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Building Socio-Ecological Resilience through Smart City Governance: Gender, Sustainability, and Disaster Management in Varanasi

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Krishna Pratap Singh^{*}, Archisman Bhattacharya^{}
and Abhinav Sharma^{***}**

Abstract

Civilisation is fundamentally defined by the evolution of civic society. As the global population is projected to reach 9.7 billion by 2050 and 10.4 billion by 2100, urbanisation remains a critical global trend. While industrialised nations currently maintain an 80 per cent urbanisation rate, less developed regions are expected to grow from 46.5 per cent to 64 per cent by 2050; specifically, India's urban population is anticipated to reach 404 million. To address this growth sustainably, the Government of India launched the Smart City Mission (SCM), focusing on retrofitting, redevelopment, and greenfield expansion. This paper evaluates the Varanasi Smart City project. Despite its cultural significance, Varanasi faces severe demographic pressures that increase its vulnerability during major festivals and fairs. By utilising secondary data, including government reports and academic journals, this research assesses how the SCM enhances disaster management, safety, and socio-economic welfare in Varanasi.

Keywords

Smart City Mission, Disaster Management, Gender, Socio-Ecological Resilience, Varanasi, Sustainable Development.

* Krishna Pratap Singh, Research Scholar (UGC SRF) Department of Political Science, Banaras Hindu University, Varanasi.

Email: kpsbais@bhu.ac.in

** Archisman Bhattacharya, Department of Political Science, Banaras Hindu University, Varanasi.

Email:

*** Dr. Abhinav Sharma, Professor, Department of Political Science, Banaras Hindu University, Varanasi.

Email:

Introduction

The rapid pace of population expansion and the migration of people into cities for accessibility of services like health, sanitation, education, ease of living, and other reasons is putting the contemporary world in a difficult situation. The current world population is about 8 billion, which will be 9.7 billion in 2050 and 10.4 billion by 2100. According to United Nations data, 21 people living in India's rural areas will continue to migrate to the metropolitan area every minute on an average for the coming 20 years. India's urban population will be approximately 404 million by 2050. The urbanisation rate in developed countries is already 80 per cent today, and it is expected to rise to 85.9 per cent by 2050. It is anticipated to grow from 46.5 per cent in 2011 to 64 per cent in 2050 in the less developed regions. Developing nations in Asia and Africa are urbanising more rapidly than other regions of the world.

The Smart City Mission was started by the Government of India to make urbanisation inclusive and sustainable. This Mission's principal goals were aimed at promoting healthy competition, raising the citizens' quality of life, and ensuring sustainable development. The Ministry of Urban Development of India mentioned that a total of 100 cities will be developed under the Smart City Mission, encompassing various sizes and types (e.g., satellite cities, capitals, religious-focused cities). This will raise the standard of living of the upper class as well as the "Neo-Middle Class" and the socio culturally and economically backward people.

The Smart City Management (SCM) framework has been structured into three primary components to enhance the quality of life, foster economic growth, and maintain ecological equilibrium:

1. **City Improvement (Retrofitting):** This component encompasses the renovation and upgrading of existing urban infrastructure to enhance its functionality and efficiency.
2. **City Renewal (Redevelopment):** This component focuses on the revitalisation and transformation of underutilised or neglected urban areas into vibrant and functional communities.
3. **City Extensions (Greenfield Development):** This component involves the establishment of new urban settlements on previously uninhabited or underdeveloped land, thereby expanding the urban fabric.

The Government of India does not impose any specific model for smart cities. The methodology for the development of all smart cities is not universal, as each city must create its own idea, vision, objective, and strategy (Smart City Plan [SCP]) appropriate to its local context, resources, and levels of ambition. The SCM will be carried out at the local level by a Special Purpose Vehicle (SPV) created for the purpose. The

SPV will design, assess, and allocate funding for initiatives aimed at creating smart cities as well as manage, carry out, monitor, and analyse them. Project Management Consultants (PMCs) may be appointed by the SPV to conceive, plan, and carry out area-based projects.

Unplanned and disorganised urban areas increase disaster proneness. In the year 2024, the Emergency Event Database (EM-DAT) recorded 393 disaster cases. These disasters collectively account for 16,753 deaths, physical and mental damage to 167.20 million people, and economic losses of US\$ 242 billion. The Asian continent is the most affected, accounting for 40 per cent of the total disasters, 49 per cent of the casualties, and 66 per cent of the affected population. The Asian continent is the most affected, accounting for 40 per cent of the total disasters, 49 per cent of the casualties, and 66 per cent of the affected population.

According to their cause and nature, disasters are frequently categorised. Catastrophes are divided into two categories: natural catastrophes and manufactured disasters. On the basis of nature, catastrophes are divided into four categories: elemental, predictable, intentional, and accidental. This study focuses on Disaster Management in the Varanasi Smart City Mission. Varanasi, also historically known as Kashi, is a significant hub for *Sanatan Dharma*, Buddhism, and Jainism. Varanasi is considered as one of the first settlements in human history and is often referred to as India's cultural centre. As per the 2011 census, Varanasi is a "Million Plus City" with a population of 1,435,113. The unplanned and unstructured nature of urbanisation, exacerbated by the extreme population pressure, renders Varanasi's municipal and district administrations susceptible to crises and tragedies during important fairs, festivals, and other events.

Due to its involvement in several scholarly, religious, economic, and societal endeavours, Varanasi is home to a large population. Varanasi attracted 6,881,192 and 2,892 tourists from India and abroad in the year 2021, compared to 20,052,629 and 708,678 visitors in the year 2019 prior to COVID-19. The process of urbanisation is unplanned and unstructured due to the extreme population pressure. Being unable to manage such a significant population effectively makes Varanasi's municipal and district administrations vulnerable to crisis and tragedy during important fairs, festivals, etc. To raise the standard of living for its residents, to assist socio-economically disadvantaged areas, to increase sustainability, and to improve Varanasi's appearance, tranquillity, safety, and integration, the "Smart City Mission," which aims to safeguard and establish a reliable disaster management system, includes Varanasi. Under India's grandiose Smart City Mission plan, no city will be separate from its own culture and civilization. Therefore, Varanasi Smart City is being constructed with the motto "*Alaukik, Adhyatmic, Adhunik*" (Supernatural, Spiritual, Modern), while keeping its own character in mind.

Table 1: Disaster Management Initiatives and Benchmarks under the Smart City Mission

S. No.	Parameter	Initiative / Benchmark
1	Transport	- Maximum travel time: 30 minutes in small/medium cities, 45 minutes in metropolitan areas - High-quality and high-frequency mass transit systems
2	Water Supply	24x7 continuous water supply 100 per cent metering of all water connections with direct supply 135 litres per capita per day (lpcd) water availability
3	Sewerage and Sanitation	100 per cent household access to toilets and wastewater connectivity 100 per cent doorstep collection and treatment of solid and liquid waste – 100 per cent recycling of solid waste
4	Stormwater Drainage	100 per cent rainwater harvesting coverage - Efficient stormwater drainage integrated with road infrastructure
5	Wi-Fi & Connectivity	100 per cent household access to telephone and Wi-Fi connectivity
6	Healthcare Facilities	100 per cent telemedicine access for all residents - Emergency medical response within 30 minutes - One 200-bed multispecialty hospital per 1 lakh population - One dispensary per 15,000 residents
7	Fire Fighting	- One fire station per 2 lakh population or within a 5–7 km radius - One sub-fire station within a 3–4 km radius

Source: Author

Literature Review

Urbanisation and the Smart City Paradigm

Rapid urbanisation refers to several significant economic, social, and demographic developments. The urbanisation of the world's population has emerged as a critical issue that must be addressed. Only 30 per cent of the world's population resided in metropolitan areas in 1950. The current world population is about 8 billion, which will be 9.7 billion in 2050. India's urban population is projected to reach approximately 404 million by 2050.

To address these challenges, the Smart City Mission (SCM) was launched to make urbanisation sustainable and inclusive. The comprehensive literature on social

innovation (Brandsen et al., 2016), collaborative innovation (Sorensen and Torfing, 2011), and urban governance (Pierre, 2011) expresses the smart city from different points of view. However, within the Indian context, the SCM is executed by a Special Purpose Vehicle (SPV), which acts as the primary institutional mechanism to plan, allocate resources, and monitor development.

Vulnerability caused by inequality in urbanisation is a core focus of recent scholarship. Cannon defines vulnerability as the characteristics of an individual or group that affect their capacity to anticipate, cope with, and recover from a disaster (Cannon, 1994 and Wisner et al. 2003). In Varanasi, unplanned urbanisation has increased this “disaster proneness”, necessitating a shift from purely technical solutions to Socio-Ecological Resilience (SER).

Gender-Responsive Sustainable Development

Recent scholarship (2015–2025) posits that sustainable development is unattainable without addressing structural gender inequalities. Kabeer (2016) and Agarwal (2018) underscore that gender-responsive planning diminishes “time-poverty” for women, thereby liberating their capacity for economic and civic engagement. This aligns directly with the SCM’s objective of enhancing “ease of living.”

Empirical evidence from the Global South demonstrates that women’s participation significantly improves governance outcomes:

- **Disaster Resilience:** In Bangladesh, consulting women in cyclone shelter design resulted in increased usage rates and a reduction in female mortality. Similarly, in Nepal, women’s inclusion in Disaster Risk Reduction (DRR) committees enhanced early warning dissemination to marginalised households.
- **Community Resilience:** The Kudumbashree network in Kerala and participatory budgeting in Brazil exemplify how women-led governance prioritises essential services such as sanitation and health, which harmonise with Varanasi’s SCM goals of “*Nirmal*” (Clean) and “*Surakshit*” (Safe) Kashi.
- **Climate Vulnerability:** The Intergovernmental Panel on Climate Change (IPCC) (2022) acknowledges that climate impacts in South Asian cities exhibit a pronounced gendered nature. Women residing in informal settlements endure “double burdens” during crises, which technology-centric SCM solutions often overlook.

Socio-Ecological Resilience (SER) Framework

To analyse disaster management in Varanasi, this study employs the Socio-Ecological Resilience (SER) framework (Folke 2016; Olsson 2017). SER transcends the notion of “bouncing back” by emphasising the capacity of complex adaptive systems to undergo transformative change. This framework is underpinned by three pivotal pillars, which are essential for operationalising the Varanasi Smart City objectives:

- **Social Pillar (Agency & Inclusion):** Resilience hinges upon the strength of social networks. Women frequently assume the role of “first responders” within households. Excluding them from the SPV’s planning strategy diminishes the community’s ability to self-organise effectively.
- **Ecological Pillar (Ecosystem Health):** This pillar entails managing natural resources to mitigate risks. In Varanasi, this aligns with SCM benchmarks such as the complete utilisation of rainwater and the efficient management of stormwater drainage.
- **Institutional Pillar (Governance):** Effective resilience necessitates coordination. The SPV and Project Management Consultants (PMCs) collectively represent the institutional capacity to manage crises effectively.

Operationalisation of SER in Varanasi

This study operationalises the SER framework by mapping specific Smart City Mission interventions in Varanasi against resilience indicators:

Table 2: SER Framework

SER Pillar	Resilience Indicator	Smart City Mission (Varanasi) Intervention
Social	<i>Inclusion & Safety</i>	“Surakshit Kashi” (Safe Kashi) initiatives; 100 per cent Wi-Fi connectivity to ensure women and marginalised groups can access risk information.
Ecological	<i>Risk Reduction</i>	“Nirmal Kashi” (Clean Kashi) initiatives; 100 per cent sewerage and solid waste treatment to prevent waterlogging and spread of disease during floods.
Institutional	<i>Response Capacity</i>	Establishment of an effective disaster management system. Benchmark of emergency medical response within 30 minutes and fire stations within 5-7 km radii.

Source: Author

By analysing these indicators, the study assesses whether the Varanasi Smart City Mission is merely retrofitting infrastructure or genuinely constructing a resilient city capable of safeguarding its distinctive “*Alaukik, Adhyatmic, Adhunik*” character.

Research Methodology

This study employs a qualitative research framework based on secondary data to assess the efficacy of the disaster management system in the Varanasi Smart City Mission.

Research Design

In this study, the researcher adopts an intrinsic and instrumental case study approach (Stake, 2000).

- **Intrinsic Case Study:** As per Stake's framework, this design was selected because the researcher requires comprehensive and in-depth knowledge about the case. Studying the case because it exemplifies a specific trait or issue is not the primary objective; rather, it is undertaken solely because the researcher finds the unique context of Varanasi captivating and believes it will facilitate a deeper understanding of resilience in a heritage city.
- **Instrumental Application:** The case also serves an instrumental purpose by providing broader insights into the interplay between "Smart City" frameworks and "Disaster Management" in the Global South.

Data Sources and Collection

The case study draws upon secondary data sourced from government publications, reports, journals, research papers, articles, books, and various websites.

- **Government Publications:** Data pertaining to the SCM's vision ("*Alaukik, Adhyatmic, Adhunik*") and benchmarks (e.g., 30-minute emergency response) are obtained from Ministry of Urban Development guidelines and the Varanasi Smart City Plan.

Tools and Techniques

To ensure the depth of the research in this study, qualitative content analysis and discourse methodologies were employed.

- **Qualitative Content Analysis:** This involved a systematic review of government documents to identify key themes related to "retrofitting" and "Greenfield development." This approach facilitated the assessment of specific SCM benchmarks against the Socio-Ecological Resilience (SER) framework.
- **Discourse Methodology:** This technique was utilised to analyse the policy language, particularly how terms such as "Surakshit" (Safe) and "Nirmal" (Clean) are constructed in policy documents. This analysis aimed to comprehend the government's intended meaning of "smartness" in contrast to the actual ground reality of disaster proneness.

Analytical Framework

The collected data was analysed through the lens of Socio-Ecological Resilience (SER), operationalised via three pillars:

- **Social Pillar:** This pillar examined agency and inclusion, particularly the gendered vulnerabilities in unplanned urban areas.

- **Ecological Pillar:** This pillar assessed ecosystem health through benchmarks such as rainwater harvesting and waste recycling.
- **Institutional Pillar:** This pillar evaluated the governance capacity of the Special Purpose Vehicle (SPV) and Project Management Consultants (PMCs).

Research Procedure

The research was conducted in four distinct phases:

Phase I: Literature and Policy Review

- This phase involved a comprehensive review of global urbanisation trends and the evolution of the SCM mandate to establish the “Smart City” definition within the Indian context.

Phase II: Data Aggregation

- In this phase, qualitative benchmarks were collected in areas such as water supply, transport, and healthcare. Qualitative descriptions of the SPV’s operational structure were also provided.

Phase III: SER Mapping

- Specific SCM projects, including command centres and storm drainage, were mapped to the three pillars of the Socio-Ecological Resilience framework.

Phase IV: Vulnerability Assessment

- The effectiveness of these projects in mitigating specific disaster risks, such as floods and crowds, was evaluated.
- The primary objective of the research was to enhance the “suramya” (appearance) and “surakshit” (safety) aspects of Varanasi.

Case Study-Varanasi Smart City

The Smart City Mission was initiated by the Government of India on June 25, 2015. The objective is to enhance basic services, promote cleaner and more sustainable urban environments, and improve the quality of life in cities. This initiative focuses on four key areas: social, economic, physical, and institutional development. It aims to introduce technology-driven solutions to address long-standing urban challenges.

Cities under this mission were to be developed through two strategies: Area-Based Development (ABD) and Pan-City Initiatives. The ABD model was to be implemented in selected parts of a city through retrofitting, redevelopment (replacing older layouts), and Greenfield development (building entirely new areas). In total, 100 cities were selected for funding and support under the mission. Across the country, 205,018 crore was allocated to carry out over 5,000 projects.

Smart City Pillars

Varanasi was included in the Smart City list in 2016. Its development plan was divided into six main pillars.

Table 3: Pillars of Varanasi Smart City Mission

S. No.	Pillars	Section	Aim and Objective
1.	<i>Suramya</i> Kashi	Area-Based Development	To preserve and enhance the city's cultural identity.
2.	<i>Nirmal</i> Kashi	Area-Based Development	Focuses on environmental health through improvements in sanitation, solid waste management, and related areas.
3.	<i>Surakshit</i> Kashi	Area-Based Development	To address public safety and disaster preparedness.
4.	<i>Samunnat</i> Kashi	Area-Based Development	To promote economic revitalisation by enhancing transportation connectivity.
5.	<i>Ekikrit</i> Kashi	Pan-City Initiatives	Focuses on integrating digital infrastructure for municipal services, using centralised data systems e.g. KICCC.
6.	<i>Sanyojit</i> Kashi	Pan-City Initiatives	Transportation planning and traffic flow regulation

Source: Author

Area-Based Development (ABD) Ward Profile

Under ABD, six wards in Varanasi - Dashashwamedh, Jangambadi, Kal Bhairav, Kameshwar Mahadev, Rajmandir, and Garhwasi Tola were selected for focused intervention. These wards were chosen for retrofitting and redevelopment due to their significant contributions to the city's cultural and economic vitality.

Ward-Level Resilience Assessment in Varanasi Smart City Mission

In Varanasi, the Climate Disaster Resilience Index (CDRI) (Chatterjee et al. 2015) assessment reveals significant spatial variations in resilience at the ward level. The six wards under study – Kameshwar Mahadev, Rajmandir, Kal Bhairav, Garhwasi Tola, Dashashwamedh, and Jangambadi - each exhibit unique profiles of strengths and vulnerabilities across the five CDRI dimensions: physical, social, economic, institutional, and environmental. These wards are situated in two central administrative zones--- Kotwali and Dashashwamedh.

Kotwali Zone: Old City Core Wards

- **Kameshwar Mahadev:** Its physical infrastructure is basic but serviceable; while utilities and housing exist, narrow lanes and dense layouts limit resilience. The

community shows strong social resilience through close-knit ties that promote awareness and provide informal support in times of crisis.

- **Rajmandir:** Rajmandir is slightly better on overall resilience with physical systems like electricity, roads, and water supply. While these services are functional, they remain prone to occasional disruptions. The ward benefits from strong community ties and general disaster awareness, a common strength in Varanasi's old city areas. However, economic resilience is low.
- **Kal Bhairav:** With an overall CDRI score of approximately 2.7, Kal Bhairav ward demonstrates moderate disaster resilience. Its physical infrastructure is relatively strong with stable electricity, water supply, and traditional housing that has historically withstood floods and tremors. Social resilience is a key strength as religious institutions and strong community networks create informal support systems, with temples often serving as shelters during emergencies. The environmental resilience in this area has room for improvement.
- **Garhwasi Tola:** With an overall resilience, Garhwasi Tola presents a mixed profile. Its strongest asset is physical infrastructure with reliable electricity, sound housing, and better-maintained roads than most old-city wards. The ward also benefits from Kotwali zone's institutional strengths, including improved coordination among agencies and enforcement of building norms.

Dashashwamedh Zone: Riverfront and Market Wards

- **Dashashwamedh Ward:** As a cultural and commercial centre, Dashashwamedh ward enjoys a high degree of social resilience: the local population, including priests, traders, and ghat workers, form tight social networks and informal support systems that prove invaluable during disasters. Dashashwamedh ward is in a hazard-prone location; it experiences annual flooding (both riverine and urban flash floods).
- **Jangambadi:** Jangambadi ward, adjacent to Dashashwamedh, also shows a mixed resilience pattern. Jangambadi shares the zone's physical infrastructure challenges: historic temples and lodging houses dominate the area, and many structures are not built to modern hazard-resistant standards. The ward's physical resilience is limited, as road access and open space are extremely limited. On the positive side, Jangambadi has powerful social cohesion. During crises, residents often work together, offering help to neighbours and protecting important religious items. This kind of local support makes a difference during floods and other emergencies.

Validation of Coalition for Disaster Resilient Infrastructure (CDRI) Assessment

The CDRI-based ward-level assessment provided a detailed picture of Varanasi's disaster resilience status just before the city was brought under the Smart City Mission in 2016. It revealed a pattern of deep-rooted vulnerabilities ranging from

weak infrastructure and sanitation to institutional gaps and economic precarity. These insights helped underscore the urgent need for targeted interventions. The Smart City Mission, in response, sought to address these shortcomings through a combination of Area-Based Development and Pan-City strategies. The following section traces how specific Smart City projects, especially in the six selected wards and Varanasi as a whole, attempted to bridge the resilience gaps identified in the CDRI assessment.

Interventions

Key interventions in the ABD zone (Dashashwamedh, Jangambadi, Kal Bhairav, Kameshwar Mahadev, Rajmandir, and Garhwasi Tola) included:

- **Upgrading Utilities and Lanes:** Antiquated 19th-century utility networks were overhauled. The centuries-old sewer and water lines in the winding lanes of these wards were completely replaced. This has markedly improved basic services and reduced chronic sanitation and waterlogging issues, which is vital for public health and flood mitigation. Alongside underground utilities, over 30 km of narrow lanes and pathways were reconstructed with durable materials. New road surfaces and better drainage systems are built to handle heavy monsoon rains and prevent flooding in low-lying alleys.
- **Public Amenities and Smart Facilities:** The ABD ward upgrades also introduced amenities that strengthen everyday resilience. Streets now feature new streetlights, benches, waste bins, and signage, improving safety and cleanliness. The city's strategy also integrated tech-based solutions in these localities; for instance, an expanded CCTV surveillance network covers the old-city lanes, feeding live footage to the central Command Centre for rapid incident response (e.g. managing crowd surges or safety incidents during festivals).

Citywide Improvements

The Varanasi Smart City Mission has launched citywide projects beyond the ABD area to improve disaster preparedness and urban resilience. These projects focus on transportation, public spaces, utilities, and digital governance, making the city more capable of handling emergencies.

- **Urban Mobility and Traffic Management:** Varanasi has invested in modern traffic infrastructure to alleviate chronic congestion and improve emergency mobility. An Urban Junction Improvement project upgraded 16 major intersections and roads (totalling ~20–30 km) connecting the old city. This included redesigning traffic junctions for better flow and adding pedestrian pathways for safe evacuation routes. Significantly, new stormwater drainage systems were built into road improvements to prevent flash floods on busy streets. The city also developed multi-level parking facilities at congested hubs like Godowlia, Town Hall, and Beniyabagh.

- **Riverfront Ghats and Cultural Assets:** The iconic ghats along the Ganga River, critical not just to heritage and tourism but also as front-line buffers during floods, have undergone structural and functional revitalisation. A dedicated Ghat Revitalisation and Façade Restoration project (₹11.88 crore) was undertaken at major ghats, including Dashashwamedh, Ahilyabai, and Darbhanga. These upgrades enhance safety during festivals and high-water events by reducing the risks of stampedes.
- **Digital Governance and Emergency Response:** A centrepiece of Varanasi's smart city infrastructure is the Kashi Integrated Command and Control Centre (KICCC) – a high-tech city operations hub. Established at over 100 crore investment, the KICCC functions as the “nerve centre” for city management, integrating data from various smart systems. It receives live feeds from over 3,000 CCTV cameras deployed citywide and monitors real-time conditions from traffic to crime to utilities. This digital command centre has vastly improved Varanasi's emergency preparedness and response capacity.
- **Environmental Infrastructure (Water, Waste, and Green Spaces):** Upgrades to urban utilities under the Smart City Mission directly contribute to resilience against environmental hazards. Sanitation and water management have seen significant improvements. Varanasi added or expanded six sewage treatment plants (Dinapur, Goithah, Ramna, Bhagwanpur, BLW, and Ramnagar), together processing hundreds of MLD of wastewater. This significantly reduces sewage pollution in the Ganga and mitigating public health risks (e.g. water-borne diseases), especially during floods when contamination can spread. The emphasis on a cleaner, “Nirmal Kashi”, also includes enhanced solid waste management systems. Waste collection is now monitored through the command centre.

Results and Discussion: Comparative Analysis and SER Integration

The analysis of the Varanasi Smart City Mission (SCM) reveals that sustainable development serves as a pivotal mechanism for mitigating structural inequalities. In a city grappling with rapid population growth and resource strain, gender-responsive planning emerges as a functional necessity for building resilience.

Gender-Responsive Sustainable Development and Adaptive Capacity Reducing Structural Inequalities

Investments in core infrastructure, particularly the SCM's benchmarks of 24x7 continuous water supply and 100 per cent household toilet access, directly address the “time-poverty” faced by women. Historically, women have borne the burden of water management in the analysed wards. By automating these services through smart infrastructure, the SCM liberates women's time for economic activities, thereby strengthening the households' financial resilience.

Women's Knowledge and Adaptive Capacity

The study underscores the significance of women's ecological and social knowledge for the SCM's success:

- **Water Management:** As primary managers of household water, women are instrumental in the “Nirmal Kashi” (Clean Kashi) initiatives, serving as early indicators of contamination or water scarcity.
- **Community Cohesion:** In the densely populated and “unplanned and disorganised” urban areas, women's informal networks function as the primary safety net during crises.
- **Health Surveillance:** Women are pivotal users of the “100 per cent telemedicine access” benchmark, enabling early disease outbreak reporting and mitigating the risk of city-wide epidemics.

Operationalising the Framework: Gender in SER

To operationalise how gender mainstreaming fortifies the Socio-Ecological Resilience (SER) of Varanasi, this study transcends the “Retrofitting” of physical assets to strengthen social and institutional connections.

Table 4: Gender in Socio-Ecological Resilience (SER) Framework

SER Pillar	Traditional SCM Focus	Gender-Mainstreamed Resilience	Implementation in Varanasi Context
Social Pillar	Connectivity: 100 per cent Wi-Fi and telephone access.	Agency & Networks: Leveraging digital access to empower women as “risk communicators” during disasters.	Utilising Integrated Command and Control Centres to send localised safety alerts specifically to women's self-help groups.
Ecological Pillar	Infrastructure: Stormwater drainage and rainwater harvesting.	Resource Stewardship: Recognising women's role in waste segregation at the household level.	Integrating women into “Nirmal Kashi” waste management logistics to ensure 100 per cent door-to-step collection efficiency.
Institutional Pillar	Governance: Special Purpose Vehicle (SPV) management.	Inclusive Decision Making: Mandating female representation in the SPV to address gender-specific safety concerns.	Ensuring “Surakshit Kashi” (Safe Kashi) investments focus on pedestrian lighting and safe toilets, not just surveillance.

Source: Author

Comparative Analysis of Gendered Vulnerabilities in Area-Based Development (ABD) Wards

The Area-Based Development (ABD) initiative in Varanasi targets six specific wards: Dashashwamedh, Jangambadi, Kal Bhairav, Kameshwar Mahadev, Rajmandir, and Garhwasi Tola. These wards are situated within the Kotwali and Dashashwamedh Zone (Old City), characterised by high population density and narrow lanes. A comparative analysis uncovers distinct patterns of resilience and vulnerability.

