voids are significant repositories to apply theory to practice helping in formation of guidelines (Shankar, 2012). Main challenge in maintaining the character of such historic precinct is ownership of structures. Majority of houses are owned by private owners leading to several challenges in restoring character of these important edifices. As mentioned in Form Based Codes, the 'Modern Traditional' can be the best approach to sustain these living cultural heritage sites. . Building upon the considerations and guidelines suggested by the AMRUT and HRIDAY schemes, further interventions can be proposed at the policy level to enhance the preservation and revitalisation of heritage structures. (National Institute of Urban Affairs, 2023).

The unique character of the town can be maintained by several ways such as control over overall signage, street furniture, hoarding designs with respect to ambience of

old town to avoid mess in visual sense. In the context of precinct-level conservation, new developments must thoughtfully incorporate architectural vocabulary, elements, and principles—such as scale, proportion, and character—that align with the historic fabric and identity identified in the study. While maintaining the street character especially streetscapes, control over any new development reconstruction in selected heritage areas such as *Shimpi Ali*, *Brahmin Ali*, *Jagtap Ali* should be in scale and proportion with the old character. Vocabulary of new developments should respect the historic architectural context. Upcoming public, semi-public structures such as new reservations for school buildings, playgrounds, town hall, library in heritage precincts or near heritage premises may lose essence of aesthetic value of precinct. This should have guidelines for controlling these types of reservations.

Main roads especially *Bajarpeth* road, new *Shimpi Ali* or *Saraf Ali*, Ambaji Pant Purandare Road, are under major transformations. Initially they were having purely mixed-use character but now these are being changed into commercial areas.

As per the survey, commercial activities are encroaching on designated residential zones. This transition needs to be addressed through a meticulous, organized, and well-regulated approach, with specific norms framed to preserve the existing character of the town.

It is imperative that the buildings contributing to the heritage ambience remain intact and not be razed. Renovations of facades within the historic core should faithfully adhere to the original architectural style. Both new constructions and renovated structures should be designed to harmonise with the district's heritage characteristics, considering factors such as massing, rhythm of solids and voids, notable design elements, and the use of traditional materials and techniques. Implementing adjustments to regulations based on these principles will aid in preserving the character of Saswad's historic core.

Conclusion

Though the historic core of Saswad is prominently demonstrating its own identity of a medieval settlement, it is suffering through urban pressures such as population growth, modernisation and its recent identity as a satellite town of Pune city. Saswad *Gaothan* is in the phase of transformation because of the rapid expansion of small settlement to the city. Recent visit to the old core of Saswad shows vanishing character of the built heritage such as newly built structures at the place of old mansions and dilapidated condition of many heritage structures. This transition from a village to a town and then to a city triggers several edges of conflicts. Certainly, a medieval village settlement with a strong character within a modernised city initiates conflicts at several levels. One is conflict of identity as an essential historic layer in the region and another is varied thought process looking towards the heritage still in existence, marking its prevailing presence in the so-called standardisation in modern times. It is essential to understand these conflicts and urgently need to be dealt in a holistic way.

Rapid urbanisation is significantly impacting the overall character of the town. The proposed airport near Saswad and various uncontrolled development projects are placing undue pressure on the historic settlement. This transformation is further compounded by the loss of traditional knowledge and a declining number of artisans skilled in vernacular construction techniques, which has greatly hindered effective restoration practices.

The absence of proper measures for adaptive reuse and a lack of sensitivity in addressing historical and heritage contexts are undermining the character of the historic core. The newly extended town fails to acknowledge the presence and value of the old settlement; instead, it is encroaching upon it. This has led to adverse impacts at all levels—from the broader precinct scale down to individual architectural elements. Recent developments in the built environment have largely turned their backs on both tangible and intangible heritage, as well as the natural heritage embedded in the town's ecological fabric, which includes two rivers and significant temples. Rapid urbanisation is neither responsive to nor in harmony with the stories, traditions, and cultural layers that are woven into every corner of the historic town.

We can't freeze the development and change is inevitable but managing change is the requisite for all such settlements in India and Saswad is one of those significant one beholding for better management of change.

Endnotes

- (i) Saswad City Council. Information about Saswad town. Accessed on 29th August, 2020, <http://saswadnagarparishad.org/>
- (ii) Saswad is located 40 kilometers away from Pune well known as capital of Peshwas in 18th Century.
- (iii) Samadhi is the small-scale sculpture usually located close to temple or riverside.