Ward-Level Vulnerability Profile

- **Physical Vulnerability:** The Climate Disaster Resilience Index (CDRI) analysis reveals significant variance. While certain areas demonstrate moderate resilience (e.g., Ward 41 at 2.64), others exhibit significantly lower resilience (e.g., Ward 44 at 2.2). The narrow lanes in wards such as Garhwasi Tola render it physically challenging for standard fire trucks to meet the benchmark of a “5-7 km radius” response, thereby increasing the likelihood of disasters.
- **Gendered Implications:** In wards like Jangambadi, the densely structured layout creates “blind spots.” Despite the “Surakshit Kashi” (Safe Kashi) objectives, the absence of open spaces hinders the construction of gender-segregated community toilets, disproportionately affecting female residents and pilgrims.

Resilience Variance

- **Commercial vs. Residential:** Wards such as Dashashwamedh and Rajmandir, being situated near the *Ghats*, benefit from higher economic activity and enhanced surveillance. Conversely, the quieter residential lanes of Kameshwar Mahadev face isolation challenges during off-peak hours, thereby increasing safety risks for women.
- **Sanitation and Health:** While the SCM aims to achieve “100 per cent sewerage and solid waste treatment,” the “unplanned” nature of these wards presents implementation challenges. The inadequate management of solid waste leads to waterlogging, which disproportionately burdens women due to the prevalence of waterborne diseases.

The comparative analysis indicates that “Retrofitting” in these six wards cannot be a uniform engineering solution. To enhance the CDRI scores in Ward 44 (2.2), the SPV must incorporate gendered spatial planning, such as installing smaller, community-managed emergency response units, to genuinely attain a “Samunnat” (Prosperous) and “Surakshit” (Safe) Kashi.

COVID-19 as a Stress Test for Smart Governance

The COVID-19 pandemic served as an unexpected but revealing stress test for urban governance systems across India. In Varanasi, the pandemic response was not

just a public health emergency—it also demonstrated how smart city infrastructure can be repurposed to enhance institutional resilience and community-level disaster preparedness.

One of the most critical tools in this response was the Kashi Integrated Command and Control Centre (KICCC). Originally designed as a central hub for civic coordination under the Smart City Mission, the KICCC was quickly converted into a dedicated COVID-19 War Room. Here, officials managed real-time data on hospital capacity, oxygen availability, quarantine centres, and emergency service calls. CCTV cameras and GIS maps enabled zone-wise containment, while drones were deployed to monitor lockdown enforcement and disinfect high-risk areas.

The Dashashwamedh and Jangambadi wards in Varanasi demonstrate moderate resilience, characterised by robust social cohesion but vulnerable physical infrastructure. Varanasi's Smart City Mission catalysed the revitalisation of *ghats*, bolstered digital governance through the establishment of the Kashi Integrated Command and Control Centre (KICCC), and enhanced environmental infrastructure. The KICCC, repurposed during the COVID-19 pandemic, effectively managed real-time data, coordinated public services, and facilitated citizen engagement via the Safe Kashi App. These initiatives not only improved urban governance but also established a foundation for future emergency preparedness.

Challenges and Limitations of the Smart City Mission in Varanasi

Despite its robust legacy value and aspirational ambitions in the Smart City Mission (SCM), Varanasi is faced with other systemic and operational challenges that undermine overall resilience and inclusive development.

ABD's Limited Spatial Focus of Implementation

Just six out of Varanasi's hundred urban wards were selected for Area-Based Development (ABD).

This geographically limited emphasis has compromised the coverage of fundamental Smart City Mission (SCM) interventions to a tiny segment of the population and, in so doing, left the majority of the city, comprising vulnerable and underserved populations, outside of coverage by the targeted resilience-building initiatives.

Overlapping Institutions and Coordination Deficiencies

Urban planning in Varanasi is undertaken by multiple agencies, such as the Municipal Corporation, Jal Kal Department, and Varanasi Development Authority, with an overlapping area of operation. The coordination among these institutions could be enhanced to mitigate project delays, reduce redundant spending, and strengthen the effectiveness of integrated urban planning.

Transport and Mobility Shortfalls

The city is experiencing prolonged traffic congestion, particularly in the high-density areas. Constricted roads, hawkers' encroachment, insufficient parking facilities, and the lack of an integrated public transportation system lead to frequent mobility hindrances. Access to emergencies is frequently hindered in the old wards because of insufficient road width and unmanaged pedestrian and vehicle movements.

Policy Recommendations: Global Best Practices for a Resilient Kashi

To transition Varanasi from a “technologically smart” city to a “socio-ecologically resilient” society, the Special Purpose Vehicle (SPV) must look beyond physical infrastructure retrofitting. By adopting proven strategies from global tourism hubs that manage similar high-density challenges, Varanasi can implement the following policies to control critical situations and improve societal well-being.

Table 5: Integrating Global Best Practices for Resilient and Inclusive Smart City Management

S. No.	Challenges Before SCM Varanasi	Global Best Practices	Policy Recommendation
1.	The "narrow lanes" of wards like Garhwasi Tola and Kal Bhairav make it physically impossible to reach disaster sites	Kyoto, a city with similar wooden heritage districts, employs "Citizen Fire Corps" (Jishubo).	Establish a " <i>Gali Rakshak Dal</i> " (Lane Guardian Corps).
2.	High-density gatherings, stampede risks.		Implement "Dynamic Flow Protocols" at major <i>Ghats</i> . The KICCC should be upgraded with predictive crowd AI that triggers automated "Red Alerts" when density crosses safe thresholds (e.g., 4 persons/m ²).
3.	The conflict between vehicular traffic and pilgrims in zones like Godowlia.	Barcelona utilises the "Superblock" (Superilles) model,	Declare the Dashash-wamedh-Godowlia Zone a "Heritage Superblock." The SPV should use retractable bollards managed by the KICCC to allow access only for residents and emergency vehicles.
4.	The "blind spots" in the winding lanes of Jangambadi create safety concerns for women, limiting their mobility despite "Surakshit Kashi" goals.	Madrid employs "Family and Woman Units" (UFAM) within their police force—specialized units trained to handle gender-based violence and tourist safety	Institutionalise "Pink Patrols" within the Tourist Police. Mandate mixed-gender police units for patrols in the narrow lanes of the Old City

Source: Author

Conclusion

The assessment of Varanasi's inner wards using the Climate Disaster Resilience Index (CDRI) conducted prior to the city's inclusion in the Smart City Mission (SCM) revealed high vulnerabilities in physical infrastructure, environmental contexts, institutional readiness, and economic resilience. Although there were resilient social networks and community support systems as local strengths, chronic imperatives like old utilities, poor sanitation, flood vulnerability, and fiscal insecurity highlighted the imperative for targeted urban resilience interventions.

In turn, the Smart City Mission positioned Varanasi at the forefront of heritage conservation, city rejuvenation, and disaster resilience. Through Area-Based Development (ABD) in culturally conscious wards as well as citywide digital infrastructure, the mission achieved tangible outcomes in service delivery, emergency management, and institutional coordination, most prominently through the Kashi Integrated Command and Control Centre (KICCC), adaptive heritage restoration, and upgrading utilities.

The COVID-19 pandemic was an inadvertent tool of assessment that not only confirmed the potential of smart governance but also revealed underlying systemic weaknesses. The Varanasi case indicates that though advanced technologies and infrastructure upgradation can improve disaster management, the efficacy of such measures is contingent on comprehensive planning, agency coordination, and consideration of socio-spatial inequalities. For its future to realise its dream of becoming a fully resilient, inclusive, and culturally rooted smart city, Varanasi's future initiatives would have to go beyond primary domains, encompass marginalised groups, and incorporate resilience into infrastructural and institutional designs—thereby keeping the mission's guiding philosophy: “*Alaukik, Adhyatmik, Adhunik*.”

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Policy Intelligence for Urban Resilience: A Bibliometric Review of Hazard and Risk Governance Research

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Arpan Paul* and Jublee Mazumdar**

Abstract

Urban resilience has emerged as a critical framework in response to climate change, rapid urbanisation, and escalating disaster risks. This study conducts a comprehensive bibliometric analysis of global urban resilience research with an emphasis on hazard and risk management. Using the Scopus database, 1,769 publications from 2000 to 2022 were examined based on search terms related to urban, social, and community resilience. VOS viewer and Microsoft Excel were employed to map keyword co-occurrence patterns, citation networks, influential authors, journals, institutions, and funding agencies. Findings indicate a substantial rise in research output after 2010, coinciding with major global policy initiatives such as the Sendai Framework and the Paris Agreement. Key scholars, including Mark Pelling and W.N. Adger, emerge as central contributors, with research originating from the United States, the United Kingdom, and Australia. Although contributions from the Global South, particularly China and India, are increasing, they remain comparatively limited. The analysis underscores the evolution of urban resilience as a multidisciplinary domain encompassing infrastructure systems, socio-economic dynamics, and community capacities. The study emphasises the importance of more inclusive, geographically diverse, and collaborative research efforts to better represent the diverse urban contexts. The results provide valuable evidence to inform future research directions, funding strategies, and policy frameworks to foster resilient and equitable urban futures.

Keywords

Urban resilience; Hazard and risk management; Bibliometric analysis; Community resilience; Climate adaptation.

* Arpan Paul, Assistant Professor, School of Human Settlements, XIM University.
Email: arpan@xim.edu.in

** Jublee Mazumdar, Assistant Professor, School of Human Settlements, XIM University.
Email: jublee@xim.edu.in

Introduction

In recent years, the concept of resilience has become increasingly associated with climate change, disaster risk, and hazard studies, with cities playing a vital role. Cities are the centres of socio-economic opportunities, cultural hubs, and technological innovation for their catchment areas. Due to rapid urbanisation, approximately 57 per cent of the global population currently resides in urban areas (2024). The share is expected to increase to 68 per cent by 2050 (United Nations, Department of Economic and Social Affairs, Population Division, 2024). Rising urbanisation and population growth contribute to higher carbon emissions across global cities. Although urban areas cover only 3 per cent of the earth's surface, they are responsible for 75 per cent of the world's total carbon emissions (Tao, Ma, Shen, & Chai, 2022). Cities are at the forefront of absorbing the brunt of such uncertainties, whether natural hazards or pandemic-like situations. The increasing urbanisation trends, characterised by high population and asset density, economic activity, and a growing global demand for infrastructure, have made cities more susceptible to such uncertainties (Zhao, Fang, Liu, & Zhang, 2022). As cities expand and face the challenges of climate change, building resilient systems has become a key focus of discussion (Oh & Lu, 2023).

Currently, research on urban resilience is attracting greater attention and significance from urban management perspectives. Resilience remains a contested and evolving concept due to its multidimensional and interdisciplinary nature. The implications of resilience research vary across contexts and research settings (Zhao, Fang, Liu, & Zhang, 2022). The increasing rate of urbanisation since the 1980s and the intensifying frequency of disasters have prompted international organisations to consider sustainable futures. Consequently, the 1980s and 1990s are known as the 'International Decade for Natural Disaster Reduction' (IDNDR), declared by the United Nations (Tao, Ma, Shen, & Chai, 2022). In the early 1990s and 2000s, the concept of 'vulnerability' was more widely debated in the context of disasters (Oh & Lu, 2023). The discussion on resilience has been a long-standing presence in the literature, encompassing social and ecological resilience (Joshi & Wende, 2022), community resilience (Liu, Cao, Yang, & Anderson, 2022), and economic resilience (Mallick, 2021). Although both terminologies share many conceptual intersections, they are considered two sides of a coin and are perceived distinctly to attain sustainability (Liu, Cao, Yang, & Anderson, 2022). Much uproar over achieving resilient urban systems was increasingly placed on the global agenda during the Paris Agreement (2015), the New Urban Agenda 2030 for Sustainable Development Goals (SDGs), and the Sendai Framework (2015-2030) to address issues of climate change and disaster. Since then, there has been a paradigm shift in the language and discussion surrounding the concept of resilience, with it now considered a crucial path towards sustainability (Zeng, Yu, Yang, Lv, & Sarker, 2022).

The urban systems and their relationships with disasters are complex and dynamic. Therefore, implementing a resilient urban systems approach for sustainability remains

non-standardised (Paul, 2020); (Sharifi, 2023). They require continuous assessment, both theoretically and empirically, to develop their knowledge base. Therefore, this paper will expand the knowledge base by mapping the bibliometric study of urban resilience and its associated sub-areas, i.e., social resilience and community resilience, in the context of disaster risk reduction.

Research Design

The paper employed a systematic literature review and an exploratory research approach, incorporating bibliometric and historical trend analyses. In terms of temporal trends in urban resilience research across diverse spatial extents, the paper quantitatively assessed global research trends at various hierarchical levels. The Scopus database has been used for the analysis. A pool of articles has been shortlisted based on the keywords of i) urban resilience, ii) social resilience, iii) community resilience, and iv) risk and hazard resilience. For analysis and visualisation, VOSviewer, an open-source freeware, has been utilised.

Table 1: Search criteria and results

Keywords used	Research Domain	Database	Language	Document type	Indexes searched	Years	Date retrieved	Results
Urban Resilience AND Social Resilience AND Community Resilience AND Risk Hazards Resilience	Social Science	SCOPUS	English	Article, Review, Book Chapter, Conference Paper, Note, Book, Short Survey	SCI-Expanded, SSCI	2000-2022	22.07.2022	1769

Source: Author's compilation from Scopus database

Materials and Methods

Data Collection

The research was conducted using a systematic literature search from the Scopus database. Keywords, namely urban resilience, social resilience, community resilience, and risk hazards resilience, have been utilised. The study's keyword search is shown in Table 1. The selected keywords were searched using the title, abstract, and authors' keywords for research articles published since 2000. All the records have been exported as a complete text file, including cited references, for later use. The whole record and cited references included publication information, such as title, author(s), year of publication, abstract, source title (journal name), affiliation, author's keywords, subject categories (disciplines), language, and the number of citations.

Data Analytical Methods

This paper uses descriptive statistics to analyse the resilience debate within disaster and climate change science. To examine trends and dimensions of urban resilience in hazard and risk management, the analysis is presented in Figure 1.

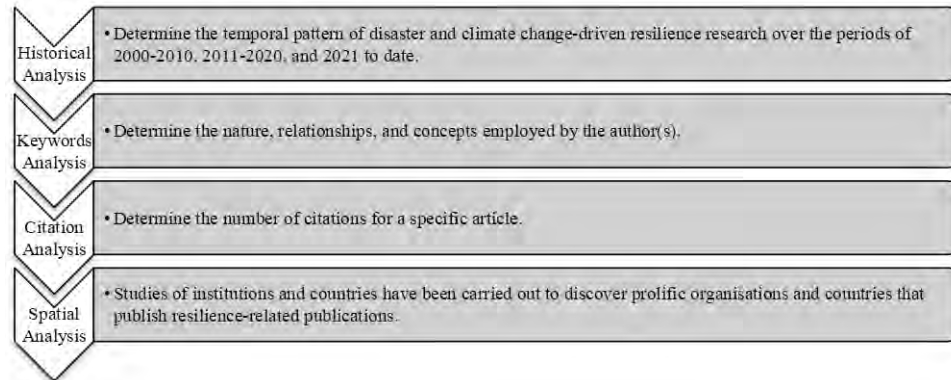


Figure 1: Aspects of the research

Source: Author's compilation from Scopus database)

For data analysis, Microsoft Excel 2019 was used. EndNote was employed for reference management. VOSviewer was used to perform keyword and co-occurrence analyses and to visualise the results.

Results and Discussion

Publication Overview

This section provides a comprehensive summary of the selected publications. Using four primary keywords: Urban Resilience, Social Resilience, Community Resilience, and Risk Hazards Resilience, a total of 1,769 research publications were identified. Of these, 88.4 per cent were research articles, followed by review papers (6.8%), book chapters (3%), and conference papers (1.4%). The majority of publications were in English, with smaller proportions in Spanish, French, Chinese, and Italian.

The number of publications attributed to a researcher is a key indicator of academic productivity and contribution. Author-wise publication analysis serves as a foundational metric in evaluating research trends and scholarly engagement within a specific domain. The volume of published work not only reflects individual output but also offers insight into the field's thematic breadth and depth.

Incorporating citation metrics alongside publication counts enables a more comprehensive assessment of scholarly impact. Citations function as a proxy for the influence, relevance, and recognition of a researcher's work within the academic community.

Table 2 identifies the most prolific contributors to the urban resilience research landscape. Professor Mark Pelling leads with 11 publications, focusing on disaster risk reduction, climate adaptation, and urban political ecology. He is followed by Professor Philipp Babcock, who has contributed nine publications emphasising climate-adaptive infrastructure and resilience behaviour across sociological and psychological dimensions. In the emerging domain of AI applications for urban resilience, Professor Ali Mostafavi has eight notable publications analysing complex adaptive systems, disaster informatics, and urban data science. Analysing top journals in this domain helps identify core scholarly outlets and key dissemination pathways. High publication frequency in established journals generally reflects strong peer-review standards, ensuring the methodological rigour and conceptual clarity that underpin influential research.

Table 2: Most prolific authors in the field of urban resilience, including publication counts and key research areas

S. No.	Author Name	Number of Publications	S. No.	Author Name	Number of Publications
1	Pelling, M.	11	11	Dainty, A.	6
2	Babcock, P.	9	12	Handmer, J.	6
3	Mostafavi, A.	8	13	Meerow, S.	6
4	Wilkinson, S.	8	14	Potangaroa, R.	6
5	Bosher, L.	7	15	Saja, A.M.A.	6
6	Kelman, I.	7	16	Babcock, P.	5
7	Lam, N.S.N.	7	17	Balaci, B.	5
8	Thaler, T.	7	18	Berke, P.	5
9	Béné, C.	6	19	Diab, Y.	5
10	Cutter, S.L.	6	20	Emrich, C.T.	5

Source: Author's compilation from Scopus database

Between 2020 and 2022, research themes in urban resilience underwent significant shifts, driven by the COVID-19 pandemic, which intensified the focus on public health resilience, urban mobility disruptions, and community-level coping mechanisms, thereby expanding the discourse beyond traditional infrastructure and hazard mitigation. Concurrent advances in remote sensing, GIS, and AI accelerated studies on data-driven resilience assessments, predictive modelling, and smart-city frameworks. Thematic priorities also diverged across regions: the United States and United Kingdom emphasised governance, climate policy, and socio-institutional resilience, while European nations and Australia advanced ecosystem-based and nature-based approaches. China focused on large-scale infrastructure resilience, climate adaptation engineering, and spatial vulnerability modelling, whereas India increasingly examined informal settlements, community resilience, and climate-related vulnerabilities.

Overall, these variations reveal a fragmented yet evolving research landscape, shaped by regional contexts and policy agendas, which highlights the need for more integrated and collaborative global scholarship on urban resilience.

Analysing the most frequently published journals in the domain of urban resilience is a key component of bibliometric analysis. It helps identify core publication outlets and assess the dissemination patterns of high-impact research. First, high publication frequency in reputable journals often reflects rigorous peer-review standards, ensuring the validity, originality, and significance of published studies. Second, the peer-review process enhances the quality of manuscripts, thereby advancing and enhancing the field's credibility.

Historical Development of Research on Resilience

Table 3 shows that academic journals serve a role far beyond mere repositories of scientific knowledge or channels of scholarly communication. They are critical platforms for disseminating research findings and play a central role in evaluating scholarly performance. Most academic output is disseminated through journal articles, book chapters, and other scholarly formats, and a researcher's academic standing is typically measured by both the quantity and quality of these publications.

Table 3: Top twenty academic journals publishing research on resilience, ranked by the number of publications, with associated impact factors, scopes, and dominant thematic areas

S. No	Source of the documents	No. of documents	S. No.	Source of the documents	No. of documents
1	International Journal of Disaster Risk Reduction	195	11	Journal of Flood Risk Management	24
2	Sustainability Switzerland	167	12	Sustainable and Resilient Infrastructure	24
3	Water Switzerland	59	13	Climate And Development	23
4	Environmental Science and Policy	48	14	Journal of Risk Research	22
5	Global Environmental Change	43	15	Safety Science	22
6	Disasters	41	16	Land Use Policy	18
7	Natural Hazards Review	41	17	Cities	17
8	Environmental Hazards	32	18	Environment And Urbanisation	17
9	Sustainable Cities And Society	29	19	Applied Geography	16
10	International Journal of Disaster Risk Science	24	20	Disaster Prevention and Management: An International Journal	16

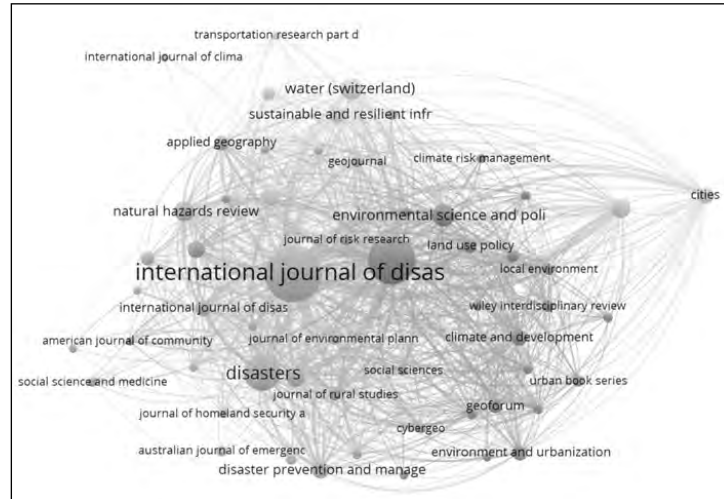


Figure 2: Publications Overview

Source: Author's compilation from Scopus database

A key indicator of the evolution and maturity of a research domain is the annual volume of publications. In the context of disaster management, climate change, and integrated resilience, the number of publications has demonstrated a consistent upward trend since 2000. Figure 2 illustrates the annual publication output specific to urban resilience research.

Table 4 shows that, since 2000, a total of 1,769 publications have been recorded. A marked increase in scholarly attention emerged around 2009–2010, signalling heightened global interest in urban resilience. This uptick coincides with escalating concerns about cities' ability to withstand, absorb, adapt to, and recover from diverse shocks, including terrorism, climate change, economic disruptions, pandemics, and other systemic threats. The annual publication count rose from a single article in 2001 to a peak of 363 articles in 2021. By June 2022, an additional 131 publications had been documented, indicating sustained academic engagement with the topic.

Although journal articles generally originate from peer-reviewed academic sources, default search results in most bibliographic databases often include non-academic content, such as periodicals and newspapers. Therefore, careful curation of data sources is essential to ensure analytical rigour. An analysis of the disciplinary distribution of the selected dataset shows that, from 2000 to 2010, urban resilience publications were predominantly concentrated in Environmental Science, Earth and Planetary Sciences, and Engineering. However, from 2011 to 2020, the focus shifted towards the Social Sciences, Arts and Humanities, Decision Sciences, and Business and Management.

This trend persisted after 2020, with the Social Sciences contributing an increasingly larger share of research outputs. Additionally, more minor but significant

contributions emerged from disciplines such as Public Health, Disaster Management, and Environmental Science. Overall, the findings indicate a disciplinary shift in urban resilience research, with the Social Sciences, particularly subfields such as Human Geography, Management Science, Communication Studies, Political Science, and Urban Sociology, now playing a leading role in shaping the discourse.

Table 4: Year-wise distribution of publication sources

S. No.	2000-2010		2011-2020		2021-2022 (June)	
	Document sources (Journals)	No. of issues	Document sources (Journals)	No. of issues	Document sources (Journals)	No. of issues
1	Water (Switzerland)	88	Annales de Geographie	71	Social Science and Medicine	12
2	Sustainability (Switzerland)	23	Sustainability (Switzerland)	28	Local Environment	9
3	International Journal of Public Administration	15	Urban Studies	14	International Journal of Interdisciplinary Social Sciences	9
4	Local Environment	12	International Journal of Geographical Information Science	12	Environment, Development and Sustainability	6
5	Society and Natural Resources	12	Water (Switzerland)	12	International Journal of Physical Distribution & Logistics Management	5
6	Sociology of Health and Illness	9	Journal of Environmental Planning and Management	11	Applied Geography	4
7	Journal of Emergency Management	8	Journal of Risk Research	11	Annals of the Association of American Geographers	4
8	International Journal of Sustainable Development and World Ecology	8	Asian Social Science	11	Child Development	4

S. No.	2000-2010		2011-2020		2021-2022 (June)	
	Document sources (Journals)	No. of issues	Document sources (Journals)	No. of issues	Document sources (Journals)	No. of issues
9	Environment, Development and Sustainability	7	Climate and Development	10	Review of Policy Research	4
10	International Journal of Disaster Risk Science	6	Climate and Development	10	Environmental Hazards	4

Source: Author's compilation from Scopus database

Scientific journals remain the primary medium for communicating research findings, recent discoveries, and emerging opportunities within the academic community. Peer-reviewed journal articles carry the endorsement of subject matter experts, making them trusted references for researchers, policymakers, and civil society alike. Journals offer a comprehensive collection of scholarly works that facilitate understanding of knowledge evolution within a field and inspire new research directions. Academic publications promote scholarly discourse, stimulate innovation, and track scientific advancements. Furthermore, publication in reputable journals enhances a researcher's visibility and credibility, expanding their professional opportunities.

To highlight the significance of journal articles within the research community, this paper presents a year-wise analysis of publication sources. Table 4 summarises the annual distribution of publications by source, alongside citation counts and issue numbers.

Between 2000 and 2010, Water (Switzerland), Sustainability (Switzerland), and the International Journal of Public Administration were the leading journals publishing research on urban resilience. Specifically, Water published 88 articles on the topic, followed by Sustainability with 23, and the International Journal of Public Administration with 15. Between 2011 and 2020, *Annales de Géographie* emerged as a prominent outlet, with 71 articles on urban resilience, followed by Sustainability (18) and Urban Studies (14). In the post-2020 period, Social Science & Medicine (12 articles), Local Environment (9 articles), and the International Journal of Interdisciplinary Social Sciences (9 articles) have made increasingly significant contributions to advancing research in urban resilience.

Keyword Analysis

Keywords in a research article enhance discoverability for other researchers seeking literature in a similar domain. They define the article's field, subfield, topic, and research focus. In this study, 6,592 distinct keywords were identified in the field of urban resilience research.