References

- Chaghatai M. A. (1941). *Poona in the Muslim period*, "Bulletin of the Deccan College Research Institute", June 1941, Vol. 2, No. 3/4, 406-410.
- Dighe V.G. (1944). *Peshwa Bajirao I and Maratha expansion.*, Bombay, Karnataka Publishing House.
- Gazetteer of the Bombay Presidency Poona.* (1954). Volume XVIII Part III.
- Lavand Vaidehi. (2018). *Understanding Heritage potential of Saswad*, "A HISTORIC Medieval Town of Deccan" *International Journal of Engineering Research* (2018) 7(special 3) 239.
- National Institute of Urban Affairs. (2023). *Guidebook for adoption of Form Based Codes*. Amrut and Hriday Schemes. Retrieved from <https://www.india.gov.in/> & [https://www.myscheme.gov.in/Saswad Varshiki](https://www.myscheme.gov.in/Saswad%20Varshiki), (2008) Annual magazine, Saswad, published by City Council Saswad.
- Oak Pramod. *Peshwe Ghranyacha Itihas.*, January. (2011). Pune, Continental Prakashan.,
- Saswad City Council. (2020). *Information about Saswad town*. Accessed on 29th August, 2020, <http://saswadnagarparishad.org/>

- Shah. (2012). "The Village in The City, The City In The Village." *Economic and Political Weekly*, December 29, 2012, Vol.47, No. 52, pp.17-19.
- Shankar P. (2012). *History Of Cities Urban History of Form and Space from beginning till today What is a City?*
- Sowani Avinash. (2011). *Maratha Town and City planning with reference to the systems of Village development during 17th and 18th centuries*, Poona, Thesis work submitted to Tilak Maharashtra Vidyapeeth, Published online.
- Venkatrama C.P. (1994). *Town planning in Ancient Dekkan.*, Madras, Asian Educational services.

Accelerating India's Electric Vehicle Revolution: Policy, Sustainability, and the Road Ahead

Nagarlok
ISSN-0027-7584
56(4), 547-560
October-December, 2024
© 2024 IIPA

DOI: <https://doi.org/10.32381/NL.2024.56.04.11>

Priti Rana* and Amna Mirza**

Abstract

India's journey towards electric vehicles (EVs) is not just an environmental necessity or an issue but also a strategic move to reduce dependency on fossil fuels, improve air quality, and foster economic growth through sustainable mobility solutions and dynamics. This paper elucidates the current landscape of EV adoption in India, analysing key policies such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) and the National Electric Mobility Mission Plan (NEMMP). It discusses the challenges of infrastructure, resource sustainability, and regulatory frameworks, while proposing key recommendations to enhance EV adoption, including financial incentives, localised manufacturing, and strengthened public-private collaborations. Moreover, the paper canvases the role of a circular economy for EVs, focusing on battery recycling and reuse to ensure long-term environmental benefits. As India works towards integrating EVs into public transportation systems and daily life, this paper elucidates the critical role of citizens, civil society, and corporate innovation in achieving a greener, more sustainable future for the nation.

Keywords

Electric Vehicles, India, EV Policies, FAME, Circular Economy, EV Infrastructure, Public Transportation, Policy Recommendations, Green Mobility.

Introduction

The advent of electronic vehicles marks a significant milestone in the journey towards sustainable mobility and environmental preservation. With transport accounting for approximately 23 per cent of global energy-related greenhouse gas emissions,

* Dr. Priti Rana, Assistant Professor, Faculty of Law, University of Delhi.
Email: prতিরanamalik@gmail.com; prana@lc1.du.ac.in

Corresponding author:

** Dr Amna Mirza, Associate Professor SPM College, University of Delhi.
Email: amna@spm.du.ac.in; amna.mirza786@gmail.com

transition to cleaner technologies has been out of compulsion rather than as a choice (International Energy Agency, 2023). EVs are strictly electricity-driven and not fossil-fuel-driven, and this means that they can play a good role in changing climate trends by reducing air pollution while boosting energy independence. In 2023, according to the International Energy Agency (IEA), more than 26 million EVs were recorded, exceeding only 1.2 million in 2015. Such an impressive growth curve is attributed largely to improvements in battery technology, decreasing production costs, and supportive government policies.

For effective policies on EVs, all stages—from production to disposal—must necessarily contain sustainability. As Lester Brown, a renowned environmentalist once opined, “The automobile is a creature of the fossil-fuel age. If we are to usher in a sustainable future, we must reinvent it with the power of renewable energy.” The conversion into EVs is indeed not merely a matter of transition of technology but a paradigm shift in governance, policy-making, and social behaviour. This paper explores the details of the EV policy framework and sustainable governance against the background of current global best practices and recommends tailored fits to India’s socio-economic nuances.