S. No.	Authors	Citations	S. No.	Authors	Year	Citations
3	Klein R.J.T. et al. (2003)	746	13	Tyler S., Moench M. (2012)	2012	331
4	Martin R., Sunley P. (2015)	531	14	O'Brien G. et al. (2006)	2006	295
5	Flanagan B.E. et al. (2020)	524	15	Gaillard J.C. (2010)	2010	293
6	Rose A. (2007)	492	16	Hammond M.J. et al. (2015)	2015	289
7	Cutter S.L. et al. (2014)	471	17	Welsh M. (2014)	2014	289
8	Pelling M., Uitto J.I. (2001)	408	18	Ritchie B.W., Jiang Y. (2019)	2019	266
9	Sherrieb K. et al. (2010)	378	19	Tendall D.M. et al. (2015)	2015	264
10	Brown K. (2014)	352	20	Weichselgartner J., Kelman I. (2015)	2015	259

Source: Author's compilation from Scopus database

At the forefront is the seminal paper “Looking for Resilience” (2008) by Prof. Fran H. Norris and colleagues, which has garnered 2,419 citations. This study conceptualises resilience as one of several potential trajectories following exposure to trauma or severe stress, emphasising resilience as part of a broader spectrum of responses to adversity.

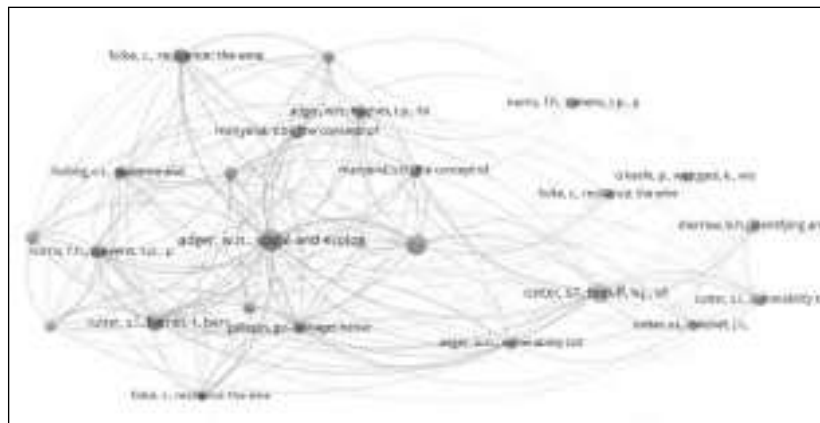


Figure 4: Citation and Co-citation analysis of the selected papers

Another key contribution is Prof. W. Neil Adger’s 2003 paper, which addresses societal challenges posed by climate change and explores adaptation strategies to both observed and projected impacts. His work has been instrumental in advancing the discourse on climate adaptation.

Additionally, *Resilience to Natural Hazards* (2003) by Prof. R.J.T. Klein and colleagues provides a comprehensive analysis of resilience in the context of weather-related hazards, with a focus on coastal megacities. This study delineates the conceptual dimensions of resilience and its applicability to hazard mitigation. These three foundational publications, each with over 700 citations, have collectively shaped the trajectory of urban resilience research.

Unlike bibliographic coupling, which retrospectively examines document similarities based on shared references, co-citation analysis takes a forward-looking approach. Since future citations reflect the evolving reception and development of academic topics, co-citation frequencies are dynamic and may change over time. Co-citation analysis identifies influential publications by measuring the frequency with which two or more documents are cited together in subsequent research. This approach enables a quantitative evaluation of the intellectual structure within a research field, revealing scientific connections and thematic linkages among cited works.

Figure 4 presents the co-citation network, constructed using a threshold of at least 25 cited references and a minimum of 20 citations per referenced document. The analysis reveals a three-cluster solution, delineating key thematic areas within urban resilience research: community disaster resilience (blue), socio-economic resilience (red), and disaster management (green). These clusters illustrate the intellectual contours and primary research foci derived from co-citation patterns in the urban resilience domain.

Institutions and Country Analysis

The number of research publications produced by a country is a key indicator of its research capacity and overall engagement within a specific domain. Since 2000, governments worldwide have increasingly invested in research on urban resilience, reflecting growing institutional interest in resilience-oriented planning, climate adaptation, and risk governance. Institution- and country-wise publication analyses, therefore, constitute an essential component of bibliometric assessments, as they help identify global research leaders, emerging contributors, and structural imbalances in knowledge production.

Country-Level Contributions (2000 - 2022)

As shown in Table 6, the United States has been the leading contributor to urban resilience research since 2000, with 566 publications, followed by the United Kingdom (285), Australia (174), China (121), and Canada (113). Notably, among Global South countries, China (4th), India (15th, with 35 publications), and Chile (19th, with 29 publications) appear on the top 20 list. Overall, 85 per cent of the top 20 publishing countries are located in the Global North, while the remaining 15 per cent are represented in the Global South. According to World Bank income classifications (Fantom & Serajuddin, 2016), China and India are the only upper-middle- and lower-middle-income countries, respectively, within this group.

Table 6: Top 20 country-wise publication sources

S. No	Country/ Territory	No. of documents	S. No	Country/ Territory	No. of documents
1	United States	566	11	France	49
2	United Kingdom	285	12	New Zealand	48
3	Australia	174	13	Spain	40
4	China	121	14	South Africa	36
5	Canada	113	15	India	35
6	Germany	91	16	Taiwan	35
7	Netherlands	81	17	Norway	31
8	Italy	79	18	Switzerland	30
9	Sweden	55	19	Chile	29
10	Japan	53	20	Austria	27

Source: Author's compilation from Scopus database

Institutional Contributions

Academic and research institutions play a central role in sustaining high-quality research ecosystems. They support scholarly development, uphold research ethics, and contribute to the global visibility of urban resilience scholarship. In this regard, institutions such as Texas A&M University (USA), Arizona State University (USA), and University College London (UK) emerge as the top contributors. As summarised in Table 7, approximately 40 per cent of leading research outputs originate from U.S. universities, followed by institutions in the United Kingdom (30%), Australia (20%), and the Netherlands (10%). This distribution underscores the continuing dominance of Global North institutions in shaping the intellectual landscape of urban resilience research.

Table 7: The top 10 institutions publishing on urban resilience

S. No.	Name of the Institution	No. of Documents
1	Texas A&M University, USA	41
2	Arizona State University, USA	24
3	University College London, UK	22
4	University of Exeter, UK	22
5	RMIT University, Australia	20
6	King's College London, UK	20
7	Griffith University, Australia	18
8	Colorado State University, USA	17
9	Delft University of Technology, Netherlands	16
10	Louisiana State University, USA	16

Source: Author's compilation from Scopus database

Funding Agency Contributions

Funding agencies form the backbone of the research ecosystem by providing financial support, infrastructure, and strategic direction to researchers and policymakers. Their evaluations consider research objectives, disciplinary focus, policy relevance, and the nature of funding instruments. Table 8 lists the top 10 funding agencies supporting urban resilience research. The U.S. National Science Foundation (NSF) ranks first, providing foundational support for interdisciplinary research in science, engineering, economics, and the social sciences. The Economic and Social Research Council (ESRC) and the Engineering and Physical Sciences Research Council (EPSRC), both operating under the UK Research and Innovation (UKRI) framework, follow closely. The ESRC is the UK's largest funder of social science research, while the EPSRC supports university-based research in engineering, physical sciences, and emerging fields such as big data analytics. Notably, the EPSRC has funded 37 urban resilience projects, reflecting its substantial role in fostering resilience scholarship.

Table 8: The top 10 funding agencies on urban resilience research

S. No.	Name of the Funding Agencies	No. of Funded Research
1	National Science Foundation	118
2	Economic and Social Research Council	52
3	Engineering and Physical Sciences Research Council	37
4	European Commission	34
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Source: Author's compilation from Scopus database

Discussion and Conclusion

Cities today face numerous challenges, including climate change, floods, heatwaves, and other disasters. As a result, the concept of “urban resilience” has become more critical than ever. This study examined the evolution of research on urban resilience, particularly in risk and hazard management. It utilised published studies from 2000 to 2022 to understand the origins of the research, its leading proponents, and the prominent trends. Based on the preceding analyses, a comprehensive picture of the global research landscape on urban resilience emerges, revealing critical insights into national contributions, institutional leadership, and funding support.

Country-Level Contributions

The bibliometric data clearly indicate that the United States dominates urban resilience research, accounting for the most significant number of publications. The United Kingdom, Australia, China, and Canada follow this. The substantial presence in the Global North (85% of the top 20 contributing countries) underscores the research capacity disparities between developed and developing regions. However, countries from the Global South, particularly China, India, and Chile, have begun to emerge as key contributors. China's position as a leading upper-middle-income country and India's presence as a lower-middle-income country in the top 20 reflect growing investment and institutional focus on resilience research in the Global South.

Institutional Leadership

Institutions play a vital role in driving research volume and quality. Texas A&M University, Arizona State University, and University College London are leading the field in urban resilience scholarship. Notably, 40 per cent of the significant contributions come from U.S.-based universities, reinforcing the country's dominant position in this domain. The presence of top institutions from the UK, Australia, and the Netherlands further underscores the Global North's robust research infrastructure and its significant influence on shaping the discourse of urban resilience. Institutional support facilitates academic productivity and nurtures interdisciplinary collaboration and innovation.

Funding Ecosystem

The role of funding agencies cannot be overstated in developing robust research ecosystems. The National Science Foundation (NSF) leads the list of top funders, reflecting the U.S. government's prioritisation of foundational scientific inquiry. In the UK, the Economic and Social Research Council (ESRC) and Engineering and Physical Sciences Research Council (EPSRC) play pivotal roles in funding social science and engineering research, respectively. These agencies have made significant investments in urban resilience research, often supporting interdisciplinary projects that combine social, environmental, and data science perspectives.

These findings highlight a concentration of research power in a handful of high-income countries, supported by strong institutional frameworks and well-funded research agencies. This landscape determines who drives the urban resilience agenda and shapes how it is conceptualised, studied, and implemented globally. Despite this progress, a need remains to bridge the North-South research divide. Encouraging collaborative research partnerships, capacity-building in lower-income countries, and increased funding for Global South institutions can contribute to more inclusive and diverse perspectives in urban resilience studies. Given the global nature of climate change and disaster risk, equitable participation from all regions is critical to ensure solutions are contextually relevant and widely applicable.

One thing that stood out was the rapid increase in research on this topic, especially after 2010. Around this time, global agreements such as the Sendai Framework and the Paris Agreement were introduced. These efforts encouraged more countries and cities to take disaster preparedness and climate change adaptation seriously. At first, resilience primarily involved building stronger infrastructure, such as roads, buildings, or flood barriers. However, over time, the idea has grown. Resilience also means examining how communities support one another, how governments respond during a crisis, and how systems such as healthcare or transportation continue to function when something goes wrong. In short, it is not just about technology or design; it is about people, fairness, and how cities function.

However, there is still an imbalance in the origin of this research. Most of it is produced in wealthier countries, such as the United States, the United Kingdom, and Australia. These countries have greater access to research funding, robust institutions, and more streamlined processes for publishing and sharing work. This means that the way resilience is discussed is often shaped by what works in wealthier places, rather than by what is needed in poorer or more vulnerable cities. There is some positive change happening. Countries like China and India are increasingly publishing more in this area, and researchers from other regions are joining the conversation. However, the Global South, including parts of Africa, Southeast Asia, and Latin America, still lacks sufficient representation. It is not because people there do not care or lack knowledge; it is mostly because they do not have equal access to funding, international networks, or academic platforms.

To fix this, we need to support research in underrepresented regions. This includes funding local projects, building partnerships between countries, and creating space for diverse voices, including those from communities that live with risk daily. We also need to value different kinds of knowledge from engineers or scientists, social workers, local leaders, and community groups.

Policymakers, urban planners, and international organisations can help by ensuring that research is shared more fairly and by listening to people who are often left out. This way, solutions will match real needs rather than simply copying models from elsewhere. Ultimately, making cities resilient is not only about technology or policies. It is about including everyone, learning from one another, and recognising that every city has its unique challenges and strengths. If we want safer and fairer towns in the future, we must ensure that everyone has the opportunity to contribute to the solution.

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Inclusive Spaces in Urban Settings: A Case Study of Ahmedabad

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Naandi Parikh* and Sunny Bansal**

Abstract

Urbanisation in the 21st century underscores the vital need for inclusive cities that ensure accessibility and belonging for all. Ahmedabad, a rapidly growing United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage City in India, embodies both the challenges and prospects of equitable urban development. Despite modernising with mass transit systems like the Bus Rapid Transit System (BRTS) and Metro, spatial disparities persist, with marginalised groups — including persons with disabilities, women, and low-income populations — often lacking access to safe and functional environments.

Existing literature, from global concepts like the “Right to the City” to local studies on Indian urbanisation, highlights issues of marginalisation and infrastructural exclusion. However, research specific to Ahmedabad tends to focus hardly on isolated aspects like transport or heritage, lacking a comprehensive, intersectional analysis that considers how gender, disability, and socioeconomic status combine to create compounded barriers.

This study addresses these gaps by evaluating inclusivity in Ahmedabad’s public transit systems - BRTS stops and Metro stations - through infrastructure audits focused on accessibility, safety, and utility, particularly for people with mobility issues. It assesses current policies like the Accessible India Campaign against national standards, such as the Harmonised Guidelines for Barrier-Free Environments, and examines the policy-implementation divide. Stakeholder interviews provide deeper insights into lived experiences. By adopting an intersectional framework, the research moves beyond theoretical discourse to offer actionable recommendations for planners and policymakers. It aims to enhance inclusivity in Ahmedabad’s urban fabric while providing transferable insights for other rapidly urbanising Indian cities.

Keywords

Ahmedabad, Inclusion, Intersectionality, Mobility, Accessibility.

* Naandi Parikh, Research Scholar, Anant National University, India.
Email: naandi.parikh.phd24@anu.edu.in

** Dr Sunny Bansal, Assistant Professor, Anant National University, India.
Email: sunny.bansal@anu.edu.in

Introduction

As cities continue to evolve under the pressures of rapid urbanisation, the design of public spaces becomes central to fostering inclusive, equitable, and vibrant urban environments. In India, where socio-economic disparities and infrastructural limitations intersect with a diverse demographic landscape, creating universally accessible spaces remains a critical yet under-addressed challenge. This challenge is often exacerbated by a significant gap between policy frameworks and standards—such as the Accessible India Campaign, the URDPFI Guidelines, and vehicle design standards (e.g., AIS-153 for buses)—and their on-ground implementation and compliance.

Inclusive public spaces, those accessible, safe, and usable for people of all ages, abilities, and social backgrounds, are essential for promoting social cohesion and participatory urban citizenship (Gupta et al., 2025; Pineda, 2022). However, in many Indian cities, including Ahmedabad, urban planning often overlooks the nuanced needs of elderly populations, persons with disabilities, and other marginalised communities. Issues such as inadequate mobility infrastructure, inferior lighting, and limited age-appropriate amenities hinder access and reinforce spatial exclusion (Khosla, 2020; Gupta et al., 2025).

Ahmedabad, a historically rich and rapidly developing metropolis, presents a compelling case for examining inclusive urbanism. As a UNESCO World Heritage City, it confronts the dual imperative of heritage conservation and infrastructural modernisation. Despite progressive policies and investments in public transport systems such as BRTS and the Metro, significant disparities persist in meeting universal design standards (Patel & Shah, 2018; Dholakia, 2020).

This study situates Ahmedabad within the broader discourse on inclusive urban design, with particular emphasis on mobility for the elderly and users with disabilities. By analysing public transportation infrastructure and policies through the lens of universal design and intersectional inclusion, the research aims to identify spatial and systemic gaps that limit equitable urban access. Through a combination of site audits, policy review, and stakeholder engagement, the study seeks to contribute to a more context-sensitive understanding of inclusivity in Indian urban planning.

Literature Review

Urban inclusion has emerged as a critical global issue, focusing on the equal distribution of public places and transport systems for all individuals, regardless of age, gender, disability, or financial status. In Indian cities like Ahmedabad, the notion of inclusion must transcend technical infrastructure to encompass the socio-spatial elements that influence access, comfort, and engagement in urban life.

Numerous studies have examined aspects of inclusive urbanism. Gehl's (2010) and Lefebvre's (1991) seminal texts emphasise the human scale of urban environments and

the concept of the “Right to the City,” respectively. These concepts remain crucial in dialogues regarding equitable urban development. In Indian academia, academics like Patel & Shah (2018) and Khosla (2020) highlight persistent socio-spatial disparities, particularly exacerbated by increasing urbanisation. Their research demonstrates that deficiencies in design and governance within infrastructure projects often exclude women, the elderly, and individuals with impairments.

Concurrently, the literature on inclusive design (e.g., Imrie & Hall, 2001; Gupta et al., 2025) underscores the need of universal design principles in public spaces. These concepts extend beyond architecture; they pertain to broader systems of equity and representation. Pineda (2022) and Steinfeld & Maisel (2012) advocate for the implementation of ramps, signage, and participatory planning to enhance accessibility in various locations. Tavares et al. (2021) and Cardoso & Rennó (2019) discuss the significance of installing proper lights for safety and fostering a sense of belonging, particularly for women.

The urban policies of Ahmedabad, notably the Slum Networking Program (Patel et al., 2015), are frequently cited as exemplars of participatory success rooted on Gandhian principles. Critics argue that such systems may fail to address systemic exclusion, particularly when their design neglects the needs of diverse user groups (Srinivasan, 2024). Gupta et al. (2025) assert that while public spaces foster culture and commerce, their inclusivity is primarily determined by the efficacy of government structures in tackling affordability, safety, and accessibility.

Green spaces are increasingly recognised for their potential to foster social cohesion (Hariyani & Pratama, 2021; Rao, 2021). Studies indicate that they enhance mental well-being, foster interpersonal relationships, and safeguard the environment (Ochodo et al., 2014; Park et al., 2025). However, these benefits are unevenly distributed across different income and skill levels, underscoring another aspect of exclusion within urban frameworks.

This is important because contemporary research frequently analyses elements of exclusion—such as gender, disability, or class—separately. Many neglect their intersectionality, a critical oversight when designing for individuals who may experience several, cumulative forms of marginalisation. Furthermore, despite the existence of international frameworks, such as SDG 11, concerning Sustainable Cities and Communities, insufficient research has been conducted on their adaptation and implementation in Indian cities.

Ahmedabad, a UNESCO World Heritage City, exemplifies the challenges of reconciling heritage preservation, modernisation, and universal accessibility in urban environments. Joshi (2019) and Dholakia (2020) critique significant infrastructure initiatives such as the Sabarmati Riverfront and BRTS for failing to satisfy inclusive design criteria. A comprehensive assessment of various public transit modes, such as BRTS and Metro, from an inclusiveness standpoint is notably lacking. Crucially,

there is a paucity of studies that systematically audit urban infrastructure like public transport against specific, measurable national standards (e.g., the Bureau of Indian Standards IS 4963 for tactile surfaces, or AIS-153 for bus body design) to quantify the policy-implementation gap.

The reviewed literature provides valuable insights into the importance of inclusive design; yet, this research aims to solve three primary gaps:

1. **Disjointed Methodology for Inclusion:** Most studies evaluate certain dimensions of exclusion (e.g., gender safety or physical accessibility) in isolation. A systematic analysis examining the interaction of age, disability, gender, and class in determining urban experiences is lacking (Banati & Bacalso, 2021).
2. **Insufficient Empirical Assessment of Urban Transport Systems in India:** Although there are critiques of particular initiatives (e.g., BRTS, Sabarmati Riverfront), a thorough, systematic evaluation of Ahmedabad's mass transit systems (BRTS versus Metro) employing universal design and accessibility standards is rare (Adhvaryu & Patel, 2019).
3. **Insufficient Integration of Global Frameworks in Local Contexts:** Indian urban planning standards do not adequately include global initiatives such as SDG 11. There are not many studies that relate these ideas to the infrastructure and everyday lives of people living in cities like Ahmedabad (Deore & Lathia, 2019).

This study rectifies these shortcomings by performing a comparative audit of BRTS and Metro stations in Ahmedabad, utilising field observations, stakeholder interviews, and policy analysis. This research centres on the experiences of users with mobility challenges and employs intersectional analysis, thus contributing to the discourse on inclusive urbanism in Indian cities. It not only critiques current design practices but also provides actionable recommendations for politicians, designers, and urban planners aiming to enhance the equity, accessibility, and resilience of Indian cities (Ar, 2023; Gupta et al., 2025).

Urban Transport and Accessibility in Ahmedabad

Ahmedabad's urban environment shows a complex interplay of historic planning customs and contemporary development pressures. The city's infrastructure, which includes the Bus Rapid Transit System and the developing Metro, attempts to satisfy the demands of a growing population. Accessibility, however, remains a complex issue, especially for vulnerable populations (Ren, 2019). The city's transportation environment has long prioritised cars over people, resulting in a public transportation system that is typically underdeveloped (Dawda et al., 2021). Furthermore, the spatial organisation of Ahmedabad, marked by residential segregation and unequal access to services, complicates accessibility issues (Joshi et al., 2020). Ahmedabad faces challenges such as traffic congestion, delays, and safety concerns caused by an overabundance of rickshaws and drivers with poor road behaviour (Trivedi, 2020).

Furthermore, urban sprawl has increased reliance on private vehicles, exacerbating these issues. Integrating paratransit into the public transportation system, such as feeder services or connections between public transportation options, depends on people's perceptions and attitudes. Unfortunately, negative perceptions of safety, accessibility, and dependability have hampered integration efforts.

Methodology

This study uses a qualitative case study method to look into how inclusive public transport systems are in Ahmedabad, focusing on the Bus Rapid Transit System (BRTS) and the Ahmedabad Metro. The methodology is intended to evaluate the alignment of these systems with the principles of universal design and to identify obstacles encountered by those with mobility impairments, the elderly, and other vulnerable user demographics. A checklist based on accessibility standards established in national frameworks such as the Accessible India Campaign, the Harmonised Guidelines for Barrier-Free Built Environment (2016), Bureau of Indian Standards (e.g., IS 4963), and universal design principles (Shah & Adhvaryu, 2016) was used to structure these assessments.

The Janmarg BRTS and Ahmedabad Metro represent two separate paradigms in the growth of urban transport in Ahmedabad, reflecting various developmental phases and system types. The BRTS, operational since 2009, serves as a cost-effective surface-level transportation system. In contrast, the Metro signifies a more recent endeavour, distinguished by elevated and subterranean rapid transit using modern infrastructure. A comparative examination of these systems enables an evaluation of their inclusivity, considering differences in planning methodologies and design criteria. This study utilises a multi-method approach that includes:

- On-Site Accessibility Evaluations
- Methodical Observations
- Photographic Documentation

Accessibility Audits

Conducting thorough accessibility evaluations at specific BRTS stops and Metro stations around Ahmedabad was the main task of the project. A checklist based on accessibility standards established in national frameworks such as the Accessible India Campaign and universal design principles (Shah & Adhvaryu, 2016) was used to structure these assessments.

Among the audit parameters were:

1. Pathways for entry and departure (railings, ramps, tactile flooring)
2. Infrastructure for ticketing (counter height, signage, availability of assistance)
3. Both horizontal and vertical circulation (escalators, stairs and lifts)

4. Interface between the platform and the train (boarding support, level differential, gap width)
5. Wayfinding and information systems (audio/visual cues, Braille, signs)

To highlight weaknesses, strengths, and user difficulties in real-time situations, each observation was photographed and annotated.

Systematic Observation and User Experience Mapping

Observations were conducted during peak and non-peak hours to capture a broad spectrum of user interactions with the infrastructure. Observers noted the presence of accessibility aids, staff responsiveness, crowd management, and the spatial behaviour of users with reduced mobility. This helped in evaluating not just infrastructural elements but also the lived experience of users navigating the system.

Results and Discussion

The comparative audit of Ahmedabad's Janmarg BRTS and Metro systems reveals a critical implementation gap between progressive national accessibility policies and on-ground infrastructure. The findings, structured against the five predefined audit parameters and benchmarked against relevant Indian standards, demonstrate that both systems exhibit significant shortcomings that hinder universal access.

1. Pathway to Entry and Departure (Railings, Ramps, Tactile Flooring)

Finding 1.1 (BRTS - Non-Compliant Clear Width): Primary pedestrian access to BRTS stations is frequently obstructed by security bollards placed at narrow intervals. Audits at stations on the Shrivranjani and Iskon routes measured clear passage widths between bollards ranging from 850mm to 950mm. This violates the Harmonised Guidelines and Space Standards for Barrier Free Built Environment (2016), which mandate a minimum clear width of 1200mm for unimpeded wheelchair passage. This design flaw forces wheelchair users into difficult manoeuvres and creates a barrier for parents with strollers.

Finding 1.2 (Metro - Excessive Ramp Gradients): While the Metro features designated ramps at elevated stations, their gradients often exceed safety standards. Using a digital inclinometer, ramp slopes at Vastral Gam and Apparel Park stations were measured at 1:10 and 1:9, respectively. These exceed the maximum permissible gradient of 1:12 ($\approx 8.33\%$) as per the Accessible India Campaign (AIC) norms and URDPFI Guidelines. Furthermore, at 40% of audited ramps, handrails were either absent or had discontinuous sections, failing to provide the continuous support required by IS 4963 (Part 2) for safe use by elderly individuals and those with mobility impairments.

2. Infrastructure for Ticketing (Counter Height, Signage, Availability of Assistance)

Finding 2.1 (Non-Accessible Counter Heights): BRTS ticket counters presented a uniform height of approximately 1100mm across all audited stations. This is 300mm higher than the recommended accessible counter height of 800mm specified in ISO 21542 (Building construction – Accessibility and usability of the built environment). Consequently, a wheelchair user cannot approach or transact comfortably. While some Metro stations had counters at 850mm, they lacked the International Symbol of Access (ISA) signage, rendering them functionally “invisible” to those who need them. No staff were observed providing dedicated assistance at lower counters.

Finding 2.2 (Insufficient Automated Gate Provision): The audit of Automated Fare Collection (AFC) gates highlighted a critical design omission. At 7 out of 12 audited Metro stations, only standard turnstile gates (clear width: 550mm) were available. This contravenes AIC norms for urban transport, which mandate the provision of wide-access gates with a minimum clear width of 900mm at all entry/exit points to accommodate wheelchairs and walkers. This drawback creates an impassable bottleneck, forcing dependence on staff intervention.

3. Horizontal and Vertical Circulation (Escalators, Stairs and Lifts)

Finding 3.1 (Complete Absence vs. Poor Maintenance): BRTS stations, being at-grade, universally lack elevators or escalators. This constitutes a complete systemic exclusion of users who cannot navigate stairs, violating the fundamental principle of universal access. In contrast, Metro stations are equipped with elevators. However, during unannounced audits, 30 per cent of elevators (e.g., at Old High Court and Shahpur stations) were non-operational, marked “under maintenance.” Furthermore, over 50 per cent of functional elevator control panels lacked Braille or raised tactile markings, failing the “sensory accessibility” requirements of IS 4963 (Part 3) for visually impaired users.