The History of Electric Vehicles

The Indian experience with electronic vehicles dates back to the beginning of the decade of 1990, but their uptake was minimal in India due to unavailability of technology capabilities and infrastructure. The FAME scheme, launched in 2015 brought in subsidies for the industry. By 2020, two- and three-wheelers had accounted for more than 80 per cent of the EV market. In 2021, the state policies and fuel price increase had a surge of 168 per cent in the EV sales. Delhi, Maharashtra, and Karnataka had dominated the list with the favourable policies. The second one was the launch of Tata Nexon EV in 2020, which again accounted for 80 per cent of the passenger EV market by 2023. India aims for 30 per cent penetration of EVs by 2030, which is also in line with its target to reduce carbon emissions by 33-35 per cent from 2005 levels under the Paris Agreement.

The Indian EV ecosystem is made possible through joint efforts of government initiatives, private sector investments, and international partnerships. Central government has been a vital force behind revolutionising the ways of going electric. The FAME II scheme was launched in 2019 with a budget of ₹10,000 crore. It is providing incentives for both EVs as well as building up the charging infrastructure. As per the latest data available up to 2023, over seven lakh EVs were supported under FAME II, which has significantly reduced upfront cost to consumers. Furthermore, state governments have also been following suit, drafting policies according to local needs.

Karnataka offers incentives for setting up EV production units to make it as the leading hub for manufacturing EVs. Maharashtra offers a subsidy of up to ₹2.5 lakh

for buying EVs besides waiving off road taxes. Indian companies have been ahead in both innovation and manufacturing of EVs. Leading the passenger EV segment is Tata Motors, which itself offers electric cars like Nexon EV and Tigor EV. Companies like Ola Electric, Ather Energy, and Hero Electric have revolutionised urban mobility in terms of affordable and high-performance electric scooters. Ola Electric became India's largest electric two-wheeler manufacturer in 2022 by producing over one lakh scooters annually. Mahindra Electric and YC Electric Vehicles dominate this three-wheeler market, adding to the convenience of last-mile connectivity through cost-effective, green, and environment-friendly transport in cities. The leading global players have also gained entry into the Indian market with the help of local associates.

Hyundai and MG Motors have launched premium EV models such as Kona Electric and ZS EV for the more affluent section. The success of EVs depends upon a robust charging network. Companies like Tata Power, Fortum India, and smaller startups like ChargeGrid are expanding charging infrastructures all over cities and highways. By 2023, India had installed more than 10,000 public EV charging stations, with plans to scale up this number significantly in the following five years (CEA, 2023). Despite all this, the main challenges remain: the dearth of widespread charging infrastructure; high battery costs; and lack of awareness on the consumer side. The push by the government to manufacture batteries indigenously and other initiatives, such as the Production Linked Incentive (PLI) scheme for EV components, will largely smoothen out these frictions.

The electric two-wheeler segment is expected to grow at a Compound Annual Growth Rate (CAGR) of 40 per cent between 2023 and 2030, with the potential to create 10 million direct and indirect jobs (NITI Aayog, 2023). Introducing renewable energy with charging systems for EVs can further strengthen the sustainability of the sector. India's transition towards becoming an electric vehicle (EV) nation has been shaped by a dynamic interplay of policy interventions, private sector innovation, and a growing consumer demand. From the humble beginnings of the Reva car to the country's ambitious goal of achieving 30 per cent EV penetration by 2030, this evolution stands as a strong testament to India's commitment to sustainable development. With continued investments in technology, infrastructure, and governance, India will hopefully emerge as a global leader in an Recreational Vehicle revolution, paving the way for a greener and cleaner future.

Policy Frameworks for Electronic Vehicles

The robust policy support in countries like Norway, China, and the United States, has proven to be a model policy support for India regarding its quest to shift to electric vehicles.

China, the largest Electric Vehicle (EV) market globally, has prioritised manufacturing and infrastructure development. Policies such as the New Energy

Vehicle (NEV) Subsidy Program and mandates requiring automakers to produce a certain percentage of electric vehicles (EVs) have driven innovation and accelerated mass adoption. As of 2023, more than 40 per cent of global EVs were produced in China, with the help of a massive charging infrastructure network of five million charging points, reports International Energy Agency, 2023. The Chinese model illustrates how subsidisation needs to be provided simultaneously with tight production quotas to make the market competitive. Federal tax credits up to \$7,500 for the purchase of EVs, together with level incentives of states, have generally propped up demand. California's Zero-Emission Vehicle Program forces auto manufacturers to sell a certain number of electric or hydrogen-fueled vehicles, making it the front-runner in terms of EV uptake.

Investments in renewable energy-powered charging stations set against this policy background underscore the participation of decentralised policy frameworks that can incubate regional EV ecosystems. Central initiatives such as the National Electric Mobility Mission Plan and FAME Scheme are framed to establish strategies at the state level, and these, on the whole, depict the government's intentions towards reducing carbon emissions, reducing dependence on fossil fuels, and providing a competitive advantage in global EVs. The National Electric Mobility Mission Plan (NEMMP), launched in 2013, targets achieving annual sales of 6-7 million EVs by 2020, along with the development of EV technologies and charging infrastructure. This policy pays more attention to demand-side incentives, supply-chain improvements, and R&D investments. While the NEMMP renders a strategic direction, the actual implementation has been challenged due to limited awareness, slow infrastructure development, and inadequate funding (Ministry of Heavy Industries, 2013).

Building upon that, FAME II, launched in 2019, has set aside ₹10,000 crores to support the increase in subsidies and charging infrastructure. By 2023, FAME II had supported the deployment of over seven lakh EVs and the installation of 2,877 charging stations across the country (Economic Survey of India, 2023). Despite these achievements, issues like delay in disbursing the subsidy and lack of transparency in the implementation process have limited the programme's overall potential. At the state level, EV policies have been tailored to suit local priorities. Delhi's EV Policy 2020 primarily focuses on demand incentives, targeting 25 per cent EV penetration in new vehicle registrations by 2024. The policy offers purchase incentives of up to ₹1.5 lakh for electric cars and waives registration and road taxes. Similarly, Maharashtra's EV Policy 2021 provides subsidies of up to ₹2.5 lakh for electric vehicles, along with incentives for manufacturers to set up EV production facilities.

Karnataka has positioned itself as the "EV capital of India," becoming the first state to implement a comprehensive electric vehicle policy in 2017. The state's targeted manufacturing incentives have attracted significant investments in EV and battery technology. By 2023, companies like Ola Electric had established manufacturing

units in Karnataka, reinforcing its status as a leading hub for EV production. (NITI Aayog, 2023).

Governance and Sustainability Arena

Sustainable governance refers to a policy and practice framework that integrates economic, social, and environmental objectives in ensuring balanced and sustainable growth. Sustainable governance, in the context of electric vehicle adoption, refers to the implementation of policies and systems that encourage EV acceptance while minimising environmental impact. It underscores long-term planning, stakeholders' inclusivity, and efficient resource utilisation to ensure that EVs contribute meaningfully to the reduction of greenhouse gas emissions, air pollution, and dependency on fossil fuels. To the United Nations, sustainable governance calls for marrying the interests of all stakeholders, from governments and private enterprises to civil society, while addressing world challenges such as climate change and resource scarcity. That means the entire vehicle life cycle — from production, to operation, to end-of-life — should aim for minimal environmental impact and maximum societal benefits (UNEP, 2023)

The success of EVs largely depends on the charging infrastructure. As of 2023, it had around 10,000 public charging stations, a number that grossly falls short compared with the estimated requirement of over 2.5 million chargers by 2030 (Central Electricity Authority, 2023). Inadequate charging density and reliability create “range anxiety” among the consumers that dampen the adoption of EVs. Combining the integration of EVs with electricity added to challenges in the capacity and stability of the grid. Demand for electricity from an increased number of EVs would cause widespread power outages if the grid was not upgraded to support the load. According to the NITI Aayog (2023), the country has to invest heavily in smart grid technologies and integration of renewable energy sources for mass adoption of EVs with sustainability. The production of EVs, particularly their batteries, poses significant sustainability challenges.

India, which is dependent on imports for these critical minerals, faces significant additional challenges related to resource security and geopolitical dependencies. Recycling and repurposing used EV batteries are required to address these concerns, though the Indian battery recycling market is still at an early stage of growth. A circular economy for used EV batteries needs to be established through effective governance to reduce reliance on raw materials and minimise waste. India's fragmented regulatory landscape often delays timely and effective policymaking for electric vehicles (EVs). Although there is the central scheme FAME II, it has failed to bring coordination in terms of policy at the state level, keeping everything inconsistent in implementation. For instance, states like Delhi and Maharashtra have advanced EV policies, but others lag due to limited resources and expertise. However, the absence of standardised guidelines for charging infrastructure, battery swapping, and EV manufacturing

creates uncertainty for investors and manufacturers. Delays in subsidy disbursements under FAME II have also deterred consumers and businesses from transitioning to EVs (Ministry of Heavy Industries, 2023). Public-private partnerships, or PPPs, are surfacing as a main mechanism for addressing the challenges in governance and sustainability of EVs. Collaboration between both sectors will accelerate infrastructure development, facilitate innovation, and ensure the effectiveness of policy implementation. As public agencies collaborate with private companies, expansion of charging networks across India continues.

For instance, Tata Power, in collaboration with the Indian Oil Corporation, set up EV charging stations across the country at fuel stations by combining public infrastructure with private expertise. Companies like Ather Energy and ChargeGrid are also making a difference in city-area charging stations, finding support in the incentives offered by the government (CEA, 2023). Public institutions and private players will have to come together to develop a circular economy for car batteries. Companies such as Mahindra Electric and Tata Chemicals have been investing in battery recycling technologies, while initiatives under the National Resource Efficiency Policy aim at achieving sustainable resource utilisation for the country. PPPs can facilitate innovation through joint research and development (R&D) efforts. For example, private investment in the production of ACC batteries has been triggered by the Production Linked Incentive (PLI) scheme, thereby minimising the need for India to import such products.