4. Interface between the Platform and the Train (Boarding Support, Level Differential, Gap Width)

Finding 4.1 (BRTS - Hazardous Platform-Bus Gap): The most severe physical barrier was identified at the BRTS platform-bus interface. Measurements revealed vertical gaps ranging from 150mm to 250mm and horizontal gaps up to 200mm. These dimensions far exceed the safety threshold prescribed in Automotive Industry Standard AIS-153 (Code for Bus Body Design), which recommends a maximum total gap (vertical + horizontal) of 50mm for accessible low-floor buses. No manual ramps or kneeling mechanisms were deployed, making independent boarding impossible for wheelchair users.

Finding 4.2 (Metro - Inconsistent Platform Edge Safety): The Metro performs significantly better, with platform-train level differentials mostly under 30mm.

However, the critical platform edge warning strip, a key tactile and visual cue for the visually impaired, was inconsistent. At 4 stations, the luminance contrast ratio between the yellow tactile strip and the grey platform surface was measured (via light meter) to be below 30 per cent, failing the minimum 30 per cent contrast requirement outlined in ISO 21542 for effective visual detection.

5. Wayfinding and Information Systems (Audio/Visual Cues, Braille, Signs)

Finding 5.1 (Multi-Sensory Communication Failure): Both systems rely overwhelmingly on visual communication. No Braille signage was found on any maps, directional signs, or lift control panels within the audit scope. In the Metro, pre-recorded audio announcements inside trains were not synchronised with real-time visual display systems on platforms, confusing users who rely on one sense to confirm the other. The visual signage itself often suffered from information overload and poor contrast, failing principles adapted from WCAG (Web Content Accessibility Guidelines) for readability. This creates a complex informational environment that excludes visually and cognitively impaired users.

Comparative Framework for Analysis

The data gathered was analysed thematically and comparatively between the two systems:

Criteria	Standard	BRTS (Janmarg)	Image (BRTS)	Ahmedabad Metro	Image (Metro)
Design Maturity		Early-stage infrastructure; retrofitted features		Recently built; incorporates some accessibility norms	
Entry/Exit Points	Min. clear width: 1200mm (Harmonised Guidelines)	Non-Compliant. Bollard clearance: 850-950mm.		Compliant for width.	
Ramps	Max. ramp slope: 1:12 (AIC/URDPFI)	Ramps do not meet the criteria of a 1:12 slope.		Non-Compliant. Slopes of 1:9 to 1:10 measured.	

Criteria	Standard	BRTS (Janmarg)	Image (BRTS)	Ahmedabad Metro	Image (Metro)
Platform Access	Max. combined gap: 50mm (AIS-153 for Buses)	Severely non-compliant. Gaps 150-250mm. No boarding aid.		Compliant. Level differential <50mm.	
Ticketing Facilities	Accessible counter height: ~800mm (ISO 21542)	Non-Compliant. Counters at ~1100mm.		Partially Compliant. Low counters exist but are unmarked.	
Signage and Wayfinding	Multi-sensory info (Audio, Visual, Tactile)	Non-Compliant. Visual-only. No audio/braille.		Partially Compliant. Audio+Visual, but unsynced. No braille.	
Overall Inclusivity		Limited inclusivity; older design norms; multiple physical barriers		Improved design; yet falls short on sensory and communicative accessibility	

Conclusion

Creating inclusive spaces in urban settings requires a holistic approach that integrates universal design principles, community participation and policy interventions. By addressing physical, social and economic barriers, cities can become more equitable and accessible for all residents, fostering a sense of belonging and shared prosperity (Mirzaei et al. 2018). Further research is needed to evaluate the effectiveness of different interventions and develop context-specific strategies for promoting inclusivity in urban environments (Mwaka et al. 2024).

Incorporating accessibility into transportation planning is essential for fostering inclusivity (Boisjoly & El-Geneidy, 2017). By addressing the shortcomings in the Janmarg system and building upon the positive aspects of the metro stations, Ahmedabad can move closer to realising its vision of becoming an inclusive and accessible city for all its residents and visitors.

In conclusion, this study underscores the complexity of creating truly inclusive urban spaces and highlights the importance of adopting a nuanced, context-sensitive approach to urban planning and design. By integrating universal design principles, promoting community engagement and addressing policy gaps, cities can create

environments that are accessible, equitable, and welcoming to all (Gutierrez et al., 1997; Meher et al., 2021). The lack of consistent accessibility in public transportation systems highlights the critical need for adherence to universal design principles (Vredenburg & Zackowitz, 2011). Public spaces should be designed to be safe and accessible for all, including people with disabilities (Pineda, 2022). Despite increasing interest in universal design, many public spaces remain inaccessible or underused by vulnerable groups, especially in rapidly urbanising medium-sized Indian towns (Gupta et al., 2025).

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Unseen Dynamics of Vibrant Streetscapes: A Critical Analysis of Literature on Street Quality in India

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Shraddha Kumar* and Kajri Misra**

Abstract

Indian streets are vibrant, multifunctional spaces that go much beyond their basic function as mobility channels. They host street-level economies, flavours of food, celebration of festivals, angst of protests and so much more, all constituting a thickly interwoven cultural and social fabric. However, despite this rich and dynamic reality, Indian street design continues to prioritise its movement-centric functions as reflected in the standards of the Indian Road Congress (IRC). These standards emphasise technical efficiency while neglecting the social, economic, cultural and ecological roles that streets play. Though the latter aspects are addressed in some street-related research in India, this is fragmented and limited, focusing mostly on issues like safety, vending, and accessibility, without offering a more comprehensive understanding of streets as public spaces. Global literature does provide more comprehensive frameworks on street quality, but being mostly rooted in developed contexts, it fails to fully capture the informality, adaptability, and layered uses of streets in India. Thus, a comprehensive, context-sensitive framework for Indian street design is missing. There is a pressing need for research that systematically explores the notion of street quality in Indian cities, recognising their roles as community spaces and incorporating culturally relevant parameters into design and policy. A more holistic, place-based understanding of Indian streets is essential for creating inclusive, functional, and high-quality urban environments.

Keywords

Quality of Public Streets, Public Spaces, Urban India.

* Shraddha Kumar, Lecturer, School of Human Settlements, XIM University, Bhubaneswar.
Email: shraddha@xim.edu.in

** Dr. Kajri Misra, Dean, School of Human Settlements, XIM University, Bhubaneswar.
Email: kajri@xim.edu.in

Introduction

In India, public streets are dynamic centres of identity, empowerment, recreation, awareness, celebration, and revenue generation that reflect the true spirit of a city. They have a substantial role in shaping a city and hence need adequate attention from all stakeholders for their upkeep. Streets have the potential to not just act as mobility networks but also as a “place” which has the potential to contribute socio-culturally, environmentally and financially. A quality street is one designed, managed and maintained to cater to the needs of its users and activities, providing safe and inclusive environments that support all age groups, genders and physical dispositions.

In contrast to this rich reality, the literature on Indian streets focuses on a movement-centric approach to street planning and design. This is well reflected in the standards by the Indian Road Congress (IRC), which is tasked with road development and providing standards for road design, including pedestrian and cycling facilities. While the technical aspects of movement efficiency are comprehensively reflected in the IRC standards, they fail to fully address critical factors such as social, cultural, economic, and political needs of the various stakeholders. In fact, there is evidence in the literature that such codes and standards largely prioritise traffic flow over the holistic needs of the diverse user groups who use the streets. While other published studies, standards, and codes in India do address the multifaceted roles of streets, these are neither comprehensive nor consistent.

Research on streets in developed nations has significantly contributed to advancing the study of street quality, with numerous studies addressing diverse aspects of street environments. Carmona et al. (2018) emphasises the importance of assessing the value of *improved streets*, while Shaaban (2018) explores the concept of *complete streets* and their impact on urban mobility. Dempsey (2009) investigates how *street quality* influences neighbourhood cohesion, and Ewing (2009) examines the role of *street design* in enhancing walkability and quality of life. Mehta (2019) focuses on the physical attributes of streets that encourage interaction and usage. Additionally, topics such as temporary urbanism, placemaking, and low-cost initiatives have garnered attention as effective methods for enhancing street quality. Street design guidelines in developed countries thus provide valuable insights into design of high-quality streets.

Public streets in developing nations, however, are substantially different in their functions and usage from those in developed countries. Unlike the formal, planned streets of developed regions, streets in developing contexts are typically more organic and informal, and adapt to the needs of their users. Streets in these contexts are complex, multilayered, and multifunctional spaces, serving a wide range of stakeholders. However, current design standards (as in India) rarely take their nature into account, resulting in sub-optimal functioning, overlaps and conflicts in usage, overcrowding and other issues. Therefore, there is a need for localised, context-sensitive approaches to understand and improve street quality in developing countries.

Many of the concepts and frameworks used to analyse the quality of streets in India are derived from international literature and public space theories from developed contexts, focusing primarily on the movement-centered technical design aspects. While these are useful, they do not fully align with the unique cultural, social, and functional context of Indian cities. On the other hand, Indian research studies on the quality of streets are few. These have added some of the important dimensions of streets in developing contexts, but mostly focus highly on safety, security, street vending, and aspects of accessibility. Recent studies and guidelines issued by various city agencies, NGOs and other agencies have drawn attention to additional context-relevant aspects. However, these studies are scattered, often limited in scope, and not comprehensive in terms of addressing all aspects of street design. This results in a fragmented approach to street design in India, with different lists of parameters scattered across multiple studies and manuals.

This paper highlights the lack of place-centric approaches in Indian literature on street quality, and analyses the gaps still to be addressed. It systematically reviews the findings in the (limited) grey literature on streets in India and compares it with more comprehensive studies from Western contexts. It examines the notion of “quality” of urban streets, their role as public spaces and the important parameters that need to be included in street design in India, which can serve as a basis for development of appropriate frameworks and parameters for designing context-appropriate quality streets in India. By pointing to the aspects still missing in our understanding of streets in India, the paper emphasises the need for a more comprehensive, context-specific framework that defines the quality of Indian streets beyond their function as movement corridors.

This paper begins by explaining the concept of streets as “public” spaces, and their social, cultural and democratic relevance. This is followed by a review of literature specifically related to public streets in the Indian context, highlighting the need to develop a contextual understanding of streets, particularly in developing countries. The study then explores the concepts of place quality and street quality, drawing on literature from both Western and developing contexts. It includes a comparison between parameters of street quality found in Indian grey literature and the well-established framework proposed by Carmona et al. (2018). The paper concludes by highlighting the need for a comprehensive, context-specific list of parameters to define street quality in Indian cities and discusses the need for further research in this area.

Public Streets

Streets are a crucial category of public space due to their versatility and intensity of use in the daily lives of every urban resident. “Streets” here can be roads, residential streets, avenues and boulevards; squares and plazas; pavements; passages and galleries; and bicycle paths (UN Habitat, 2015). In the Indian context we might refer

to them as roads, pathways, streets, pedestrian walkways, and cycle tracks. “These are public spaces in the fullest sense of the word because they are publicly owned and maintained, accessible and enjoyable by all without charge and at all hours, day and night. They are the most versatile in terms of public enjoyment: they can host open-air markets, performances, events, political rallies, demonstrations, and informal sector activities.” (UN Habitat, 2015). Carr (1992) rightly mentions them as the most “public”, responsive, accessible, diverse, democratic and multipurpose utilities.

Due to the highly restricted structure of the streets in the inner parts of cities, the prioritisation of functions becomes a difficult choice. There are cities such as Copenhagen, Vienna, Paris, Berlin and London where car-sharing models have been used to reduce vehicle area and to provide spaces for other activities. However, in most of the developing countries, the highest share of streets are directed to accommodate motorised vehicular traffic (Anciaes, 2020). The predominant view of streets by policymakers today is of their single purpose of passing vehicular and user traffic. But it is essential to balance place-based functions and movement Carmona et al. (2018). Successful streetscapes are inclusive and provide for the competing requirements of their users (Transport of London, 2016a, 2016b:1). Hence the streets need to be viewed as spaces that welcome all users and diverse priorities. Streets are complex places with economic and social exchanges along with the purpose of movement. Carmona et al. (2018). The intention is to plan for streets that are capable of integration for multi functionality. In short, contemporary literature points to managing streets as “places” where social and cultural activities have a space.

Public Streets in India

India’s transport policies have traditionally prioritised vehicles over people due to the economy’s emphasis on supporting auto manufacturers. This emphasis, fueled by easily accessible automobile loans, has encouraged widespread vehicle ownership. Consequently, Urban Local Bodies (ULBs) have largely focused on motorised transport, measuring transport infrastructure efficiency solely by car speed and viewing wider roads and flyovers as solutions to congestion. However, a recent shift towards prioritising people in city design and processes has emerged. The National Urban Transport Policy (NUTP) of 2006 embodies this shift, aiming for a new planning approach centred on people’s well-being. The National Mission on Sustainable Habitat (NMSH) in 2009, part of the National Climate Change Action Plan, targets improved urban planning and a shift towards public transport. In the past decade, national-level policy documents on non-motorised transport have increasingly acknowledged the importance of people-centric planning in urban mobility systems. (BDA, Street Design Guidelines for Bhubaneswar, 2021)

Design standards and specifications for streets in India have been addressed by diverse bodies, from different perspectives. Indian Road Congress (IRC) was set up

by the Government of India for the development of roads. The IRC categorises urban roads into four types—arterial, sub-arterial, collector street, and local street—each with prescribed geometric design specifications. These include parameters such as road functions, design speed, road width, and traffic volume. The codes also offer detailed drawings and technical standards for road intersections, carriageway widths, footpaths, cycle tracks, medians, and parking spaces. However, the document is not able to fully help cities prioritise planning for design elements that tackle safety, circulation, environmental, health and socio-cultural issues.

The Ministry of Urban Development, in collaboration with the Institute of Urban Transport, has developed five Urban Road Codes in 2012. These codes are designed to address the evolving nature of urban roads. The objective of this new code is to narrow the disparity between ongoing research on creating safe urban roads and the design of safe roads tailored for present-day Indian cities. Each code outlines the specific type and nature of urban roads based on their functions, whether they prioritise accessibility, safety, or both simultaneously.

The Comprehensive Street Design Manual by Institute of Transport and Development Policy (ITDP) (2020) meticulously outlines various street elements and their integration into different types of streets. Its primary objective is to aid in the creation of safe, pedestrian-friendly, and vibrant streets in urban areas of India (Refer to figure 1). By recognising the diverse functions of streets and advocating for the design of inclusive streets, it offers an alternative perspective that emphasises the prioritisation of non-motorised traffic. This manual is specifically tailored for use by planners, urban designers, landscape architects, civil engineers, and notably, government officials and citizens who play a crucial role in shaping urban streets. (BDA, Street Design Guidelines of Bhubaneswar, 2021)

Unified Traffic and Transportation Infrastructure (Planning & Engineering) Centre (UTTIPEC) was set up by the Delhi Development Authority (DDA). The intention was to enhance mobility, promote traffic safety and reduce congestion for the city of Delhi. UTTIPEC has issued Street Design Guidelines, 2009 for roads in Delhi. These are guidelines for the architects and engineers working on mobility projects to make roads safe and inclusive for all genders and abilities. The Delhi Development Authority, UTTIPEC (2012) guidelines represent one of the more progressive attempts in India to move beyond a purely vehicular focus and introduce people-centric street design principles. The document addresses several gaps highlighted in the paper—particularly by foregrounding pedestrian priority, multimodal integration, universal accessibility, and context-sensitive street typologies. However, while it makes an important contribution, its efficacy and acceptance in practice have been uneven. Implementation across Delhi has been limited, and the guidelines have not translated into a widely adopted or standardised framework across Indian cities-- big or small. Moreover, the document does not consolidate the full spectrum of parameters required to understand street quality as a holistic public space.

Element		Presence in		
		Arterial street	Collector street	Local street
	Segregated footpath	✓	✓	Only on streets with RoW $\geq$ 12 m
	Segregated cycle track	Only on streets with RoW $\geq$ 24 m	Cycling in mixed traffic with traffic calming	Cycling in mixed traffic with traffic calming
	On-street parking	✗	✓	✓
	Carriageway (*refer street design elements for details)	Not more than 3 lanes per direction	Not more than 2 lanes per direction	Not more than 1 lane per direction
	At-grade crossings	✓	✓	✓
	Public Transport	✓	✓	✗
	Mass Rapid Transport	○	✗	✗
	Service lane	○	✗	✗

✓ should be present
 ○ may be present
 ✗ should be absent

Table 01: Street elements and their presence in arterial, collector, and local streets

Figure 1: The (limited) range of elements and their integration into different types of streets as provided by Institute of Transport and Development Policy

Source: ITDP, (2020).

Functions of Public Streets in India

The culture of socialising on the corners of streets, under a tree, or next to a tea stall on the sidewalks is very typical of Indian streets. One is likely to come across men playing chess, cards and simply exchanging their political views on the side of the footpaths. It is a melting pot of diverse languages, culture and attire. Streets host religious processions, cultural performances, street arts and installations. These streets also turn into venues for public gatherings, protests, political rally, *nukkad nataks* and *Rahagiris*. These streets are places of commerce with bustling markets and *bazaars*, vendors have set up stalls and carts, footpaths are used by cobblers, barbers and tea stalls, meeting the day-to-day needs of the people. Street food served by small food vendors is a huge part of food culture in India. All of these street activities are an excellent showcase of the entrepreneurial spirit of the country. The functions of an Indian street are culturally rich and socially diverse reflecting the rich tapestry of India itself. It is, therefore important to develop a context-appropriate and relevant set of parameters and guidelines that could successfully capture these diverse aspects.

Quality of Streets

The concept of quality in relation to a space is often understood through a set of key characteristics. The first is physical, encompassing design elements such as form, proportion, scale, texture, light, and enclosure. The second is experiential, referring to how people interact with the space and how well it supports its intended functions.

A third aspect is cultural, which reflects the uniqueness of the space within its specific social and geographical context.

Carmona (2019) describes “that a high-quality place is one which returns the greatest value to its users with regard to meeting and sustaining them in healthy, socially rich and economically productive lifestyles that touch lightly on the environment.” The Place Value Framework designed by the Place Alliance Report and Carmona (2019) clearly states that place quality directly delivers a place value that has health related, social, economic, and environmental outcome. This has been explained diagrammatically in Figure 2.

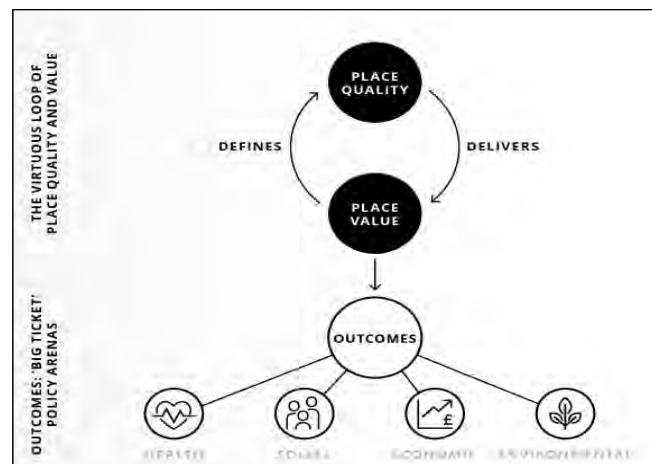


Figure 2: Place value framework

Source: Place Alliance Report, Carmona, 2019

Carmona’s definition is for all public spaces, and therefore applicable to public streets as well. That is, the quality of streets can also be assessed in relation to the extent of value it affords the users. Since Indian streets are used differently than in the developed countries, with diverse users and various types of usage, quality of streets in India (or in the Global South) must be assessed differently.

Quality of a Street

The first question to be put to the test is — What is the quality of a street? Literature stands testimony to the fact that the quality of a street can be understood using multiple lenses. Since the quality of streets relates to the variety of functions it serves, as a public place beyond its function to channel the movement of vehicles, it is clear that the understanding of streets as thoroughfares – as currently reigns – is inadequate. Currently quality is understood as the physical fabric of streets and not its quality in terms of its value to users, or impact on revenue, ecology, efficiency on movement, etc. In other words, the quality of streets in any context must be understood from a user-perspective, for the people using it, not as quality is defined by agencies responsible for

building and operating it. The quality of a street would differ depending on its context and geographical location. The quality of street in a city of a developed country would look very different to the one in a developing nation. Hence, it becomes crucial to explore literature on quality of streets in developed and developing countries separately.

Quality of Street in Literature of Developed Countries

Literature from the developed countries has contributed to the study of quality of streets to a great extent. There are multiple studies on assessment of value of quality street post improvement, evaluation of complete streets, measurement of quality and cohesion in neighbourhoods. Several published papers discuss the street environment design for quality of life, urban design qualities for walkability, and physical characteristics on streets that support human use and social interaction. There is literature on temporary urbanism, lighter, cheaper quicker and other placemaking initiatives that improve the quality of streets.

A quick study of the street guidelines of developed nations helps identify the different ways the streets are treated across different nations. It goes without saying that most of the guidelines and standards of developing nations have drawn their inspiration from the ones in the western part of the world. The terminologies, concepts, and most techniques to resolve design issues are inspired from there. However, the understanding of typologies and hierarchy of streets are different in different geographic conditions. The international street guidelines are more experimental in nature. There are opportunities to run trials of converting the entire street with complete access to only pedestrians or only children. Due to different climatic conditions, and availability of resources, the material palette and the kinds of street furniture differ heavily. There are often discussions and practices of running financially sustainable streets with emphasis on self-financed maintenance. Table 1 provides a list of studies that focus on the different elements of a quality street. The different themes have been covered (walkability, environmental design, evaluation tools, cohesion in neighbourhood, physical characteristics, etc.) across different places globally.

Table 1: Literature from Developed countries on Quality of Streets

Author	Theme	Aspects	Approach	Location
Yin, 2017	Street level urban design qualities for walkability	Influence of street level urban design features on walkability	Pedestrian count, walking score, Google street view imager, GIS 3D model	Buffalo
Carmona et al. (2018)	Value of street improvement	Assessing value of quality street post improvement	Place Quality Checklist, Market and occupancy analysis, Movement analysis	London

Author	Theme	Aspects	Approach	Location
Dempsey, 2009	Measuring Quality and cohesion in neighborhoods		Multiple Regression analysis of features of quality of the built environment and social cohesion	UK, Oxford, Sheffield
Ewing, 2009	Urban Design Qualities related to Walkability	Measurement of Physical characteristics of streets and their edges, imageability, enclosure, human scale, transparency and complexity		Validation study in New York
Mehta, 2010	Physical characteristics that support human use and social interaction on Main Streets		Visual Survey, Interviews	Cambridge

Source: Compiled by the author.

Quality of Street- Literature from Developing Countries

Streets in Indian cities play multiple roles in the day-to-day lives of its users. From movement to earning livelihood, from socio-cultural activities to recreational needs, the streets in India manage to accommodate it all. To understand the existing literature on quality of streets in the Indian context, published research papers in quality journals were examined. Alongside, many road standards and street guidelines of government agencies and transport authorities both at central and state level, have also been analysed. The parameters emerging in the sparse Indian literature relating to the quality of Indian streets has been listed in Table 2. It has been observed that a large number of works around streets in India revolve around the theme of safety, street vending and level of services (LOS).

Table 2: Parameters for quality of street as mentioned in literature from developing countries

Literature	Theme	Aspects	Approach	Location
Basu, 2020	Ecology— Trees and vendor relation	Relationship between Vendor and trees	Ethnography, interview of 75 vendors	Chennai, India
Sahani, 2013	LOS criteria of off-street pedestrian facilities	Pedestrian space, flow rate, speed, volume to capacity ratio	Affinity Propagation Clustering	Bhubaneswar, Rourkela, Odisha

Literature	Theme	Aspects	Approach	Location
Bhuyan & Rao, 2012	LOS of Urban Street	Average travel speed	K-means, K-method clustering	Mumbai, India
Harirchian et al., 2018	Urban Street Design	High speed and lack of pedestrian safety	Case study	Tehran, Iran
Kumar, 2021	Urban Design Quality for Pedestrians.	Imageability, Enclosure, Human scale, Transparency, and Complexity.	Ewing and Handy (2009)	Gurgaon, Haryana
Hussain et al., 2021	Impact of Street Infrastructure on Pedestrian safety	Buffer, ease of walking, unsafe driving practices, and poor infrastructure condition and maintenance. Nighttime safety, zebra crossings and footpath continuity.	Aggregate and city-specific ordinal logit models have been developed to evaluate how urban street infrastructure affects the safety perception of pedestrians.	Varanasi, Jaipur and Hyderabad
Sharma (2017)	Condition of Food vendors	Waste Disposal, Personal Hygiene	Interview	Delhi
Rahman (2015)	What makes people use streets	Attractions on the street, activities on street, commute distance (proximity), congestion and other supportive factors	Mix method- Interviews	Kuala Lumpur
Shaaban, 2018	Evaluate complete streets in developing countries		10-point assessment tool	Qatar
Wey, W. M., & Wei, W. (2015).	Street environment design for quality of life	Urban street environment, quality of urban life	Quality function deployment, Analytic network process, Zero-one goal programming	Taipei City, Taiwan

Source: Compiled by author.

It appears from the Indian literature that street quality has not been explored holistically till date. Table 3 covers some of the recent street guidelines, standards and design toolkits developed by different organisations in India that have been discussed earlier in this paper. It also covers parameters and standards for assessing quality of streets. Table 3 touches upon the sub-themes that have been explored under the various parameters. Only the aspects relevant to this study have been listed here without claiming to cover all the topics of the document.

Table 3: Parameters for quality of street mentioned in the Indian street guidelines

Guidelines	Section Headings discussing Street Quality	Various street quality parameters discussed in guidelines
BDA Street Design Guidelines, 2021	Street Design Toolkit Implementation Framework	• Hierarchy, network • Street design elements- (Pedestrian Zone, Cycle Zone, Multi Utility Zone), Carriageway, Median & Refuge, Street lighting & Signages, Intersections, Traffic Calming, Storm Water Management • Street Design Process • Monitoring & Evaluation Checklist • Advocacy & Awareness Campaign • Communication, Outreach & Marketing Strategy
Indian Road Congress (IRC), 2020	Draft Guidelines for Pedestrian Facilities	• Principles • Design Standards • Pedestrian facilities at intersection • School Zone Improvement • Pedestrian facilities around transit stations • NMT Transport streets & Greenways • Test on site • Materials • Implementation & Maintenance • Management Enforcement • Monitoring & Evaluation • Communication and Outreach • Walking Score

Guidelines	Section Headings discussing Street Quality	Various street quality parameters discussed in guidelines
ITDP, 2020	Complete Street Design Manual	• Street Design Principles • Street design Elements • Street Design Templates • Intersection Design • Transit System & Streets • Street Material • Participatory street design
Delhi Development Authority, UTTIPEC, 2012	Checklist of Quality Audit for UTTIPEC Approved-Projects.	• Planning and Safety
ITDP EPC, 2011	Better streets, better cities A guide to street design in Urban India	• Street Design Elements • Street Templates • Intersection Templates
Indian Road Congress (IRC), 2011	Geometric Design Standards	Classification, Design Speed, Space Standards, Cross Sectional Elements, Kerb, Camber, Sight Distance, Alignment, Clearances
UTTIPEC, 2009	Street Design Guidelines	Design Toolkit – Mandatory Components & Additional Requirements
Safetipin, 2019	Guidelines for an Index on Gender Friendly Cities	• Land Use & Built use • Public Infrastructure • Public Transportation • Security
Institute for Transportation and Development Policy, 2019	Infant, toddler, caregiver friendly neighborhood Design Guidelines	• The first Public Realm • Limit, link and share streets. • Segregation and uses • Parking Strategy • How to approach the design of street and public realm • Guidelines for street components • Safe Streets • Green Streets • Playful and inclusive

Guidelines	Section Headings discussing Street Quality	Various street quality parameters discussed in guidelines
Delhi Urban Art Commission, 2019.	Street Design Recommendations Recommended Street Sections Maintenance & Management	• Pedestrian Zone • Vehicular Zone • Universal Accessibility 12M, 18M, 20M, 24M, 30M, 45M 60M ROW

Source: Compiled by the author

It appears that the standards, and guidelines set out by the Centre and state- level transport and development agencies have pointed to a wide range of aspects that need to be taken into consideration while designing quality streets in India. Majority of the guidelines throw light on streets from urban design and planning perspectives. A lot of the guidelines have drawn inspiration from international guidelines and standards.

Other Parameters for Quality of Streets

In their assessment of the value of street improvements in the UK, Carmona et al. (2018) used an existing analytical tool to evaluate the physical characteristics of the streets. They note that numerous methods and indicators could be employed to measure the quality of the physical fabric, and the potential variations in checklists are virtually limitless. Rather than creating a new tool, they chose to adapt Transport for London's *Healthy Streets Checklist* for their analysis. This framework comprises a complete street template with the aspiration that streets should be easy to cross, not too noisy; have clean air, shade and shelter, places to stop, things to see and do; are used by pedestrians from all walks of life; and are places that people chose to walk and cycle, feel safe, and feel relaxed. The checklist includes a set of indicators under each theme (or aspiration). Each theme is further articulated through multiple parameters, and the checklist employs a scoring system with carefully calibrated parameters for each indicator. Carmona et al. (2018) listed themes for the checklist are given below:

- Easy to cross (a balance between pedestrian, cycle and vehicle users)
- Shade and shelter (provided against the weather)
- Places to stop (to rest and for social interaction)
- People feel safe (against injury collisions and crime)
- Things to see and do (a range of activities)
- People feel relaxed (a sense of well-being and comfort)
- Pedestrians from all walks of life (a diverse mix of users)

- Environmental quality (green and unpolluted)
- Place character (a distinctive and coherent character)
- Adaptability (capable of adapting to future demands)

Carmona's exhaustive checklist, covering a huge variety of aspects for assessing quality of streets, including many not addressed in the Indian literature, has extensive coverage as compared to the other assessment tools. Its indicators are simple, and the scoring process is very practical to use. However, despite its comprehensiveness, it cannot directly be applied to the Indian context; since the parameters from Carmona's study pertain to the European cities, it is limited in its applicability to streets in India. Carmona's parameters are based on narrow case studies and specific user groups within a developed-country context, limiting their broader applicability.

There is much wider diversity of users, and usages of public streets in India --- the variety of different streets and its user types in the Indian contexts are not exhaustively covered in Carmona's checklist. Hence, this checklist appears to be inadequate to capture the values of streets in India. To ensure a contextually relevant assessment of the quality of Indian streets, additional parameters would have to be added to this checklist, to include specific needs and functions that are typical to Indian streets. Some of these are already identified in the few Indian studies and design guidelines. Table 4 lists the parameters from Indian guidelines added to the place quality checklist of Carmona et al. (2018).

Table 4: Parameters added to the place quality checklist

Parameter	Carmona et.al., 2018	BDA, 2021	DDA, 2012	IRC, 2020	ITDP, 2020	UTTIPEC, 2009
Safety	✓	✓	✓	✓	✓	✓
Journey time	✓	✓	✓	✓	✓	✓
Connections	✓	✓	✓	✓	✓	✓
Way finding	✓	✓	✓	✓	✓	✓
Public Transport Integration	✓	✓	✓	✓	✓	✓
Comfort	✓	✓	✓	✓	✓	✓
Attractiveness	✓	✓	✗	✓	✓	✓
Mix of Uses	✓	✓	✗	✓	✓	✓
Greening	✓	✓	✓	✓	✓	✓
Air Quality	✓	✓	✗	✓	✓	✓
Noise Pollution	✓	✓	✗	✓	✓	✓
Design	✓	✓	✗	✓	✓	✓
Adaptability		✗	✗	✗	✗	✗
Street Vending	✗	✓	✓	✓	✓	✓

Parameter	Carmona et.al., 2018	BDA, 2021	DDA, 2012	IRC, 2020	ITDP, 2020	UTTIPEC, 2009
Parking		✓	✓	✓	✓	✓
Building Edge to Edge Age	✗		✗		✗	✗
Age and Ability	✗	✓	✓	✓	✓	✓
Street Amenities	✗	✓	✓	✓	✓	✓
Waterlogging	✗	✓	✓	✓	✓	✓

Source: Compiled by the author.

It can be observed that some of the core contextual phenomenon of streets in India such as presence of street vendors, issues related to inadequate parking, lack of building edge area design, consideration of age and ability while designing streets, lack of street amenities and waterlogging issues have been covered well in the Indian street guidelines.

For clarity, ease of understanding and to ensure consistency in the meaning and interpretation of the terms used in the study, all the parameters discussed above have been defined in Table 5. These definitions serve as a common reference point.

Table 5: Parameters and their definitions

Parameter	Definitions
Safety	Feeling of safety; Streets from theft, robbery, assault or harassment and Safety in movement; from various types of accidents on streets.
Journey time	Time taken to travel from origin to destination
Connections	How well different places are linked through street networks
Way finding	Signs and boards for information at appropriate location on the street facilitating way finding
Public Transport Integration	Coordination between different modes of transportation
Comfort	User comfort in context to provision of shade, shelter, seating; Comfort in use of streets with universal accessibility.
Attractiveness	Well-designed streets cleanliness and adequate maintenance
Mix of Uses	Streets with multiple land uses and at close proximity
Greening	Presence of plants, trees, shrubs and other greenery along streets
Air Quality	Cleanliness of air on street
Noise Pollution	Intensity of sound present in street environment
Design	Thoughtfully well-designed streets enhancing image ability, incorporating street art and respecting human scale.

Parameter	Definitions
Adaptability	Streets that have the ability to change temporarily as per the different activities and user needs
Street Vending	Presences of street vendors and ability of the street to host activities of selling goods and services
Parking	The space occupied by parking vehicles along the edge of the street
Building Edge to Edge	Buildings are constructed right up to the property line with little or no setback, creating a continuous build edge along street
Age and Ability	Streets which are accessible to everyone, regardless of their physical or cognitive abilities
Street Amenities	Presence of street infrastructure such as lighting, signage, toilets, drinking water and public utilities.
Waterlogging	Accumulation of surface water on street due to inadequate drainage capacities, poor street gradients or blocked outlets

Source: Compiled by the author.

Comprehensive Checklist for Quality Streets in India?

One of the key understandings of “quality” of public streets is the Carmona et al. (2018) definition, according to which it must respond to the needs of all users. However, given the multi-functional nature of Indian streets, the range and diversity of uses, and therefore users, the number of parameters are seen to be much larger than in the context of Carmona’s research. It is also likely that there would, therefore be competing or divergent needs and thus conflicting views of quality among the users. The differences and gaps found in the various existing frameworks for assessing street quality can often be traced back to two main factors: the context in which they were developed (such as countries in the Global North versus the Global South), and the priorities of the organisations that created them (for example, the Indian Roads Congress focuses mainly on traffic and engineering aspects). These variations suggest that different stakeholders—such as researchers, traffic engineers, and urban development authorities—assign different levels of importance to specific parameters when evaluating the quality of public streets.

Additionally, the relevance of certain parameters may vary depending on the type of street. For instance, what matters most on a commercial street may be different from what is important on a local, arterial, or collector street. As a result, the idea of street quality—especially as it relates to public spaces that serve multiple functions and user groups—remains unclear and underexplored. This study highlights the need to better understand how diverse users experience street quality and explores the development of a meaningful quality assessment framework tailored to the Indian context, specifically in view of the following issues—

Fragmented Approach to Street Quality in India

A review of both international and Indian literature on street quality reveals a clear gap: existing frameworks for assessing the quality of Indian streets often overlook the diversity of users and uses. As a result, many relevant parameters are being excluded from current evaluations. Some Indian studies referenced in this paper also reflect these limitations. Meanwhile, several guidelines developed by Urban Local Bodies (ULBs) and other agencies in India adopt a more holistic approach, incorporating functional, social, and cultural dimensions of street quality. While some of these guidelines draw from international studies, they are generally well-adapted to local conditions. However, these guidelines are dispersed across various projects and manuals, with no unified framework or comprehensive list of parameters to assess street quality in the Indian context. Through a systematic review, this study attempts to identify and compile key contextual parameters found in these guidelines.

Neglected Dimensions of Street Quality: Maintenance, Temporality, and Management

The review of available Indian literature on street quality shows a predominant focus on aspects such as level of service, user-friendliness, safety, and the informal nature of streets, while several other important factors have received comparatively less attention in existing guidelines. Firstly, there is a lack of discussion on maintenance of street facilities and infrastructure. The focus remains on placemaking of streets rather than “*place-keeping*” them. Secondly, the recent discussion on placemaking focuses on the need to consider impermanency of structure for lighter quicker cheaper arrangements making streets more accommodating to the changing needs of the people. However, most street guidelines are devoid of this concept and purely more on permanency of infrastructure. Indian streets host *pandals*, *nukkad-natak*, or weekly *bazaars* and many more frequently. Hence, the space of temporality of functions is a need. Thirdly, street management is little addressed; in fact, a very crucial aspect of the financial sustainability of the streets has been completely ignored. It is assumed that the streets are a liability and the concerned agencies would fund their development and maintenance, bringing us back to the discussion of streets being considered as a liability rather than an asset. Revenue generation, or self-maintenance mechanisms, paid license businesses on streets are rarely discussed.

Future Scope and Application

Based on the discussion in this paper, an important next step is to develop a clear and comprehensive list of parameters to assess the quality of urban streets in the Indian context. This assessment tool can help understand the current condition of streets and support local authorities in making better decisions. It can also be used to compare street quality before and after any improvement work, making it easier to evaluate the success of redevelopment efforts. In the long term, this can guide better planning and

investment in street projects. Additionally, the tool could be useful in future research that explores how street quality relates to other factors, such as public health, social interaction, or economic activity.

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Inclusive Planning for Women in Sustainable Indian Cities

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Shweta Kapoor* and Vidhu Bansal**

Abstract

Women remain disproportionately excluded from economic, social and spatial opportunities due to gender insensitive planning and governance frameworks, even if women constitute half of the population in cities. Historically, cities have been designed for men and by men precisely for their mobility patterns, limiting women's access to education, employment and public life (World Bank, 2020). Equitable access to transport Infrastructure and services is important to all demographic groups of women, children, caregivers and other marginal communities, which is possible through Inclusive Urban Planning. This paper examines how mobility challenges, safety concerns, and limited representation in public spaces and transport severely constrain female labor force participation. Using intersectionality and empirical fieldwork, analysing barriers and recommendations for inclusive gender -response planning measures. Intersectionality is a term introduced to address experiences of oppression that cannot be adequately understood as the result of ordinary patterns of discrimination. The findings emphasise the importance of participatory processes, improved data systems, and contextual policies to foster sustainable cities that empower all residents. A mixed-method approach is applied for combining secondary research, field observations in Ahmedabad, and investigating through gendered experiences of public spaces and mobility. Analysis identifies six structured dimensions-Access, mobility, safety, services, climate vulnerability, and economic participation that collectively shape women's economic participation. Critical gaps appear in gender-responsive transportation, pedestrian infrastructure, safety-oriented design, government capacity and data systems. By bridging empirical insights with policy frameworks, the study proposes a pathway towards gender-inclusive planning that strengthens urban sustainability.

Keywords

Gender responsive Planning, Mobility, Urban safety, Intersectionality, Built-environment, Inclusive cities.

* Shweta Kapoor, Research Scholar, School of Architecture, Anant National University, Gujarat, India.
Email: shweta.kapoor.phd24@anu.edu.in

** Vidhu Bansal, Assistant Professor, School of Architecture, Anant National University, Gujarat, India.
Email: vidhu.bansal@anu.edu.in

Introduction

For centuries, urban planning has shaped human settlements, reflecting cultural priorities, technological capabilities, and social hierarchies. From regimented Roman colonial towns, compact medieval mercantile centers, and ecologically integrated ancient Indian cities, built environments have historically mirrored societal structures and governance systems (Biswas, 2024; Gehl, 2010).

In India, rapid urbanisation has produced multi-municipal metropolitan regions characterized by uneven spatial development, rising socioeconomic disparities, and strain on public infrastructure. Due to structural inequalities in planning, governance and cultural norms, Women in particular face limited access to mobility, employment opportunities and public spaces. Women's mobility patterns are more complex than men's due to domestic responsibilities. Thus, research shows that men and women interact with urban space differently.

Although women have always contributed to city life and urban production, their needs remain systematically overlooked in the planning process. Thus, despite their central role in sustaining urban economics, women encounter barriers such as inadequate street lighting, poor connection of transportation, lack of sanitation facilities, harassment in public spaces and limited representation in the planning process.

This paper argues that inclusive planning must move beyond gender-neutral assumptions and adopt intersectional frameworks that consider caste, class, religion, ability, sexuality and age. Achieving gender-responsive planning requires integrating women's voices into decision-making using gender disaggregated data and applying intersectional analysis across policies, transport systems, and land use planning.

Literature Review

Economic Participation & Gendered Mobility

Study on Labour force participation signifies that some of the factors which women consider for entering the economic participation are----- easy assessable location, last mile connectivity, less likely to take jobs in far off locations, hence avoiding long distance travel or unsafe journeys. Thus, indicating that transport conditions and distance can outweigh purely economic factors. (Lama, 2022; Ministry of Labour & Employment, 2023; Muralidharan et al., 2018; ITDP India, 2015).

Gendered mobility research in Indian cities shows that women rely on walking, public transport and intermediate public transport and their trips are shorter, more frequent, and heavily shaped by unpaid care responsibilities. (ITDP India, 2017; SPRF, 2024). Aligning with international evidence on trip chaining, combining work, childcare, and errands in a single complex journey that transport systems rarely account for. (ADB, 2013; Mobilize City, 2025).

Security, Perceived Vulnerability and Public Space

Surveys in multiple cities report harassment, sexual assault in poor lighting, visibility & surveillance, which signifies a reduction in women's willingness to travel, particularly at night, directly affecting their access to jobs, education and leisure (World Bank, 2023; NIUA, 2025; NARI Report, 2025). Identification of safety parameters for gender-inclusive cities identifies pedestrian mobility, urban amenities, transit systems, and security as interlinked criteria that shape women's perceived and actual safety, as shown by recent analytical reports (Haq et al., 2023; Ramaswami et al., 2023).

Feminist urbanism and "right to the city" emphasise that public spaces planned without women's perspectives reproduce patriarchal norms, limiting women's presence in the urban realm (Vidhi Centre for Legal Policy, 2021; Schretlen et al., 2025). oppressive norms that limit women's access to public spaces and transport are due to the gender-blind design (Criado Perez, 2024). Thus, the research highlights that fear is not produced by crime incidents but also by design elements such as dark, empty streets, lack of amenities and discontinuous footpaths (Gupta, S, Calabresse, L, & Van Nes, A (2019). (Vuyiswa Letsoko; Nompumelelo Mzobe; Trynos Gumbo, April 2025).

Gender-responsive Urban Planning and Intersectionality

Policy briefs and toolkits are gender-inclusive mobility in India (eg, ITDP's "Women and Transport in Indian Cities", Niti Aayog's gender-responsive urban mobility toolkit, and World Bank gender toolkits, which provide indicators and principles, but there are still persistent gaps in measuring the city-level gender-disaggregated data and institutional capacity. This study contributes by combining intersectional framing with grounded observations and safety-audit methods in specific Indian urban contexts. (Vidhi Centre, 2021; CORP2025).

Technological Responses and Policy: Practice and Toolkits

There are efforts in showing promise in gender sensitive initiatives such as fare concessions, reserved seats, women-only services and state-level reforms like Kerala's gender-sensitive public transport and data frameworks (T20 India, 2023; WRI India, 2023; GIZ/Mobilize Your City, 2023). But has a gap in implementation and monitoring of actual impacts on women's mobility and labour outcomes (World Bank, 2023; Nikore Associates, 2022).

Various technological tools like safety apps and safety tools like Safety-pin explore how crowd-sourced data and geospatial analytics can inform safer routes, lighting upgrades, and targeted interventions (Viswanath & Safetipin, 2015; Oxfam/Safetipin, 2015). The studies above can provide apps which can strengthen reporting of harassment, but they are not integrated or included in the planning thoroughly (Safetipin, 2015; Mobilise Your City, 2025). This study focuses on the combination of both the app-based reporting and safety audits. This addresses the implementation gap

by positioning digital tools as one input into a broader, participatory planning process rather than a standalone solution (Vidhi Centre, 2021; CORP 2025).

Stronger evidence from the literature review shows evidence that mobility conditions, safety, and urban design shape economic opportunities, yet there is still limited intersectional, city-scale empirical work that links public-space experience, everyday mobility and labour force participation in Indian metropolitan contexts (Ideas for India, 2021; SPRF, 2024; systematic reviews on perceived safety, 2023–2025).

Research-gap

Gender-responsive mobility demonstrates that Indian transport systems fail to account for women's trip-chaining, care-related travel, and higher reliance on walking and public or informal transport (ITDP India, 2017; SPRF, 2024; GIZ & Mobilize Your City, 2023). It is still largely designed for a default male commuter. Toolkits and policy briefs call for integrating a gender lens in urban mobility, but have a huge gap in implementation, gender disintegrated data and institutional capacity at the city level (World Bank, 2019; NITI Aayog & World Bank, 2019; T20 India, 2023).

Studies that rarely connect spatial and design-related safety conditions to measurable impacts on women's labor force participation and economic choices are harassment on streets, poor lighting, lack of "eyes on the street" (Jane Jacobs 1961), and unsafe or discontinuous pedestrian infrastructure. Especially in the urbanised or rapidly growing Indian metropolitan regions (Vidhi Centre for Legal Policy, 2021; Haq et al., 2023)

Women's labour force participation is lowest in India compared globally. Wider gender gaps in urban areas, and that mobility, distance and safety are key constraints to take work outside the home (DGE–MoLE, 2023; Klasen & Pieters, 2021; VoxDev/ Ideas for India synthesis). The transport and urban design are treated as just background factors, without analysing how concrete features of public transport and public spaces shape women's employment decisions in specific city contexts (World Bank, 2019; ITDP India, 2015).

There is a gap in the empirical work that includes intersectionality within planning tools (mobility surveys, safety apps and safety audits) and also the use of this evidence to create concrete urban design and governance decisions (CORP 2025; T20 India, 2023). Intersectionality highlights how gender intersects with caste, class, and location, layered vulnerabilities; some groups of women, especially tribal, low-income or migrant women, remain totally invisible in urban safety and mobility frameworks (Vidhi Centre for Legal Policy, 2021; articles on structural invisibility of tribal women, 2025).

Rigorous evaluations linking interventions of gender-focused mobility initiatives in a few Indian states and cities (fare-free, subsidised travel, night-drop policies, and women-focused services) and women's perceived safety, mobility freedom, and

labor force participation remain scarce (World Bank, 2023; WRI India, 2023; GIZ & Mobilize Your City, 2023).

The key research gap is a city-level empirical study and intersectional analysis that links directly with experience in public spaces (safety, access and mobility patterns) and transportation with labor force participation. Thus, the study demonstrates how gender-responsive and intersectional planning tools can be integrated into urban transport and public design in Indian cities (World Bank, 2019; ITDP India, 2017; Vidhi Centre for Legal Policy, 2021).

Research Questions

How do differences in trip-chaining, time of day travel and mode choice, age, income, caste and settlement type get ignored in current mobility planning and design?

How do the features of transportation and public spaces in the Indian metro influence women-labor force participation?

In view of making Indian cities more gender-inclusive, how can intersectional evidence from tools such as women's safety audits, user surveys and digital safety be integrated into urban planning and transport governance?

How does improved women's daily mobility, freedom and labor force participation influence gender-responsive interventions? They succeed or fail under what institutional and socio-cultural conditions?

Methodology

Philosophical and Methodological Foundations

This study adopts pragmatic mixed-methods paradigm (Creswell & Plano Clark, 2018), integrating quantitative spatial metrics with qualitative lived experiences to address urban mobility's complexity. Mixed-methods superior for gender-responsive planning, combining "breadth of quantitative patterns with qualitative depth" (Teddlie & Tashakkori, 2009). Approach mirrors WRI India Mobilise HER project methodology (2025) employing surveys, participatory appraisals, focus groups across Ahmedabad/Bengaluru/Kochi.

Reliance on a single research method often produces partial or biased insights when examining complex urban gender issues. Quantitative approaches, while useful for identifying broad patterns and statistical relationships, frequently fail to capture intersectional lived experiences shaped by caste, class, age, caregiving roles, and spatial context. Conversely, purely qualitative methods provide rich contextual depth but may lack generalizability and policy scalability. To overcome these limitations, the study adopts a sequential explanatory mixed-methods design (Ivankova et al., 2006), which integrates the strengths of both approaches in a structured manner.

The process begins with surveys to establish measurable mobility patterns, safety perceptions, and participation constraints across different groups of women. This is followed by in-depth interviews that unpack the nuanced, intersectional realities underlying the quantitative trends. Subsequently, spatial safety audits and field observations ground these narratives in the physical urban environment, linking perceptions to actual infrastructure and design conditions. Finally, stakeholder validation with planners, officials, and community representatives ensures that findings are contextually accurate and policy-relevant.

This layered methodology enhances analytical robustness, improves triangulation, and strengthens the translation of gendered mobility evidence into actionable urban planning and governance recommendations.

Secondary Data Sources

National

Periodic Labour Force Survey (PLFS) 2021-2024 (MoSPI, 2024) provides sex-disaggregated LFPR; National Family Health Survey-5 (2019-21) mobility indicators.

Local: AMC Development Plan 2021-31[file:1], BRTS operational data (Janmarg, 2025), Gujarat State Women's Commission harassment reports.

Global Benchmarks: World Bank Gender Mobility Toolkit (2019), ADB Gender Toolkit Transport (2013).

Primary Data Collection (October-December 2025)

Study Sites: Three stratified zones representing Ahmedabad's socio-spatial diversity:

East (slum/industrial): Naroda GIDC, Odhav (low-income migrants)

West (middle-class): Satellite, Vastrapur (professionals)

Central (mixed): Manekbag/ Ellis Bridge (students/caregivers)

Quantitative Survey (N=150)

Sampling: Stratified purposive (50 women/zone), power calculation 95% confidence/5% margin (n=150 adequate) (Krejcie & Morgan, 1970). Instrument: 45-item questionnaire (Likert safety scales 1-5, travel diaries 7-day recall). Pilot-tested (n=30, Cronbach $\alpha=0.87$ reliability).

Administration: SEWA Shakti Kendras/home-based worker clusters within 2km of 23 BRTS stops (Mobilize HER protocol). Data entry: Google Forms → SPSS v27.

Survey Sample Characteristics

Table 1: Survey Sample Characteristics

Zone	N	Age (Mean)	LFPR	Monthly Income (₹)	Trips/Day	Caste (% SC/ST)
East	60	28.4	18.2%	12,500	2.9	55%
West	50	34.2	32.4%	28,000	2.5	12%
Central	40	31.1	25.3%	19,500	2.7	28%
Total	150	31.2	24.6%	19,667	2.7	35%

Source: Primary survey data, October-December 2025 (Author's fieldwork)

Qualitative Interviews (N=25)

Sampling: Purposive from survey respondents (5/zone, saturation at 25 per Guest et al., 2006). Profiles: migrant workers (9), professionals (8), students/caregivers (8).

Protocol: Semi-structured 45-60min interviews (audio-recorded, Odiya/Hindi/English), thematic guide: trip-chaining, safety adaptation, institutional barriers.

Analysis: NVivo 14 transcription → thematic coding (Braun & Clarke, 2006); interrater reliability $\kappa=0.82$.

Spatial Infrastructure Audits

Protocol: 10km BRTS corridors (Naroda-Maninagar 4km, Narol-Vastrapal 6km) using standardised walkability checklist (ITDP India, 2017). Metrics: sidewalk continuity (0-100%), lighting adequacy, encroachments, station accessibility. GPS-mapped via ArcGIS Pro (spatial autocorrelation Moran's $I=0.67$).

Pedestrian Audit Results

Table 2: Pedestrian Audit Results

Corridor	Sidewalk Continuity (%)	Lighting Post-Dusk (%)	Encroachment (%)	Station Access Score
Naroda-Maninagar	38	42	62	2.1/5
Narol-Vastrapal	45	48	58	2.4/5
Average	41.5	45	60	2.25

Source: Spatial audits, 10km BRTS corridors, ITDP India (2017) methodology (Author's fieldwork)

Data Analysis Procedures

Quantitative: SPSS descriptive statistics, ANOVA zone comparisons ($p < 0.01$ significance), correlation LFPR-walkability ($r = -0.68$).

Qualitative: Thematic analysis six dimensions, member-checking transcripts.

Integration: Joint displays (survey themes → interview elaboration → audit validation) (Guetterman et al., 2015).

Safety Perception Metrics

Table 3: Safety Perception Metrics

Metric	East (n=60)	West (n=50)	Central (n=40)	F-stat	p-value
Safety Score (1-5)	2.1±0.8	3.4±0.7	2.8±0.9	28.4	<0.001
Night Avoidance (%)	85	45	60	-	-
Harassment Lifetime (%)	72	38	55	$\chi^2=15.2$	<0.01

Source: Primary survey (N=150), SPSS analysis (Author's fieldwork).

Ethical Considerations & Limitations

Ethics: Anant National University IRB (#ANU-URB-2025-017), informed consent (95% response), anonymity codes. Vulnerable groups compensated ₹200.

Limitations: Urban bias (no rural migrants), self-reported bias mitigated triangulation. Future: longitudinal tracking post-interventions.