International collaborations such as those with Tesla and BYD have further expanded India's techno-capability in the EV segment. At the heart of the country's success in transitioning into EVs are governance and sustainability: While EVs certainly are benefitted with crucial environmental advantages, urgent attention needs to be given to challenges associated with infrastructure, resource sustainability, and regulatory framework. Sustainable governance has to take a holistic approach by covering the entire lifecycle from production to disposal of an EV in an equitable manner. Coordinated policies and multi-stakeholder collaboration, in public-private partnerships, can further reinforce efforts in overcoming those challenges. Literature Review associated with the governance framework emphasises the role of coordinated policies and multi-stakeholder collaboration in promoting the adoption of electric vehicles. Sovacool et al. (2020) have argued that environmental, economic, and social dimensions must be integrated into governance strategies to ensure sustainable transitions in mobility. Successful governance of EVs requires harmony between public sector regulations, private sector innovation, and civil society engagement. According to case studies from Europe and Asia on EV policies, Sovacool et al. determine that well-defined governance structures were typical of countries that could achieve high EV adoption rates, such as Norway, "both by offering attractive tax incentives and by investing considerably in infrastructure and involving local governments in implementation."

Literature Review

Several studies have examined the environmental benefits of electric vehicles (EVs), while also addressing concerns about their impacts across the entire life cycle.” Hawkins et al., (2013) conducted a comprehensive lifecycle comparison of EVs with conventional internal combustion engine (ICE) vehicles focusing on greenhouse gas emissions. Their results indicate that EVs emit drastically fewer emissions during usage, but the manufacturing emissions of batteries, mainly lithium-ion batteries, can negate these benefits. From this foundation, researchers such as Gaines (2021) have explored avenues to reduce the environmental footprint of the batteries used in EVs, like recycling and second life. For Gaines, this is crucial to prevent overdependence on raw materials and to generate waste well. For India, this highlights the fact that it must give top priority to policies and investments in battery recycling technologies to make the transition towards EVs sustainably environmental. Charging infrastructure is currently one of the biggest factors affecting the adoption of EVs. Wang et al. (2019) studied the effect of charging infrastructure on the increase of growth of the EV market in China, and observed that a direct correlation exists between the density of charging stations and the level of willingness to buy EVs. It was shown that urban centers with well-developed charging networks grew faster than rural areas.

Sharma et al., (2023) further examined state-level EV policies, noting a significant difference in their implementation. States like Delhi and Maharashtra, which offered comprehensive incentives and infrastructure support, outperformed others in EV adoption. The authors argue that the lack of a uniform national policy framework creates disparities and hinders the overall growth of the EV market. Their recommendations include establishing standardised guidelines for charging infrastructure, streamlining subsidy processes, and encouraging inter-state collaborations to address regional disparities. The social and economic implications of adopting EVs have also been exhaustively considered in academic literature. Banerjee and Dutta (2021) emphasized the potential for jobs in manufacturing, battery production, and maintenance arising due to the adoption of EVs. According to an estimate by them, the gradual transition to EVs can create jobs worth up to 10 million by 2030 if the government is ready to invest in skill building and local manufacturing.

On the social side, Narayan et al., (2022) have highlighted the importance of inclusive EV policy that responds to the needs of the lower strata of society. They concluded that high upfront costs and little access to charging infrastructure in rural areas proved to be disincentives for the use of EVs by economically weaker sections. They have suggested targeted subsidies, low-cost financing options, and awareness campaigns so that the benefits of EVs are equitably distributed across society. The literature underlines that, for EVs, governance and sustainability are not independent but interdependent elements necessary to understand the requirement of a multi-dimensional approach that assimilates environmental, social, and economic objectives. Though, in India, policies have been designed and public-private partnerships

promoted at a significant level, it is necessary to address infrastructure deficits, resource sustainability, and regulatory inefficiencies. By availing itself of global best practices and adapting them to the particular localities, India can build a sustainable and inclusive EV ecosystem which supports its broader goals of economic growth and environmental preservation. Key Analysis of Reports on Governance and Sustainability; International Energy Agency (IEA): Global EV Outlook 2023 by the International Energy Agency gives an overview of global EV adoption trends, policy frameworks, and sustainability challenges. According to the report, EV sales had reached more than 14 million units in 2022, reaching 14 per cent of all new vehicle sales worldwide, led by China, Europe, and the United States.

The most important insight here is that robust governance structures enable these areas to encourage consumers and manufacturers with integrated policies that ensure economic and environmental advantages.

For India, in particular, the report foresees it becoming as a global hotbed for the electric vehicle sector because of its rising demand and manufacturing capacity. It flags, however several challenges --- such as inadequate charging infrastructure, reliance on imported critical minerals, and a fragmented regulatory landscape. The IEA suggests that India put emphasis on the implementation of integration of renewable energy, public-private partnerships, and battery recycling as it targets global sustainability directions.

NITI Aayog: India's Green Mobility Report (2023)

The NITI Aayog, in its India's Green Mobility Report, develops the Indian road map towards attaining its EV goals while pointing towards necessary sustainable governance frameworks. The report further states that 30 per cent of its private vehicles, 70 per cent of commercial vehicles, and 80 per cent of two- and three-wheelers are proposed to be electric by 2030. These are lofty targets that are supported by policies such as FAME II and the Production Linked Incentive (PLI) Scheme for Advanced Chemistry Cell (ACC) battery manufacturing. It concludes on crucial gaps in India's EV ecosystem, be it lack of charging infrastructure in tier-2 and tier-3 cities, slow implementation of state-level policies, or inadequate investment in R&D for battery technology. These recommendations have favoured a region-specific approach to governance on the EV, with states coming together for the development of infrastructure and sharing best practices. The report further emphasises on the need for integration of renewable energy into EV charging systems, indicating that this might reduce CO₂ emissions by as much as 20 per cent in 2030.

Economic Survey of India (2023)

The Economic Survey of India (2023) dedicates a section to electric mobility, emphasising its potential to advance the nation's climate goals and energy security

objectives. The survey notes that EV penetration in India remains low, with only 1.3 million EVs sold in 2022, compared to 14 million globally. It attributes this to high upfront costs, limited charging infrastructure, and delayed implementation of Central and state policies.

The survey applauds the FAME II scheme for incentivising EV adoption and manufacturing but points out that disbursement delays and bureaucratic hurdles have limited its impact.

It also highlights the success of state-level policies, particularly in Delhi and Maharashtra, where comprehensive incentives and infrastructure support have significantly boosted the higher adoption of EVs.

Recommendations for Advancing EV Governance and Sustainability in India

To spur greater adoption of electric vehicles (EVs) and improve sustainability, India must fine-tune and extend its policy framework. Although the Indian government introduced initiatives such as FAME and the National Electric Mobility Mission Plan, (NEMMP), much is required to be done to integrate both schemes in a more viable manner. There are several policy improvements that can be considered. Among those, the enhancement of financial incentives is one major improvement to the extent that the value added will now be higher under the scheme.

The subsidy under FAME II has helped cut the initial cost for electric vehicles. However, the main challenges have been delays in disbursement of subsidies and insufficient coverage across EV categories.

The Indian government should simplify the process of the subsidies disbursed to the customers, ensure punctual payment, and encourage more categories with incentives, including incentives for two-wheelers and commercial vehicles, which constitute the lion's share of India's vehicle fleet. Critical parts such as Battery production of the battery should be incentivised locally. India can develop a strong base for EV manufacturing by engaging with domestic industries and their workforce. The government should incentivise local battery, electric motor, and charging equipment manufacturing. This would not only create jobs but also help in reducing the costs associated with EVs. Special attention needs to be laid on R&D in battery technology, especially on improving energy density, decreasing cost, and increasing the life cycle of batteries. Public funding for R&D may be boosted by private sector participation through tax breaks or matching funds for innovation.

There is a need for the government to encourage the development of advanced recycling facilities, coupled with a legislation to encourage the safe collection, disposal, and recycling of used EV batteries. Developing this infrastructure between the private and public sectors will be crucial in building an efficient collection and

processing system for batteries; this alternative also includes battery reuse and second-life applications. For example, spent EV batteries are repurposed for stationary energy storage, contributing towards the stability of grids along with renewable sources. Nevertheless, public awareness campaigns can motivate consumers to recycle old batteries at collection points with the aim of recycling them safely and minimising negative impacts on the environment. Integration of battery recycling and second-life applications would offer more benefits that reduce the demand for new raw materials while creating economic opportunities such as battery refurbishment and materials recovery. The adoption of EVs by private customers is important for reducing carbon emissions and pollution.. as the buses auto-rickshaws, and taxis are major contributors to pollution in most Indian cities, significantly affecting local air quality and contributing to national greenhouse gas emissions.