Rigor Validation: Methodological triangulation (Denzin, 2017); member-checking (Lincoln & Guba, 1985); peer-debriefing (Anant faculty panel).

Ahmedabad Case Study: Empirical Findings

BRTS Infrastructure Reality Check

Janmarg BRTS Phase 3 (2025 expansion) spans 160km serving 1.2M passengers daily, yet field audits reveal critical gender gaps: 40 per cent stations lack ramps, toilets, or seating.

Naroda-Maninagar corridor (4km audit): 60 per cent sidewalk encroachments, 38 per cent continuity. Women report 25-minute last-mile walks through unlit service lanes post-alighting. Metro integration failure: Blue Line (2024) serves 200K daily but 35 per cent stations lack feeder rickshaw stands despite women averaging 2.8 chained trips/day vs men's 1.7.

Intersectional Mobility Profiles

Case Study 1: Low-Income Migrant

Rani, 28, East Zone, Scheduled Caste, Naroda GIDC factory worker Daily 4km walk to BRTS stop ,Avoids 6-8AM peak crowding (pays ₹50 extra auto), Monthly transport: ₹2,200 (18% income) Safety score: 1.8/5, Middle-Class Professional, Priya, 35, West Zone, OBC, IT sector,18km roundtrip: school → work → office, Post-8PM travel restricted (staring in shared autos),Adds 12 minutes daily route adaptation.

Case Study 2: Student-Caregiver

Seema, 22, Central Zone, college student 1.5km walk + toddler to anganwadi → college 2025 heatwave forced rescheduling Zero shaded paths exist SC/ST Analysis: 55 per cent respondents report higher vulnerability (78 per cent route modification vs 42 per cent general category).

Climate Vulnerability Multiplier

Ahmedabad 2025 heatwave (14 days >45°C) reduced women's walks 35 per cent per 7-day travel diaries. Eastern zones: 0% shaded paths despite 4-5km daily factory treks. Women carrying children endure 22 per cent longer heat exposure. BRTS waiting areas covered only 28 per cent.

Heatwave Walk Reduction by Profile

Table 4: Heatwave Walk Reduction by Profile

Profile	Baseline Walks (km/day)	Heatwave Walks	% Reduction
Migrant Workers	4.2	2.7	36%
Professionals	3.1	2.2	29%
Students/Caregivers	2.8	1.9	32%
Average	3.4	2.3	35%

Source: 7-day travel diaries (N=150), Ahmedabad 2025 heatwave data (Author's fieldwork)

Spatial Economic Exclusion Patterns

Eastern industrial zones (Naroda, Odhav) employ 200K women yet exhibit 18.2 per cent LFPR vs West's 32.4 per cent. Correlation: Infrastructure score ↔ LFPR $r=0.74$ ($p<0.01$). Spatial mismatch: Jobs located 5-7km from residences without reliable transit bridges gap.

GIS Analysis

Moran's $I = 0.67$ confirms spatial autocorrelation—poor infrastructure clusters create exclusion hotspots.

Behavioral Adaptations Institutionalised:

Women systematically adapt to infrastructure deficits:

- 82% route modification (adds 22 minutes daily)
- 63%-night avoidance (limits job types)
- 41% proximity employment (career ceiling)
- 35% heatwave cancellations

These rational adaptations become structural exclusion, explaining 23.5 per cent LFPR despite economic opportunities.

Municipal Budgetary Prioritization Failures

Ahmedabad Municipal Corporation's (AMC) 2025-31 Development Plan reveals systemic gender-blind budgeting, prioritizing vehicular expansion over pedestrian/non-motorized transport (NMT) critical for Women [file:1].

AMC 2025-31 Budget Gender Analysis

Table 5: AMC 2025-31 Budget Gender Analysis

Category	Allocation (₹ Cr)	% Total Budget	NMT Share (%)	Gender Metrics?	Women's Impact
Road Widening	4,200	62.1	0	No	Increases walking hazards
BRTS Expansion	850	12.6	12	Partial (pink buses)	Station ramps 40% missing
Pedestrian Infra	210	3.1	62 encroached	No	82% women route modification
Metro Phase 2	1,800	26.6	8	No	Last-mile unaddressed
TOTAL	6,760	100	5.2	No	₹15K Cr annual GDP loss

Source: AMC Development Plan 2025-31 (file:1), Author's analysis

Only 5.2 per cent budget supports NMT despite pedestrians comprising 68 per cent road users, 80 per cent women during peak chained trips (ITDP India, 2017). Gender budgeting absent despite national mandates (Ministry of Women & Child Development, 2023).

Representation Paradox: Elected vs Executive

73rd/74th Constitutional Amendments mandate 33 per cent women in Urban Local Bodies (ULBs); Gujarat raised to 50 per cent since 2015 yielding 46 per cent women councilor's AMC-wide (MoPR, 2024). Yet executive bureaucracy remains male-dominated, AMC Gender Representation Disparity

Table 6: AMC Gender Representation Disparity

Level	Women %	Key Statistics	Gender Impact
Councilors	46%	64/139 women (2022)	Low institutional training
Engineering Dept	8%	Rakhi Trivedi sole senior woman	Male gatekeeping committees
Planning Officers	12%	No women heads	Gender-blind master plans
IAS Administrators	20% national	Gujarat Urban Development 15%	Top-down prioritization

Source: MoPR (2024), IIM-A (2019)

IIM-A (2019) study documents women councillors face male discrimination, excluded from committees despite child/women issue sensitivity. “First-time councillors struggle understanding formal structures” lacking training modules.

Data and Monitoring Deficiencies

No sex-disaggregated travel surveys since 2018 AMC Household Travel Survey; planning relies aggregate averages masking gender gaps (World Bank, 2023). Absence GIS-mapped harassment hotspots despite 15 per cent post-COVID rise Gujarat public transport (State Women’s Commission, 2024).

Institutional Silos

AMC Health Department manages sanitation, Engineering roads, Transport BRTS—no Gender Cell coordination. Contrast: BMC Mumbai’s ACG Gender Amenities Cell implements reservations (housing, markets, care centers).

Capacity and Training Gaps

Zero intersectionality training AMC planners despite national guidelines (UN Women, 2022). 8 per cent female planning staff vs 48 per cent urban women population. Patriarchal norms persist: women councilor’s report “male counterparts delegate no responsibilities” (IIM-A, 2019).

National Context: India urban bureaucracy 20 per cent IAS women (DoPT, 2025), 12 per cent police—restricting gender-balanced leadership. Gender sensitization lacking: officials untrained addressing women-specific needs (ICRIER, 2023).

Policy Implementation Barriers

Statutory Plans Gender-Blind: AMC ignores Gujarat Town Planning Act gender provisions, no pedestrian safety audits mandated. Nirbhaya Fund Gujarat allocation (₹150 Cr 2023-25) underutilized AMC (15 per cent spent), prioritizing highways over lighting/walkways.

Political Economy: Corporator priorities favor road contracts (male-dominated engineering lobbies) over NMT despite 68 per cent pedestrian demand. CSR Bypass: Private sector lighting initiatives uncoordinated with AMC master plans.

Institutional Gap Assessment

Table 7: Institutional Gap Assessment

Gap Type	Evidence	Impact on Women	Benchmark Solution
Budget	5.2% NMT	60% sidewalk encroachment	20% gender budget
Representation	46% elected vs 12% exec	Committee exclusion	BMC ACG Gender Cell
Data	No disaggregated surveys	Invisible gender gaps	Annual sex-disintegrated travel
Training	Zero intersectionality	Gender-blind plans	WRI 500-planner modules
Coordination	Departmental silos	Uncoordinated safety	Gender coordination cell

Source: Author's institutional analysis

Comparative Urban Governance Lessons

BMC Mumbai: Akshar Centre Gender Amenities Framework coordinates housing/market reservations via dedicated cell.

Indore: NITI Aayog #1 via 30 per cent women consultations, gender audits in plans.

Kochi: Women-led transit committees + reporting apps increased evening usage 15 per cent.

Economic Quantification of Gaps

Gender-blind governance costs Ahmedabad ₹15,000 crore annually foregone female productivity (10% LFPR gap × 4.5M working-age women × ₹33,333 avg wage). Infrastructure ROI: ₹1 NMT investment yields ₹15 economic return via LFPR gains (World Bank, 2023)

Key Findings: Six Dimensions Analysis

Access Barriers (Dimension 1)

42 per cent of women spend >15 per cent household income on transport versus 8 per cent men, confirming global patterns (ADB, 2013). BRTS “pink buses” cover only 12 per cent routes, scheduling mismatches care-work peak hours (7-9AM school drops + 4-6PM pickups). Eastern zone women (n=60) average ₹2,200/month transport costs (18% income), forcing job proximity over career advancement.

Table 8: Transport Affordability by Zone

Zone	% Income on Transport	BRTS Usage (trips/week)	Pink Bus Access
East	18%	4.2	8% routes
West	9%	7.1	15% routes
Central	12%	5.8	12% routes

Source: Primary survey (N=150)

Mobility Reliability & Last-Mile Gaps (Dimension 2)

Janmarg BRTS Phase 3 serves 1.2M daily but 40 per cent stations lack ramps/toilets forcing 500m detours through unlit service lanes. Women average 25-minute last-mile walks post-BRTS alighting. Naroda-Maninagar corridor (4km audit): 60 per cent sidewalk encroachments(vendors/parking), 38 per cent sidewalk continuity.

Metro-BRT integration fails: 35 per cent Blue Line stations lack feeder rickshaws despite women chaining 2.8 trips/day (vs men's 1.7). Reliability impacts job retention: 67 per cent women report missing work due to transport delays.

Safety Perceptions vs Reality (Dimension 3)

82 per cent women modify routes avoiding dark segments despite actual assault rates 0.8 per cent (low but perception dominates). Primary fears: staring (68%), groping (22%), verbal (45%). Eastern zone safety score 2.1/5 vs West 3.4/5 (ANOVA $F=28.4$, $p<0.001$).

Night avoidance rates: 85 per cent East, 45 per cent West, 60 per cent Central. Route adaptation adds 22 minutes daily travel time, constraining employment windows (6AM-6PM only).

Safety Metrics by Zone

Table 9: Safety Metrics by Zone

Zone	Safety Score (1-5)	Night Avoidance	Harassment %	Route Change %
East	2.1±0.8	85%	72%	89%
West	3.4±0.7	45%	38%	62%
Central	2.8±0.9	60%	55%	78%

Source: Primary survey, ANOVA analysis.

Essential Services Deficit (Dimension 4)

BRTS station amenities: 40 per cent lack toilets, 28 per cent lack seating, 62 per cent lack ramps. Caregivers (n=32) report no childcare near transit nodes, forcing trip-chaining compromises. Sanitation crisis acute: 72 per cent East zone women avoid long journeys due to toilet absence vs 38 per cent West.

Anganwadi gaps compound: only 12 per cent within 1km BRTS corridors despite national norms. Heat + childcare = 35 per cent trip cancellations during 2025 heatwave.

Climate Vulnerability Amplification (Dimension 5)

Ahmedabad 2025 heatwave (14 days >45°C) reduced women's walks 35 per cent per travel diaries. Eastern zones: 0 per cent shaded paths despite 4-5km daily treks. Women with children endure 22 per cent longer heat exposure carrying infants. BRTS waiting areas covered only 28 per cent.

Intersectional impact: SC/ST women (55% sample) report 41 per cent walk reduction vs 29 per cent general category during heat peaks.

Cumulative Economic Impact (All Dimensions)

Six dimensions operate synergistically:

- Poor access
- Unreliable Mobility
- Safety avoidance
- Service gaps
- Climate constraint
- Institutional neglect = 23.5 per cent female LFPR (vs 45% male). Annual GDP loss: ₹15,000 crore Ahmedabad (10% LFPR gap × 4.5M women × ₹33,333 avg wage).

Policy Recommendations & Implementation Framework

Statutory & Budgetary Reforms (Immediate: 0-12 months)

Gender Audits Mandatory: Amend Gujarat Town Planning Act requiring 20% sex-disaggregated mobility data in all statutory plans (AMC 2026-31 onwards). Benchmark: Indore NITI Aayog #1 via gender metrics.

Gender Budget Mandate: 20 per cent NMT allocation (₹420 crore/5 years) ringfenced pedestrian upgrades. Line item: ramps/toilets 100 per cent BRTS stations by 2028.

AMC Safety Reporting App: Real-time harassment platform integrated 1,200 BRTS CCTV cameras. Target: 10,000 downloads Year 1, GIS-mapped hotspots for targeted lighting.

Infrastructure Prioritization (12-36 months)

Last-Mile Network: 100km shaded feeder paths residential → transit corridors. Priority: Naroda GIDC (200K women workers), Odhav (textile hubs).

Universal Station Access: Ramps, toilets, seating 100 per cent BRTS/metro by 2028 (₹150 crore). Pink bus routes expanded 50 per cent coverage.

Lighting Standards: 90 per cent post-dusk coverage promenades/stations (Nirbhaya model). Solar-powered prioritised heat-prone East zones.

Institutional Transformation

1. **Planners Academy:** Train 500 AMC officials WRI India intersectionality modules (Q3 2026 start, ₹10 crore/5 years). Curriculum: Crenshaw framework, Jane Jacobs application.
2. **Gender Coordination Cell:** BMC ACG-model cell overseeing housing/transport/sanitation. 50 per cent women staff, direct commissioner reporting.
3. **Data Mandate:** Annual sex-disaggregated travel surveys resuming 2026. GIS harassment database public access.

Participatory Governance

Indore Model: 30 per cent women ward committees mandatory. SEWA federations (120K Ahmedabad women) institutionalised consultation.

Women-Led Transit Committees: Kochi model (15 per cent evening usage gain) at 10 pilot BRTS corridors.

Phased Implementation Roadmap

Table 10: Phased Implementation Roadmap

Priority	Action	Timeline	KPI	Budget (₹ Cr)	Benchmark
Critical	Safety app	6 months	10K downloads	5	Kochi app
High	Gender audits	12 months	100% plans	2	Indore NITI #1
High	Station ramps	24 months	100% coverage	150	Delhi Nirbhaya
Medium	Shaded paths	36 months	100km	200	Bogotá Ciclovía
Long-term	500 planners trained	Ongoing	100% turnover	10/year	WRI modules

Source: Author's policy recommendations

Total Investment: ₹367 crore yields ₹50,000 crore GDP (ROI 136x, 5-year horizon).

Economic & SDG Justification

10 per cent LFPR gain = 450,000 additional women employed × ₹4 lakh/year avg wage = ₹18,000 crore direct + multiplier effects. SDG 5 (Gender Equality) + SDG 11 (Sustainable Cities) alignment unlocks NITI Aayog funding, 100 Smart Cities grants.

CSR Leverage: Adani/Ambani's illuminate 50km corridors (₹100 crore value). Tata Trusts fund Gender Cell (₹20 crore).

Monitoring Framework

KPIs: LFPR +5% (2028), harassment reports -30%, women evening BRTS +25%. Annual AMC Gender Report to state legislature. NITI Aayog Sustainable Cities Index inclusion.

Political Strategy: Tie 15th Finance Commission grants to gender KPIs. AMC Standing Committee presentations quarterly.

Risk Mitigation: Corporator resistance countered women voter data (52% electorate). Engineering lobbies addressed hybrid road-NMT contracts.

Findings

Primary and secondary data collection are integrated to trace the pathways from:

Transport design and urban form, actual and perceived safety—mobility avoidance and choices—labor and education outcomes.

Governance and policy recommendations on gender-disaggregated data systems, participatory safety audits, integration of safety-app data into planning, and gender budgeting.

Adapted design guidelines for footpaths, amenities, lighting, and last-mile connectivity. These pathways are compared with existing gender-responsive toolkits to identify priority gaps in infrastructure, behaviour, and governance in the study areas.

To make sustainable cities in India and support gender-inclusiveness, intersectional evidence can be operationalised within urban and transport planning. Thus, this methodology approach is not intended to show whether or not women feel excluded or unsafe in the urban spaces.

Recommendations

Participatory planning: Women should be involved in planning; regular safety audits should be conducted, and policies should ensure community input (World Bank 2020).

Governance

Anti-harassment laws, including quotas in leadership, enhancing gender-responsive budgets and monitoring, equality in pay (Asian Development Bank, 2013a, 2013b).

Technology

Anonymously reporting systems (Anoop & Manju, 2023), improving safety apps with emergency failures, and offline capabilities.

Social Change

Challenging care-role norms, encouraging men's participation in household work (UNDP, 2020), promoting gender-sensitive education and challenging childcare norms.

Conclusion

Indian metropolitan cities stand at a critical juncture where persistent gender inequities in urban planning directly constrain national economic growth and sustainable development. This study's empirical evidence from Ahmedabad demonstrates that women's low labour force participation (23.5%) is not merely a cultural or educational issue, but fundamentally a spatial and infrastructural problem rooted in gender-blind urban planning and governance.

The six-dimensional analysis—spanning access, mobility, safety, services, climate vulnerability, and institutional capacity—reveals how seemingly discrete infrastructure deficits compound synergistically to create structural exclusion. The finding that 82 per cent of women modify daily routes, adding 22 minutes per trip to avoid unsafe segments, translates to 134 hours annually per woman—time that could otherwise contribute to economic productivity, education, or leisure.

Comparative analysis of Mumbai's Gender Amenities Cell, Kochi's women-led transit committees, and Indore's gender mainstreaming demonstrates that targeted institutional interventions yield measurable LFPR improvements of 3.9-5.4 per cent within 3-7 years. The economic case is compelling: Ahmedabad's ₹15,000 crore annual GDP loss from gender mobility gaps far exceeds the ₹367 crore investment required for comprehensive gender-responsive infrastructure, yielding a 136:1 return on investment.

The study's intersectional framework reveals that planning interventions must be differentiated—Scheduled Caste women in Eastern industrial zones experience qualitatively different mobility constraints than upper-caste professionals in Western suburbs. One-size-fits-all policies will perpetuate rather than eliminate layered vulnerabilities.

Critically, the research exposes the representation paradox: despite 46 per cent women councilors, only 12 per cent planning staff and 8 per cent engineering officials are women, with zero intersectionality training. This institutional imbalance ensures that even well-intentioned policies fail at implementation. The establishment of dedicated Gender Coordination Cells with technical capacity, budgetary authority, and data systems is non-negotiable for sustainable change.

Indian metro cities can indeed set a global example by embedding gender equity in every aspect of urban policy and design. The pathway forward requires four simultaneous transformations: (1) statutory mandates for gender-disaggregated data

and gender impact assessments, (2) reallocation of municipal budgets toward pedestrian infrastructure prioritising women's mobility patterns, (3) institutional capacity building through intersectionality training and gender-balanced technical staff, and (4) participatory governance mechanisms that institutionalize women's voices in planning processes.

The evidence is clear, the frameworks are available, and the economic imperative is urgent. What remains is political will and implementation commitment. As India's urbanisation accelerates—projected 600 million urban residents by 2031—the choices made today will determine whether cities become engines of inclusive prosperity or perpetuate structural gender exclusion. Ahmedabad, and Indian cities more broadly, have both the opportunity and obligation to choose inclusion.

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Exploration of Built Environment through the lenses of Elderly – A Case of Amarabati, Kolkata

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Sudeshna Roy^{*}, Varsha Vinod^{} and Keya Mitra^{***}**

Abstract

The planning and design of built environment plays a crucial role by influencing the perception and behaviour of its users. The initiatives by World Health Organisation (WHO) to promote age-friendly neighbourhoods, creates an opportunity to develop the built environment to accommodate the elderly to lead active lives, with enhanced health, social engagement and independent identity. Issues like senile dementia, visual impairments, cognitive mapping challenges, and a range of psychological issues are frequently brought on by ageing. Hence, the psychological impact, safety, comfort, social potential of urban and architectural spaces plays a major role. This paper aims to explore the built environment through the perception of the elderly, at a neighbourhood level, and identify the various potential challenges to enhance the liveability of the elderly. An extensive literature study, followed by analysis of secondary case studies and CPWD guidelines, aided in understanding the user requirements. The study underscores the importance of addressing elderly issues in urban design and planning guidelines.

Keywords

Elderly Friendly, Built Environment, Urban Spaces, Human Behaviour, Environmental Psychology.

Introduction

Built environment is considered as the manmade structure that encloses open spaces, dedicated for social, cultural and economic exchange. The scale can range in size from houses and parks to cities and neighbourhoods, and they frequently include the

* Sudeshna Roy, Undergraduate Student, Department of Architecture and Planning, IEST Shibpur, West Bengal.

Email: sudeshna.arch25@gmail.com

** Varsha Vinod, Faculty, Department of Architecture and Planning, IEST Shibpur, West Bengal.

Email: ar.varshavinod@gmail.com

*** Keya Mitra, Professor, Department of Architecture and Planning, IEST Shibpur, West Bengal.

Email: keyamitra@arch.iests.ac.in

infrastructure that supports them, like energy or water supplies. The design of the built environment influences user behaviour and perception. The planning of built environment of public spaces, plays a very significant role, considering the multiple user groups, based on their age, gender and abilities. It is thus significant for designers to understand the psychology of its users, assess the existing public infrastructure and issues faced, in order to address the existing issues as well as implement the design strategies in respective design projects.

Specific to this study, the researchers have attempted to explore a public node, in the sub locality of Amarabati, Kolkata, through the perspective of the elderly. The need to create settings, goods, and services that put the comfort and well-being of the elderly first is growing as elderly people become more prevalent in societies across the globe. Age-friendly communities, according to the World Health Organisation (WHO), are places where older people, communities, policies, services, settings, and structures collaborate to support and facilitate a healthy ageing process for all. Designing a space for the elderly involves a systematic approach that prioritises safety, assistance, cognitive considerations, and overall well-being. This involves providing a safe, secure environment, legibility, and social interaction opportunities. Specific recommendations have been made to enhance accessibility, cognition, safety, and social interaction hotspots. Key aspects include ergonomics of furniture, proper lighting, landscaping tools, accessibility measures, and safety measures (Belinda Yuen C. W., 2018). Promoting age-friendliness in public spaces does not require additional costs, but intentional design modifications can significantly improve lives, foster an active lifestyle, and facilitate increased mobility. By implementing thoughtful design elements, the environment for older individuals is significantly enhanced. This approach also considers the needs of the younger population, ensuring that the well-being of older individuals is effectively planned for the evolving needs of a shifting demographics.

Aim & Objectives

The aim of this study is to explore the selected urban node through the lens of an elderly and develop strategies to create an age-inclusive urban public space. The significance of the study is multifaceted and holds crucial implications, especially when considering the Indian scenario of an ageing population. The study explored the problems faced by the elderly, factors that define well designed public spaces and existing guidelines related to architectural and urban design for ageing community. Subsequently, secondary case studies are referred to understand the scope of design in contributing positively to the geriatric society, and the study is assessed through lens of an elderly. This allows for strategic recommendations to transform public spaces with minimal changes while ensuring they are safe, accessible, and easily navigable for the elderly.

Literature Review

According to the UN, individuals aged 60+ are considered elderly—a definition widely accepted in India based on life expectancy, retirement age, and health issues (Belinda Yuen P. N., 2018). However, family roles and physical condition also influence perceptions of old age. The 2011 Census recorded 104 million Indians over 60 (8.6% of the population), with more women than men. India's elderly population has tripled in 50 years and is projected to reach 11.1 per cent by 2025 (UNDESA, 2012). The elderly are often grouped into young-old (60–70), middle-old (70–80), and old-old (80+).

Ageing brings physical, psychological, and cognitive challenges—such as dementia, visual decline, and slower mobility. A typical comfortable walking range for seniors is 2000–7000 steps/day, with speeds from 900–1300 metres/hour (Belinda Yuen P. N., 2018). Urban spaces must address mobility through ramps, lifts, and accessible paths. An 'Inception Workshop on Elderly-Friendly Design' held in Hong Kong, 2017 (HKSAR, 2019) highlighted key outdoor challenges for seniors (Cheung, 2021), stressing the need for elderly-centred planning. The challenges are as follows:

- 100% of the respondents experience trouble in finding proper seating area for resting.
- 100% of respondents experience absence of shaded seating area.
- 89% of the respondents face challenges to find building signage.
- 78% of respondents fear climbing long flights of staircase and also, uneven floor surface.

Aging in West Bengal

The present context of the elderly in India reveals significant demographic, social, and health-related trends. As per the Census 2011, India has approximately 104 million elderly people (aged 60 and above). In West Bengal, the elderly population is notable (8.5% of total population, Figure 1). The different living arrangements of the elderly population are noted from the census data (2011) as shown in Figure 2.

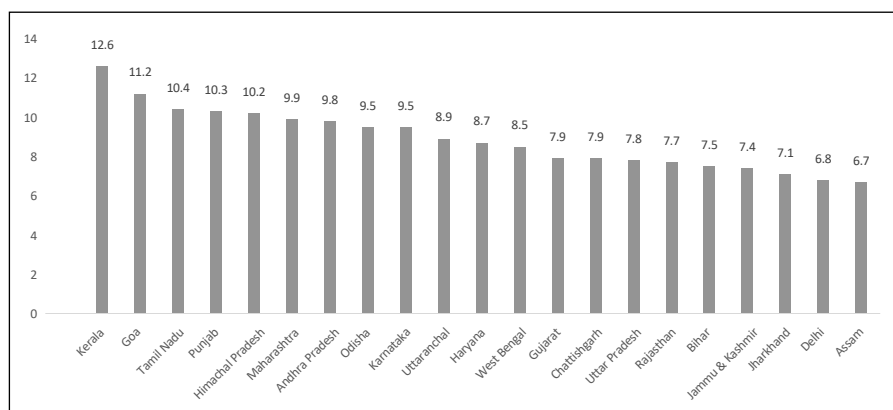


Figure 1: Population Aged 60 years and above according to Census 2011

Source: Census data 2011

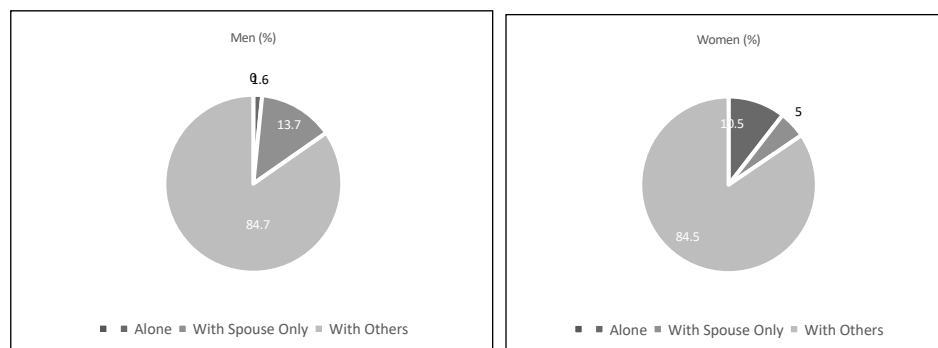


Figure 2: Living arrangement of the elderly by sex, West Bengal 2011

Source: Census data 2011

The sex ratio among the elderly population increases with age — from 1,053 females per 1,000 males in the 60–69 age group to 1,376 in the 80+ age group — highlighting a growing female dominance in older age (Figure 3). Elderly individuals face several physical and cognitive challenges, including difficulties with vision, hearing, walking, chewing, speaking, and memory. These problems tend to intensify with age, especially after 80 years (Figure 4).