Public transport vehicles converted to electric models can greatly reduce the pollution levels, benefitting the environment as well as human health. This, however, requires coordinated planning, investment, and policy reforms. The Government will have to incentivise the electrification of public transport systems by offering incentives for buying and operating electric buses, taxis, and auto-rickshaws. PPPs may also help increase the size of EV fleets in urban centres. Cities like Delhi and Mumbai can achieve large-scale adoption of electric buses by offering incentives that cover both the cost of the buses and the development of charging infrastructure. The main challenge is that the upfront cost of these electric buses is too expensive for many state transport authorities. In this regard, the government should offer long-term finance and low-interest loans to make these vehicles more affordable. Additionally, collaborations with education institutions for supporting research in sustainable transportation can establish an innovative and problem-solving environment.

Influencing consumer behaviour towards responsible decision- making, such as shared electric mobility solutions or reduced use of personal vehicles, can further enhance a culture of sustainability. A circular economy for EVs, significantly through improved recycling and battery reuse structures, will ensure that the environmental benefits from electric mobility are not diminished by unsustainable practices. It will also help in reducing emissions, cleaning up the air, and easing traffic congestion by strengthening public transportation systems and integrating EVs into urban mobility networks. The role of citizens and civil society is huge in developing a culture of sustainability. With the correct combination of policy support, development of infrastructure, and active public engagement, India can establish a sustainable EV ecosystem that will drive the country towards a greener and cleaner future.

Case Studies Analysis

Some of the specific examples highlighting the experiences of individuals, companies, and government initiatives in adopting and promoting EVs in India are given below.

These cases are backed by actual reports, press releases, and market research—**Electric Vehicles Policy and its adoption in Delhi**—Delhi, the world's most polluted city, is now at the forefront of India's campaign for electric vehicles. In 2020, the Delhi government launched an ambitious EV policy aimed at accelerating the adoption of electric mobility in the city. The policy offers significant incentives, with a subsidy of up to ₹30,000 on electric two-wheelers and up to ₹1.5 lakh on electric cars, besides rebates on road tax and registration fees. Anjali, a middle-class professional in Delhi, grabbed the opportunity presented by the Delhi EV Policy in 2021 when she brought home an electric scooter. She was motivated by the financial incentives as well as the government's push to reduce pollution. Anjali says that the savings on fuel costs---from petrol to electricity---and the overall lower maintenance costs of the electric scooter were big motivators. On the infrastructure front, she is lucky to have a charging point at her home, so it is a convenient option for her. However, she mentioned that public charging infrastructure remains underdeveloped in most parts of the city, especially in congested areas. This has the potential to overcome a significant challenge as the Delhi government plans to install over 200,000 charging stations by 2025.

Maharashtra's EV Fleet Adoption – Vijay's Case from the Fleet Owner's Perspective

Maharashtra, one of the biggest states in India and known to be the most industrialised, rolled out its EV policy in 2021 with a target of achieving 10 per cent EV penetration in vehicle sales by 2025. This policy covers all kinds of incentives for consumers and businesses — subsidies for electric vehicle purchase, infra support for the installation of charging stations, among others. Vijay, an auto-rickshaw fleet operator in Pune, has chosen to convert a few of his fleet to electric vehicles. He operates 20 rickshaws and has replaced three with electric versions. The trigger for him was when the state government announced EV subsidies along with long-term fuel savings. These electric rickshaws operate with lesser costs compared to the normal rickshaws as they do not consume expensive fuel and have fewer moving parts that require maintenance. In addition, Vijay's case illustrates the problems of the adaptation process of EV in fleet operations. The main problem was the absence of fast-charging infrastructure in parts of Pune. It takes more time than refueling a traditional rickshaw to charge an electric rickshaw, which translates into downtime between passenger trips. Still, Vijay is upbeat about the future of EVs, mainly since the Pune Municipal Corporation is planning to roll out more public charging stations in the city as part of the Maharashtra EV policy. In the short run, his case will make a case for developing reliable charging infrastructure to make the adoption of EVs possible for fleet operators.

Bengaluru's Electric Vehicle Adoption by Ola Electric: Ride-Hailing Services

Ola Electric is also one of the major players in the electric vehicle revolution in India. Ola Electric was launched in 2021 as an electric scooter called the Ola S1. It became

an instant hit when it arrived in the market due to its competitive price and modern features. In Ola's strategy, electrification of the ride-hailing fleet has been included. Ravi Kumar is a case from Bengaluru who was an Ola driver. These ride-hailing services can benefit much from electric mobility, and in this case, Ravi had switched to an electric scooter after incentives were offered, along with access to the Ola Electric network of charging stations.

He observed that his daily running cost was significantly reduced as compared to his earlier petrol scooter. The maintenance cost and the savings on fuel also helped save his earnings, and he loved the green impact of driving a car in a city known so much for pollution. But Ravi says the critical cost of entry for electric scooters remains a significant barrier for most drivers, especially the ones who get paid daily. He suggests the government should provide more subsidies to bring electric two-wheelers upto the reach of the low-income groups, constituting the large share of the ride-hailing market.