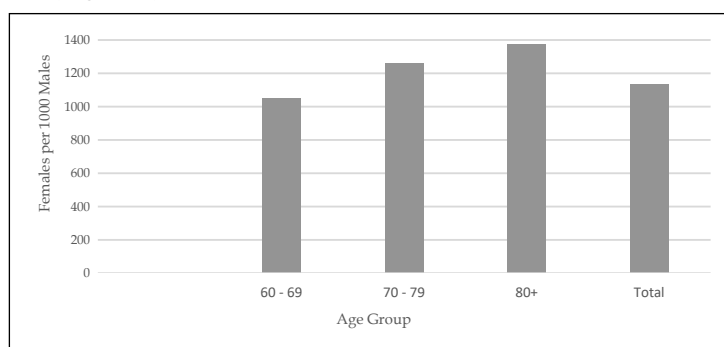


Figure 3: Sex ratio (females per 1,000 males), West Bengal 2011

Source: Census data 2011

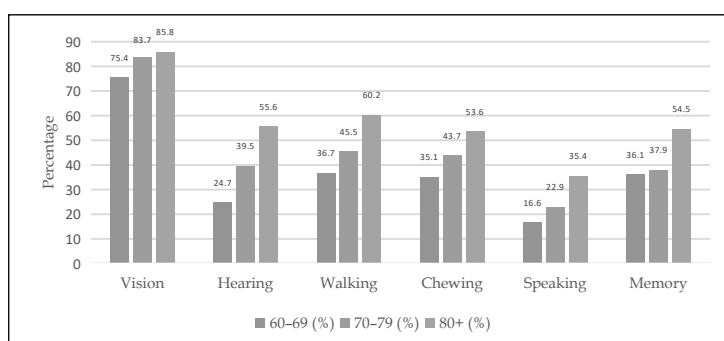


Figure 4: Elderly by type of disability and age, West Bengal 2011

Source: Census data 2011

Regarding income, elderly men in West Bengal primarily rely on salaries and wages, whereas women depend more on social pensions. A significant proportion of elderly women report having no personal income (Figure 5). Self-rated health status indicates better health perceptions among elderly men and younger age groups, in Figure 6. Overall, 37 per cent of rural elderly and 28% of urban elderly rate their health as poor, reflecting a critical need for improved healthcare and support systems tailored to the aging population.

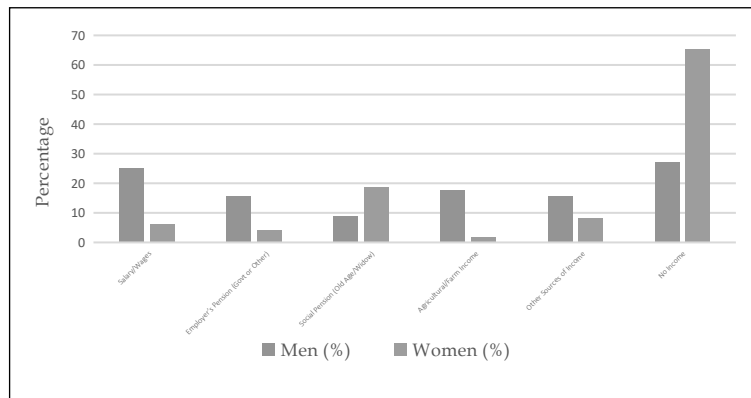


Figure 5: Elderly by sources of current personal income according to sex, West Bengal 2011

Source: Census data 2011

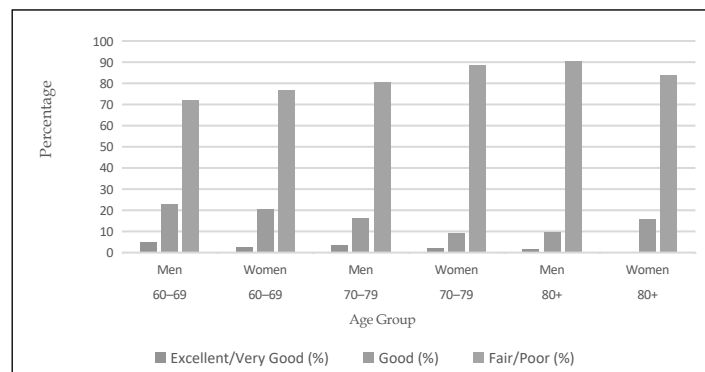


Figure 6: Self-rated current health status by age and sex, West Bengal 2011

Source: Census data 2011

This demographic context highlights the increasing proportion of elderly individuals experiencing mobility limitations, social dependence and chronic health challenges, reinforcing the need for inclusive and age-friendly neighbourhood public spaces. These demographic insights justify the selection of Amarabati, Kolkata, as the study area, where elderly users actively depend on local parks and community spaces for daily physical, recreational and social engagement. Therefore, the demographic characteristics of the elderly population inform the evaluation parameters of the

present study and guide the assessment of built-environment adequacy in relation to elderly perception.

Importance of Public Spaces in the concern of the Elderly

Public spaces serve as the backdrop for everyday social life (Carr, 1992), allowing people from different social and cultural groups to meet and interact (Németh, 2009). These spaces are central to daily life, defined by how and by whom they are used.

For older adults, aging often brings increased loneliness and a need for meaningful interaction (Cornwell, Laumann, & Schumm, 2008). Regular engagement with peers in public spaces like streets, parks, and markets helps support their mental well-being (Budihardjo & Pandelaki, 2012). When elderly individuals are respected, included, and supported to live independently, they experience a better quality of life. An inclusive society reduces social isolation, values their contributions, and fosters a sense of belongingness across all age groups. A high quality of life, improved service integration, and reduced redundancy in care-- all contribute to fostering an inclusive and equitable environment for people of all ages.

Characteristics of a Good Public Space

A well-designed public space supports community life and enhances the quality of urban living. The following key characteristics contribute to making public spaces vibrant, inclusive, and effective (Figure 7) (NCUDC, 2020).

Access & Linkages

It defines visual appearance of the space from a distance and its connectivity between the space and surroundings.

Comfort & Image

Public spaces should be attractive by its first impression and should be safe, clean, green, walkable, settable and attractive to the public

Uses & Activities

People visits public spaces for recreational and relaxation purposes, space should offer diverse activities, flexible enough to multiple uses.

Sociability

Sociability achieves for the presence of activities and welcoming nature of that particular activity to public participation.

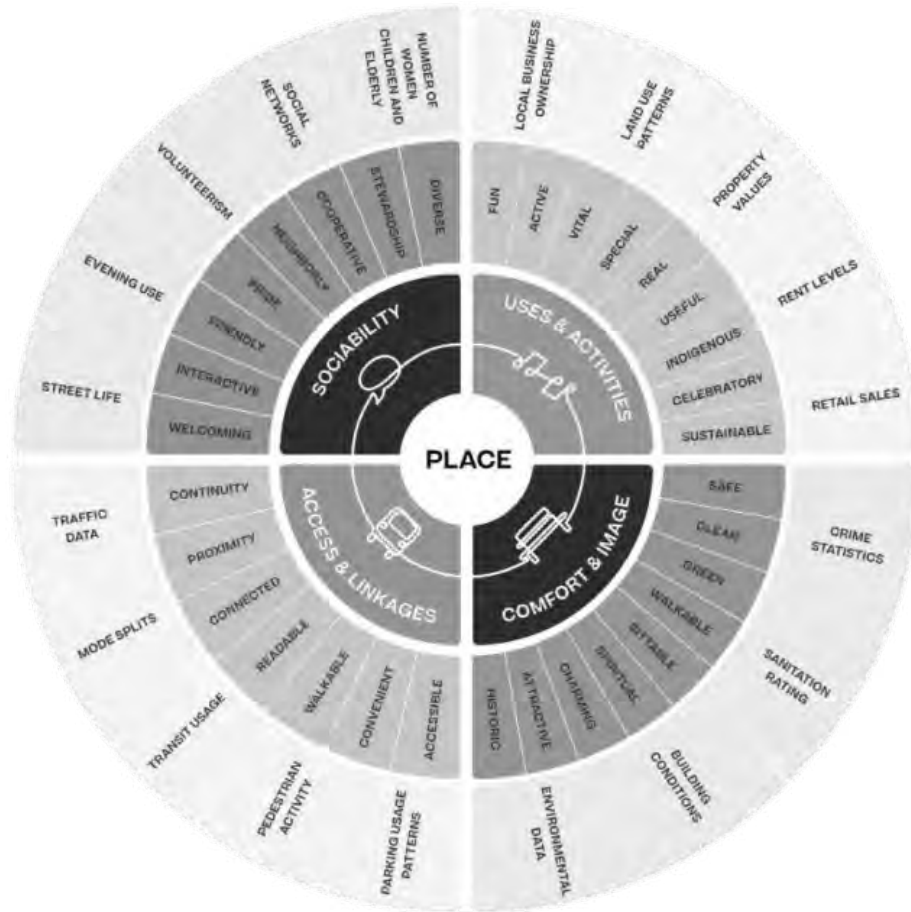


Figure 7: The Place Diagram “Qualities of a Great Public Space”

Source: Rohinikumar, 2017

Challenges Faced by the Elderly

Elderly individuals face several challenges in engaging with their surroundings due to physical, psychological, and cognitive limitations (Mohamed, 2023). Common issues include visual impairments affecting spatial perception, psychological conditions such as depression or anxiety that reduce environmental interaction, and cognitive decline, including dementia, which impacts memory and decision-making. Many elder citizens also experience cognitive mapping difficulties, making navigation and spatial recognition harder.

Elderly-friendly Design Guidelines

Ensuring safety in urban environments is vital for the elderly, who are more vulnerable to falls and may struggle to perceive risks. This can be improved through even, slip-

resistant flooring compatible with walking aids, along with thoughtful lighting and navigation features. Accessibility should include direct pathways, well-designed ramps, and clear layouts, supported by traffic control measures.

Elderly individuals face multiple challenges in engaging with their surroundings due to physical, psychological, and cognitive limitations. Common issues include visual impairments that affect spatial perception, psychological concerns such as depression or anxiety that reduce willingness to interact, and cognitive decline, including dementia, which impacts memory and decision-making. Many also struggle with cognitive mapping difficulties, making it harder to navigate or recall spatial layouts (Hing Wah Chau, 2021).

Exploring Elderly-friendly Design through Case Studies

Isaacs (2002) describes the transformation of Pioneer Courthouse Square, often referred to as “Portland’s Living Room,” highlighting how redesign interventions responded to evolving social and cultural needs (ISAACS, 2002). Considering the peak usage timings of the park, as shown in Figure 8, it highlights that 3pm-6pm serves a high density of people. The most recent redesign of the square focussed on aspects such as accessibility, comfort, social-interaction, safety and security. The access to the square was designed in such a way that it includes people of varied abilities and can use the space with any assistance. The square is 2150 m² of open plaza space that can be used for a variety of events. Amenities for public conveniences such as restrooms, help centres etc. were provided with special focus on universal design standards (Kathy Black, 2020). The square was well equipped to cater to societal integration activities such as live performances, provision for seating for friendly conversations, etc.

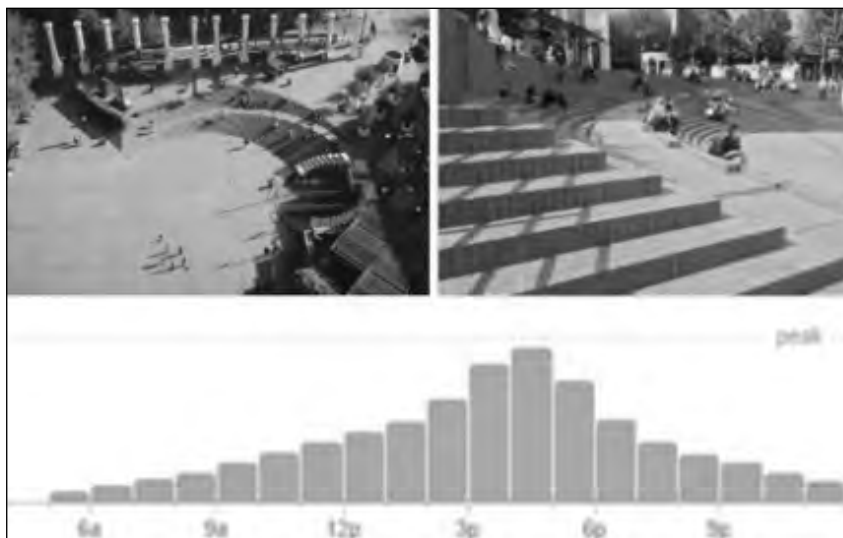




Figure 8: Pioneer Court Square; (Rohinikumar, 2017)

This case study indicated that accessibility is the primary factor for any urban public space, and especially in case of the elderly, the design of the access considering the legibility, safety and security is of utmost importance.

Rohinikumar (2017) examines Lodhi Colony Central Park, a 3-acre community park in New Delhi serving diverse age groups through recreation, social interaction and physical activity (Rohinikumar, 2017). The park is majorly a focal point for leisure, exercise, play and social interaction. The design provides open green spaces for younger age group to play in their designated area with children equipment. It also provides space for low pressure outdoor gym, for physical activities, walkways, and ample seating space for rest and social exchange.

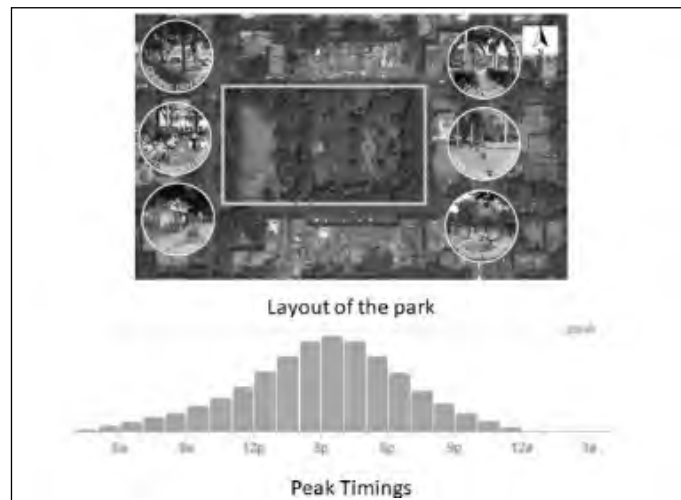




Figure 9: Lodi Colony Central Park, (Rohinikumar, 2017)

The park, with extensive open green areas, supports a range of activities for different user groups (Figure 9). Benches with armrests and backrests enhance comfort for older users, though some are placed on uneven surfaces that collect water. A shaded walking track along the boundary improves visibility and comfort for strolling. Retired seniors often spend several hours here engaging in conversations, games, and light exercise using available equipment. These case studies collectively demonstrate how accessibility, environmental comfort, ergonomics, and social interaction shape elderly use of public open spaces and inform the evaluation parameters applied in the Amarabati study.

These case studies collectively illustrate how accessibility, environmental comfort, ergonomics, and social interaction function as critical built-environment factors influencing elderly use of public open spaces. The insights derived from these examples help frame the parameters used to evaluate neighbourhood public spaces in the Amarabati case study.

Methodology

A background study is first conducted to establish the research goal and challenges faced by the elderly. The second phase involves analysing literature, case studies and CPWD guidelines to understand user requirements. This is followed by questionnaires, interviews, visual and photographic surveys to examine issues in detail. After analysing the data, conclusions are drawn and design guidelines are formulated.

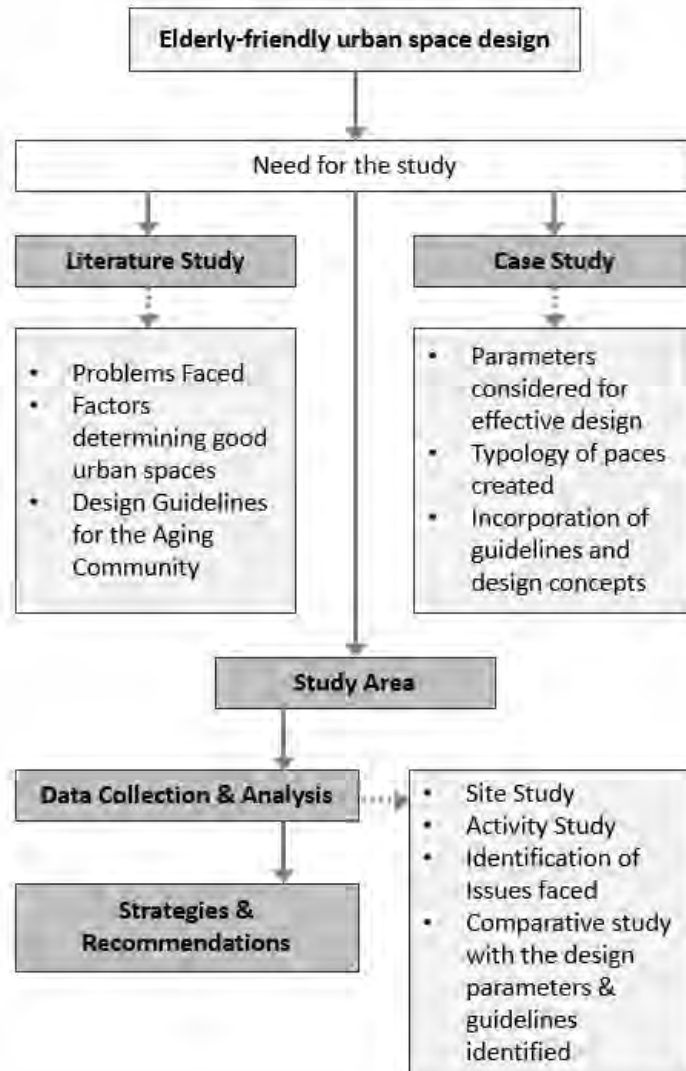


Figure 10: Research Methodology

Source: Authors

Study Area

For conducting the research study on elderly friendliness in urban public spaces, the area under Kolkata Metropolitan Authority (KMA) was chosen. The KMA is a densely populated region of 1,886.67 sq. km, including three municipal corporations and 38 municipalities. KMA includes a mix of urban and rural areas, with a significant portion dedicated to green spaces. These green areas include parks, wetlands, agricultural land, and other vegetation.

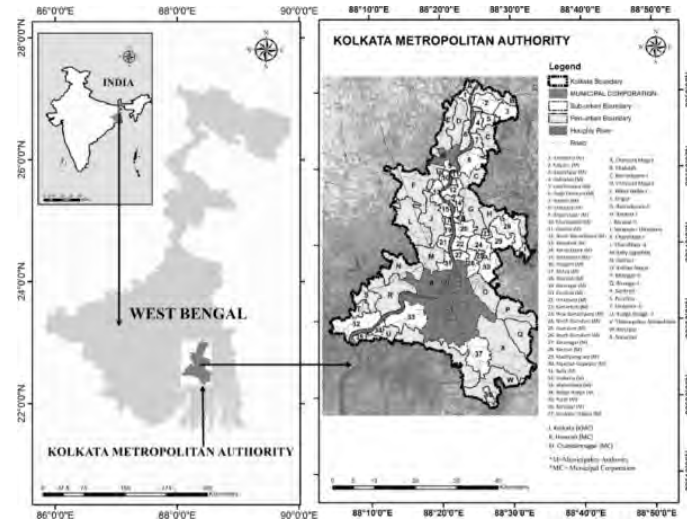


Figure 11: Map of Kolkata Metropolitan Authority (KMDA, 2011)

Within the KMA, two urban locations in Panihati Municipality were selected as the study area. The municipality contains substantial green spaces, though population density remains high. Vegetation mapping shows a mix of greenery and built-up zones, indicating limited yet valuable open areas. This blend influences the availability of accessible, safe, and comfortable public spaces for elderly residents who depend on such areas for rest and social interaction.

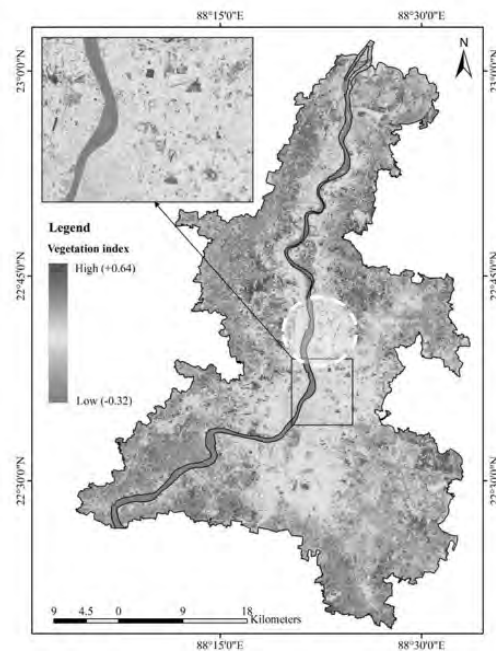


Figure 12: Vegetation Density Map of KMA (KMDA, 2011)

Therefore, the selected study area is located in an urban neighbourhood of Amarabati, Sodepur which comes under Panihati Municipality of Kolkata Municipal Authority of West Bengal in India. The study area includes a community park and a community religious space, along with the access road, connecting the two. The total study area was 1285 sq.m, of which, Trikone Park (neighbourhood level) was 240 sq.m, Charakatala Jora Shiv Mandir, temple complex of 325 sq.m and the connecting road being 72m long, as shown in Figure 13.

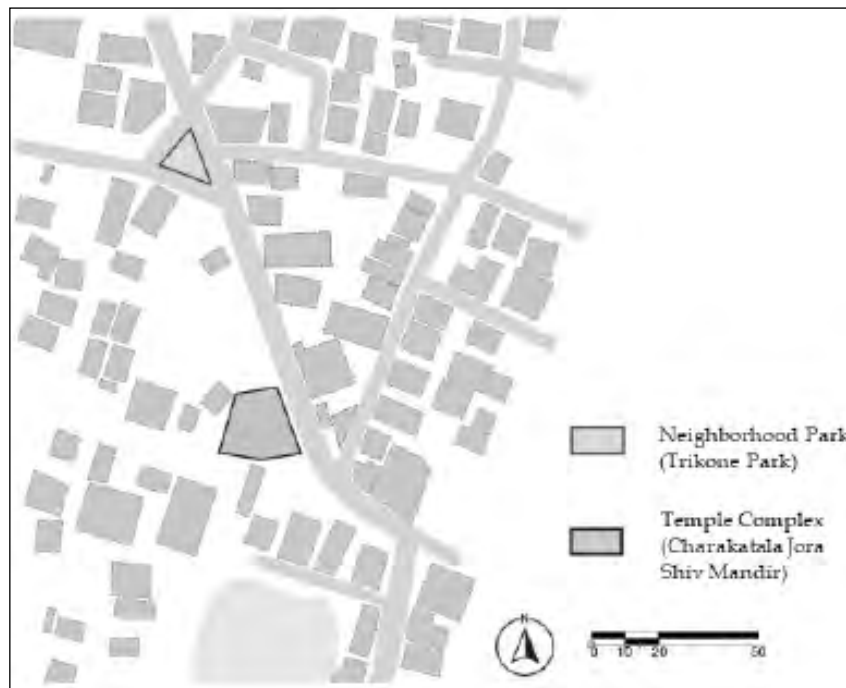


Figure 13: Location of Study Area

Source: Authors

Observations and Inferences

The temple complex consists of garbhagriha, community area and green open space. The entrance to the temple complex is directly from the access road, with high compound walls. The community area is used for yoga practice as well as social gatherings and food offerings. The steps and the plinth of the temple area used seating spaces, and green areas for multi-purposes. The temple has a closed boundary, and is mostly used by the neighbourhood community, considering their religious composition. There is some open green space between the two temples for different purposes. In the morning and evening, these areas are used for spatial interaction. However, it is devoid of essential amenities like a ramp for temple access and a public lavatory. There is no signage available.



Figure 14: Primary Observations (Temple)

Source: Authors

Considering this scenario, the park acts as a refreshing area with seating in its periphery. Fountains and water works have been designed in the centre of the park, with lighting, to create interest. The public space also has a boundary that encloses the area for security, but does not obstruct the visual axis to the park. It was also observed that the lighting is insufficient at late evening or night time, or is obstructed by outgrown trees. This endangers the safety of the park, and also is difficult to navigate through the perspective of an elderly. However, there is no view of the interior from the exterior due to the surrounding trees. The perimeter has been designed with small seating areas that are primarily used in the evening. There is not a ramp available to enter the park here either. There are occasionally traffic issues at the park because it is situated at the intersection of four roads.



Figure 15: Primary Observations (Neighbourhood Park)

Source: Authors

To evaluate the elderly-friendliness of urban public spaces, a detailed questionnaire was administered, focusing on the needs and experiences of older individuals. The survey was conducted in neighbourhood parks and temple complexes commonly used by elderly residents in the Amarabati area, Kolkata. A total of 18 elderly individuals participated.

General Information and Park Usage

The questionnaire gathered demographic and behavioural data from elderly respondents, including age group (60–69, 70–79, 80+), as shown in Figure 16, park visit frequency (Figure 17), visit duration (Figure 18), preferred time of day (Figure 19), and main purpose—exercise, relaxation, socialising, or events (Figure 20). This information highlights how urban parks serve as vital recreational and social spaces

for older adults. The following graphs and charts illustrate how parks support their physical, emotional, and social well-being.