Conclusion

India holds significant potential for the adoption of electric vehicles (EVs) as a strategic response to the country's pressing environmental, economic, and energy security challenges. A robust regulatory framework is very much needed to support the wide-scale adoption of electric vehicles. In India, for instance, the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme has played a significant role in subsidising EVs and developing charging networks. Similarly, in the European Union, the Green Deal emphasises clean energy transitions and focuses on expanding the support systems for EVs. The United States, for example, has set aside billions of dollars in its National Electric Vehicle Infrastructure (NEVI) program to develop charging stations along highways to make long-distance travel easy for users of electric vehicles. Such initiatives go to show that integrated policies are essential in filling the gap for charging infrastructure and the overall adoption of electric vehicles globally.

Temporal Analysis of Progress in EV Usage

Electric vehicle adoption has made great strides over the last two decades. It was in the early 2010s that EV adoption was slowly picking up with global registrations barely crossing 200,000 units. Advances in technology, declining battery costs, and policy support paved the way for exponential growth. Global sales of more than 1.3 million units in 2015 were due to the incentives and public awareness created. In the post-2020 period, the pace again to reach 10 million globally, thanks to climate commitments, mass production, and companies such as Tesla and BYD. By 2023, it had registered over 26 million EVs, making it evident that regulatory frameworks and sustainable energy policies can change the transportation sectors.

In order to make this transition successful, a multi-pronged approach could be very supportive, including enhanced policy incentives, localised manufacturing, and continued investment in research and development. Strengthening of financial incentives, expansion of public charging infrastructure, promotion of local manufacturing of EV components, reduction of costs, and improved access to consumers—all these are important suggestions. In addition, a circular economy for EVs that aims at recycling and reuse of materials, such as batteries, can solve the environmental concerns and ensure resource sustainability. Strengthening public transportation systems, so as to integrate electric buses and shared mobility solutions, will further reduce emissions and make EVs a viable option for urban commuters. The role of citizens and civil society cannot be overlooked: public awareness campaigns coupled with active participation of the individuals, local community, and environmental organisations will positively foster a culture of sustainable mobility.

References

- Banerjee, P., & Dutta, A. (2021). *Electric Vehicles and Employment Generation in India: Opportunities and Challenges*. *Energy Policy*, 149, 111925.
- Brown, L. R. (2009). *Plan B 4.0: Mobilizing to Save Civilization*. Washington, DC: Earth Policy Institute.
- Central Electricity Authority. (2023). *Annual report 2022–23*. Ministry of Power, Government of India.
- Gaines, L. (2014). *The future of automotive lithium-ion battery recycling: Charting a sustainable course*. *Sustainable Materials and Technologies*, 1–2, 2–7.
- Hawkins, T. R., Singh, B., Majeau-Bettez, G., & Strømman, A. H. (2013). Comparative environmental life cycle assessment of conventional and electric vehicles. *Journal of Industrial Ecology*, 17(1), 53–64. doi:10.1111/j.1530-9290.2012.00532.x.
- International Energy Agency (IEA). (2021). *Global EV outlook 2021: Accelerating ambitions despite the pandemic*. Paris: IEA.
- International Energy Agency. (2023). *Global EV Outlook 2023*. IEA Publications.
- International Energy Agency. (2023). *Global EV Outlook 2023: Catching up with climate ambitions*. IEA.
- Ministry of Heavy Industries. (2013). *National Electric Mobility Mission Plan 2020*. Government of India.
- Ministry of Heavy Industries. (2022). *Annual report on the FAME India Scheme*. New Delhi: Government of India.
- Narayan, P., Mehta, R., & Joshi, A. (2022). *Designing inclusive EV policies: Socio-economic challenges and opportunities for India*. *Energy Policy Perspectives*, 47(2), 134–148.
- Narayan, R., Singh, L., & Verma, K. (2022). *Bridging the Gap: Inclusive Electric Vehicle Policies for Rural India*. *Journal of Sustainable Transportation*, 16(5), 345–359.
- NITI Aayog. (2023). *India's EV transition: Opportunities and challenges*. New Delhi: Government of India.

- Sharma, A., Gupta, R., & Mehta, S. (2023). *Assessing the Impact of State-Level Electric Vehicle Policies in India*. *Renewable and Sustainable Energy Reviews*, 191, 114014.
- Wang, N., Tang, L., & Pan, H. (2019). *Analysis of public awareness and acceptance of electric vehicles in China*. *Transportation Research Part D: Transport and Environment*, 67, 1–13.
- Zarazua de Rubens, G., Noel, L., Kester, J., & Sovacool, B. K. (2020). The market case for electric mobility: Investigating electric vehicle business models for mass adoption. *Energy*, 194, 116841. doi:10.1016/j.energy.2019.116841.