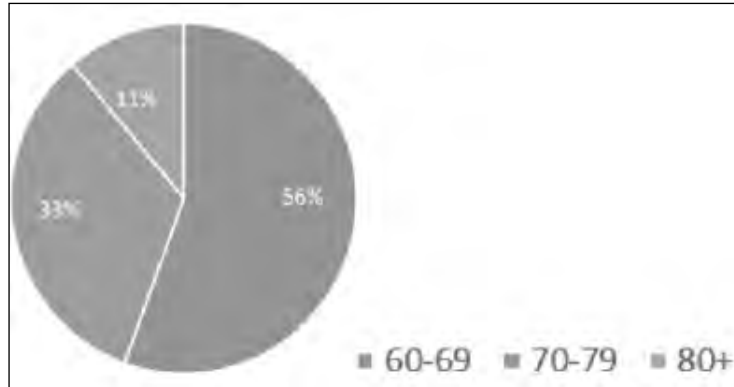


Figure 16: Classification of elderly respondents based on age

Source: Authors

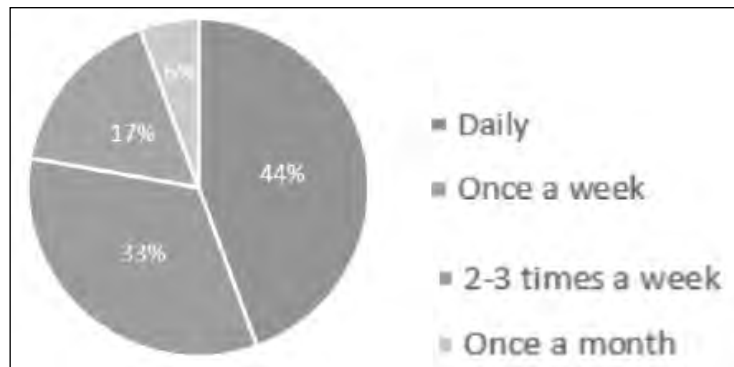


Figure 17: Frequency of visiting parks

Source: Authors

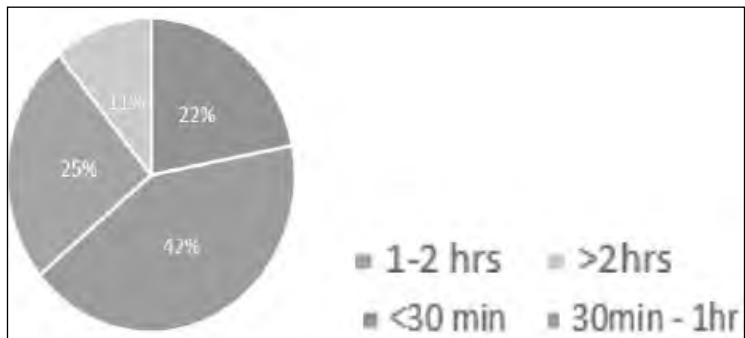


Figure 18: Duration of park visit

Source: Authors

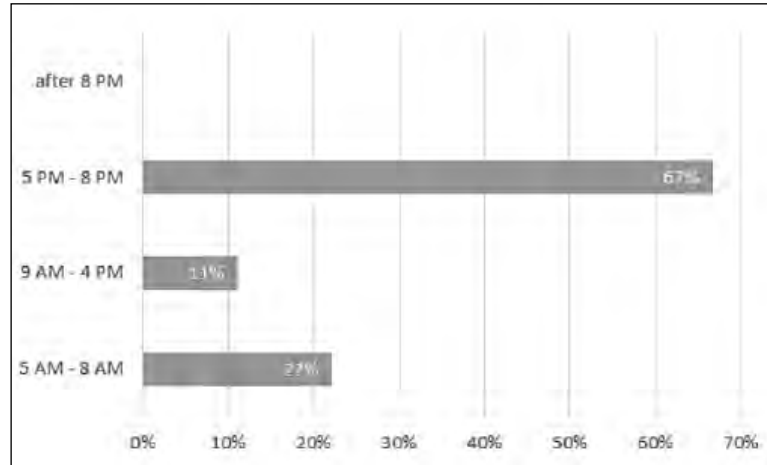


Figure 19: Preferred time of park visit

Source: Authors

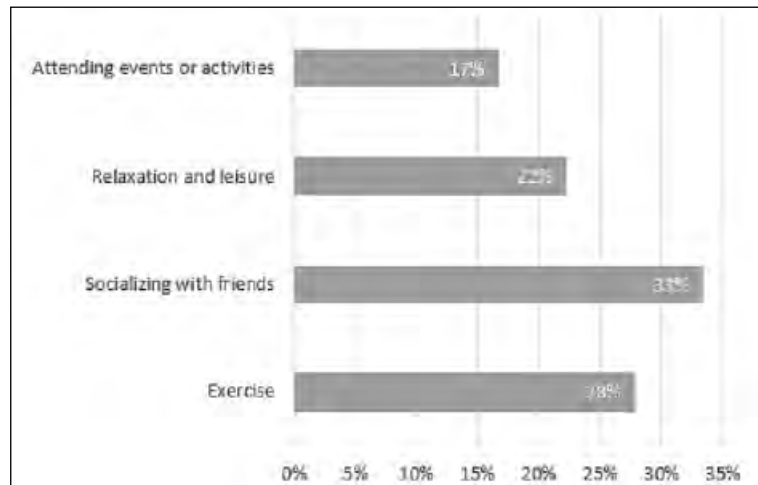


Figure 20: Purpose of park visit

Source: Authors

Assessing indicators for elderly friendly Urban Public Spaces

Based on insights from literature review and case studies, a series of assessment indicators were formulated to evaluate the elderly-friendliness of selected urban public spaces. These indicators guided the surveys and interviews conducted with senior citizens to fulfil the objectives of the study. The key design indicators identified include:

- Accessibility
- Safety
- Comfort & Amenities

- Impact on Health
- Social Interaction & Physical Activity

Each of these indicators was analysed through specific parameters, which are detailed in the following sections:

Accessibility

To assess the level of accessibility within the selected urban public spaces, a set of targeted questions were posed to elderly respondents, each to be answered with a simple 'Yes' or 'No'. These questions focused on key factors that influence ease of movement and navigation for older adults. The survey examined whether walking paths within the area are continuous and easy to navigate, whether the pavement materials are non-slippery and suitable for safe walking, and whether necessary support features like guide rails are present. Additionally, the questionnaire explored the availability and consistency of signage to aid navigation, the ease of moving within the space through connected pathways, and the extent to which the location is accessible via local urban transport systems.

The results of these responses are illustrated in the accompanying bar graph, offering a visual interpretation of how accessible the spaces are perceived to be by the elderly.

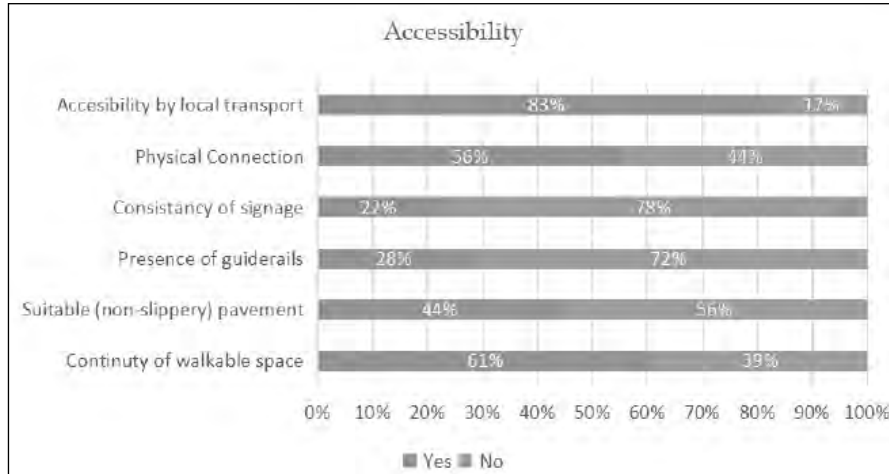


Figure 21: Study Area accessibility Parameters

Source: Authors

Safety

To understand the safety of urban public spaces from the perspective of the elderly, a set of focused questions were included in the survey. These addressed aspects such as ease of access and exit, adequacy of lighting, clarity and maintenance of pathways, sufficiency of seating provisions, and the presence of security surveillance.

The responses, shown in the graph, reflect the users' perception of how safe and accommodating these spaces are for older adults, highlighting both satisfactory features and areas requiring further attention.

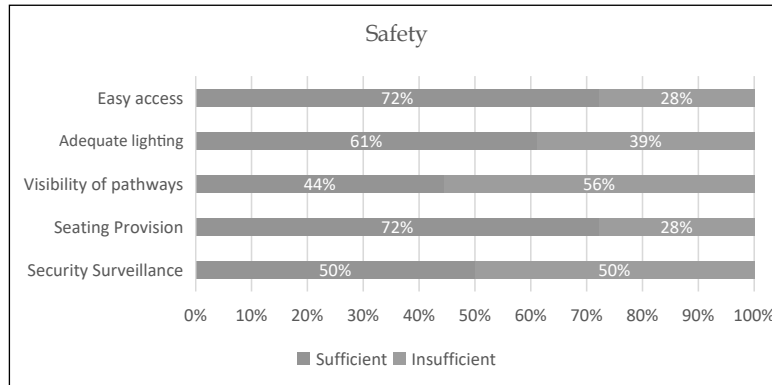


Figure 22: Study Area Safety Parameters

Source: Authors

Comfort & Amenities

The assessment of comfort and amenities in public spaces is crucial to understand how inclusive and user-friendly these environments are, especially for the elderly and physically challenged individuals. Key aspects considered in this evaluation include whether the seating areas are suitable for all weather conditions and if the materials used are appropriate for the local climate. Additionally, the ergonomic design of the seats, the provision of assistive armrests for ease of sitting and standing, and the availability of clean drinking water and well maintained toilet facilities for both male and female users were examined. The following charts illustrate the sufficiency and insufficiency of these amenities based on user feedback.

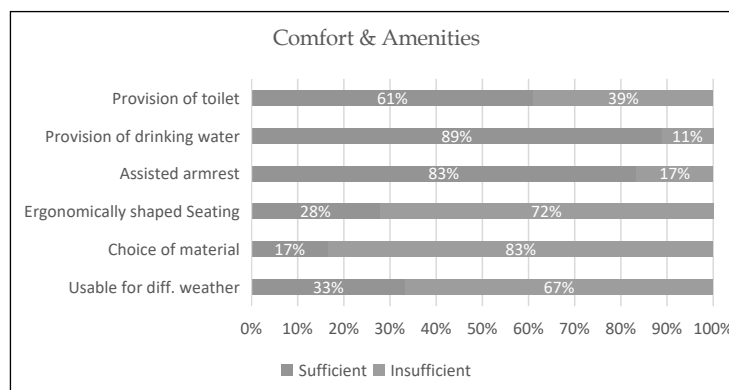


Figure 23: Study Area Comfort & Amenities Parameters

Source: Authors

Impact on Health

This section assesses how park visits impact users' physical and mental health. Respondents rated health improvements on a 0–3 scale and shared whether visits affected mental well-being positively, neutrally, or negatively. The role of social interaction in promoting health was also explored. The charts below present these insights, highlighting parks' contribution to community wellness.

Interview responses indicated that elderly users experienced difficulty spending longer periods in the park due to noise, lack of shaded seating and disturbances from movement flows. Shaded and quieter corners were stated to be desirable for improving relaxation and enabling longer outdoor stays. These insights highlight the need for sensory and calm spaces, reinforcing the significance of environmental comfort in elderly-friendly public space design.

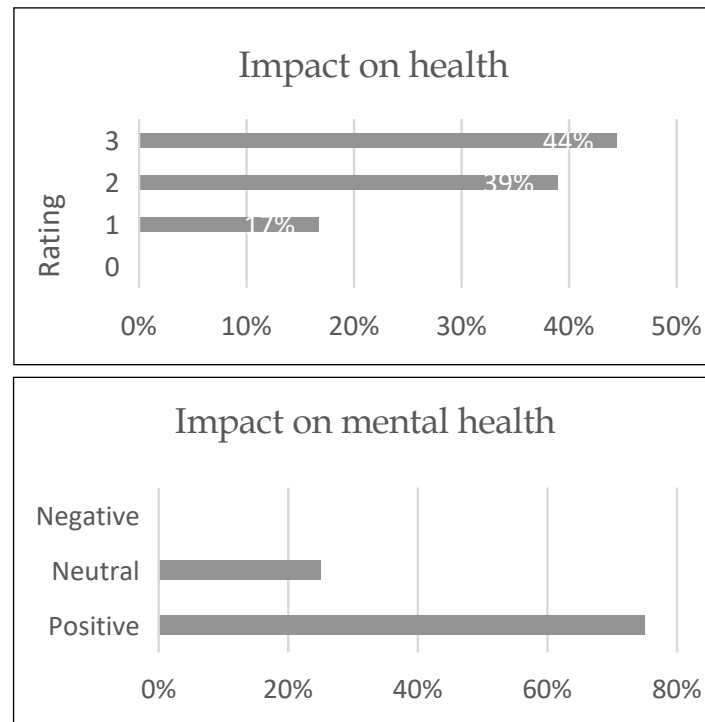


Figure 24: Study Area Impact on Health Parameters

Source: Authors

Social Interaction & Physical Activity

This section of the survey explores how public parks support social interaction and physical activity. Participants shared their involvement in group activities like yoga, exercise classes, games, and community events. The survey also captured the frequency and duration of physical activities like walking, along with how often users meet new

people. The charts below illustrate participation levels and social engagement in park settings—

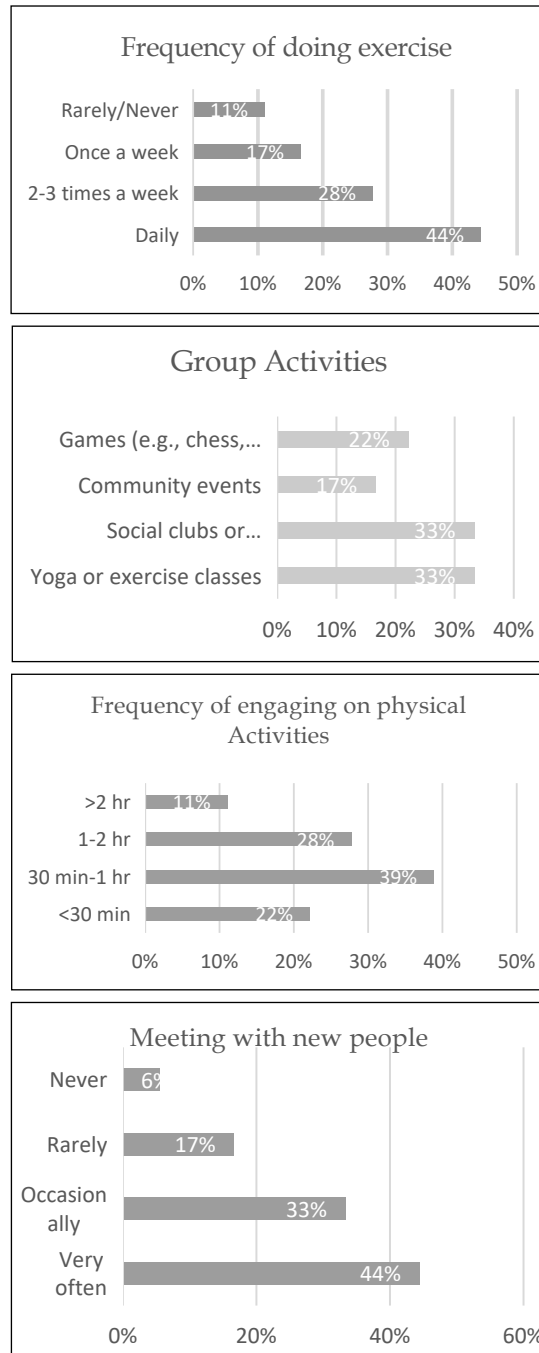


Figure 25: Study Area Social Interaction & Physical Activity Parameters

Source: Authors

- Qualitative Insights from the Interviews
- Expectation for accessible, shaded, and comfortable seating to rest and interact without physical discomfort.
- Need for a calm and quiet environment to reduce stress and allow reflective time in nature.
- Desire for a safe and visually clear environment with adequate lighting and unobstructed pathways to navigate confidently.
- Positive emotional response when engaging in community activities, which enhances motivation to visit regularly and improves social belonging.

Interview insights revealed that elderly users expect public spaces to provide comfort, safety, and a sense of belonging. Shaded seating, peaceful zones, good lighting, clear visibility, and accessible pathways were highlighted as essential for relaxation, confident movement, and meaningful social interaction, emphasizing the need for emotionally comfortable and sensory-balanced environments.

Additional qualitative insights from interviews revealed that elderly users expect neighbourhood public spaces to offer comfort, safety, and a sense of belonging beyond basic infrastructure. Respondents emphasised the need for shaded seating areas, quieter corners for peaceful interaction, and pathways with good lighting and clear visibility to support confident, independent movement. Many noted that noisy or crowded spaces reduce the duration of their visits, whereas calmer, well-organised environments encourage longer stays and meaningful social engagement. These perceptions highlight emotional comfort and balanced sensory conditions as essential elements of elderly-friendly parks.

Discussion and Analysis

The survey evaluated how well public parks support elderly users' well-being. Key issues affecting accessibility, safety, comfort, and inclusiveness were identified, suggesting the need for strategic improvements to create more age-friendly environments.

- *Accessibility Issues:* Poor transport links, unclear signage, and disconnected paths hinder ease of access.
- *Unsafe Pavements:* Slippery, uneven surfaces raise fall risks; non-slip materials are needed.
- *Uncomfortable Seating:* Lack of ergonomic seats with backrests and armrests reduces comfort.
- *Safety Concerns:* Dim lighting and no surveillance cause insecurity, especially at off-peak hours.
- *Limited Social Spaces:* Few gathering zones restrict interaction and community bonding.

- *Poor Amenities:* Inadequate toilets and drinking water lower usability.
- *Lack of Weather Protection:* No shaded/sheltered areas make parks uncomfortable in harsh weather.
- *Limited Activity Spaces:* Scarcity of elderly-friendly fitness zones like walking tracks or yoga areas.
- *Mental Well-being Impact:* Parks help mental health but need more sensory and calm spaces.

Comparative Analysis

Table 1 presents an overall analysis of the study, combining comparative literature-based standards (such as CPWD guidelines) with data from human-interacted surveys conducted at selected sites. The final column lists the inferences derived from this comparative analysis, highlighting key gaps and suggesting improvements for better accessibility and elderly-friendly design.

Table 1: Comparative Analysis of the Parameters on the Spatial Elements of the Study Area

Spatial Element	Standard (CPWD, India)	Study Area		Inference
		Temple Complex	Trikone park	
Accessibility				
Walkways				
Width	1200 mm for one way & 1800 mm for two way	1800 mm wide	1500 mm wide	Maintained width of 1200-1800 mm
Material	Non- slippery material	Concrete pavement	Tile Paving	Non- slippery material used
Other	Avoid drainage ditches to eliminate obstruction for users with walking stick/ crutch	Flat smooth surface	No drainage ditches	As per standards
Ramps				
Gradient	Preferably 1:15 to 1:20	Element not present	Element not present	Needs to be incorporated where necessary, to enhance accessibility.
Width	Minimum of 1800 mm			
Guiderails	900 - 1000 mm height			

Spatial Element	Standard (CPWD, India)	Study Area		Inference
		Temple Complex	Trikone park	
Stairs				
Depth	Tread width > 300mm , Riser < 150 mm	Tread 250 mm, Rise 150 mm	Tread 220 mm, Rise 150 mm	Needs to be refined, as per standards.
Handrail	Height < 950 mm from floor	not present	not present	
Minimum no. of steps	more than 2 steps	3 steps	2 steps	
Additional measures	Provide colour contrast/ tactile clicks at starting and ending positions.	White Marble surface	Coloured Tile surface	
Safety				
Traffic				
Location	Near Neighbourhood area	Located in Neighbourhood area	Located in Neighbourhood area	As per standards
Traffic crossing	Safe crossings and signalised interactions			Crossing and signals should be designed accordingly
Falls				
Pavement surface	Non-slippery, even paving surface	marble surface of the temple	Tile, Not suitable for walkways	Choose non-slippery material and provide handrails at level difference
Kerbs	Kerb wall protected through the walkways	Maintained	Maintained	
Handrails	Handrails on steps and ramps	Not present	Not present	
Crime				
Clear vision	Paths with clear lines of sight, avoidance of foliage that obstruct view	Small walkway, Visible pathway	Installation in the middle obstructs the sight	Walkways should be clearly visible with ample lighting
Lighting	Sufficient natural light	Optimum lighting within the premises	Dark roads during night	
Surveillance	Natural surveillance available in whole daytime	Natural Surveillance by local residents	Natural Surveillance by local residents	

Spatial Element	Standard (CPWD, India)	Study Area		Inference
		Temple Complex	Trikone park	
Liveliness	lively throughout the day with people participation in various events.	Present in the morning and evening	Present in the morning and evening	
Comfort & Amenities				
Seating Spaces				
Location	Along walkways, shaded area	Ample of seating space on temple plinth	Ample of seating benches	Requirement for seating along the walkways with shade
Design of element Angled back support Height from the floor level Armrests Suitability on weathering condition	Bench with back support 450mm to 500 mm 250 mm from seat level Natural material (stone, Wood)	Not present	No armrest or back support present	Ergonomically shaped seating spaces. Stone or wood used as material
Drinking fountain				
Location & proximity	Alongside crowded walkways	At the Extreme back side of the temple	No provision of drinking fountain	Locate in high pedestrian area in walkways
Surrounding Environment	Maintain clear surroundings	Dark shabby area		Maintain clear surroundings
Consistent Signage	Clear and visible signage	No signage		Clear and visible signage
Social Interaction				
Space for Physical activities				
Walking loops	Walkway around the boundary	Around the temple	Around the installation	Walkways with sufficient width and ample natural light
Exercise Equipment	Not present	Community hall used for yoga practice	Not present	Low impact equipment for neighbourhood people

Spatial Element	Standard (CPWD, India)	Study Area		Inference
		Temple Complex	Trikone park	
Open space for other activities	Ample space in between the seating for various events	Green space for various purpose	Not present	Green space for other activities
Space for social interaction				
Interactive seating spaces	Amphitheatre seating	The plinth is designed in that way	Benches placed not interactively	Face to face seating space, shaded area
Community Centre	Community area for social events	Multipurpose hall	not present	Community area for reading spaces or group activities
Space for playing together	stepped seating used as the main seating	Green space and also seating	not present	Open or semi-open area for social events

Source: Authors

Strategies and Recommendations

Strategies to improve the study area for the elderly focus on four key aspects: accessibility, safety, comfort, and social interaction. These simple, neighbourhood-level measures aim to encourage seniors to step out, offering spaces to rest and connect socially, rather than remain confined at home due to unsafe or unwelcoming environments.

Accessibility

To enhance accessibility for elderly users and individuals with mobility challenges, design interventions are proposed for the neighbourhood parks and the temple complex as shown in Figure 26. The existing entrances, located at the corners of both sites, hinder visual connectivity and create unsafe crossing conditions. Relocating these entrances towards the centre of the site boundaries improves visibility and pedestrian safety. Additionally, the incorporation of right-angle turns with splayed or rounded corners along internal pathways can reduce sharp directional changes and minimise accident risks. The installation of ramps alongside park and temple stairs ensures barrier-free access, complying with universal design standards. These spatial improvements collectively contribute to making the public spaces more inclusive, safe, and user-friendly for all age groups.

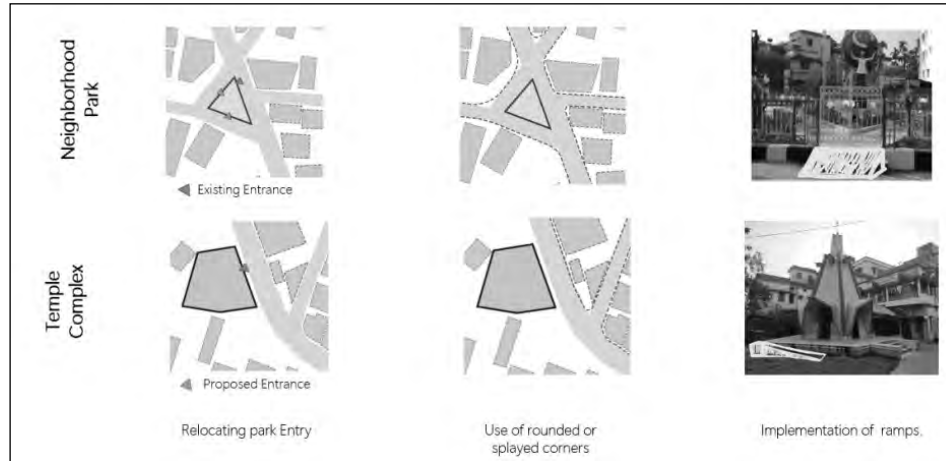


Figure 26: Enhancement of Accessibility in the study area

Source: Authors

The proposed road sections shown in Figure 27 focus on improving accessibility and user safety around the neighbourhood park and temple complex. Key interventions include ramps with a 1:10 slope for easier access to plinths, tactile pavements for the visually impaired, and adequate street lighting for comfort and safety. Guardrails on temple plinths act as both support and protection. Maintaining appropriate ground levels, along with the addition of zebra crossings and traffic signals, ensures safer pedestrian movement across the site.

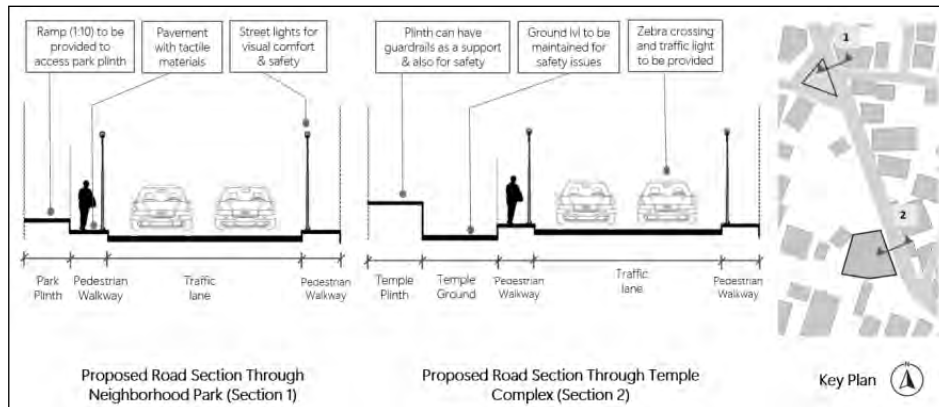


Figure 27: Proposed Cross Section of the Roads of the Study Area

Source: Authors

Safety and Security

Ensuring safety and security in public spaces is essential for creating a comfortable and inclusive environment, especially for vulnerable groups like children and the elderly.

The proposed strategies aim to minimise risks and enhance user experience through targeted interventions across the park and temple complex areas.

- Provide adequate and well-distributed lighting along pathways, seating areas, and entrances to improve visibility and prevent accidents, especially during the evening.
- Ensure walkways are free from uneven surfaces, potholes, or sharp turns to minimise fall risks.
- Install sturdy handrails and guardrails along paths and elevated areas to support balance and safety.
- Enhance security through visible personnel or surveillance systems to ensure a sense of safety for elderly visitors.
- Strategically position:
 - Traffic lights at key intersections.
 - Zebra crossings near the park and temple to support safe pedestrian movement.
 - Speed breakers along main access roads to control vehicle speed and improve pedestrian safety.

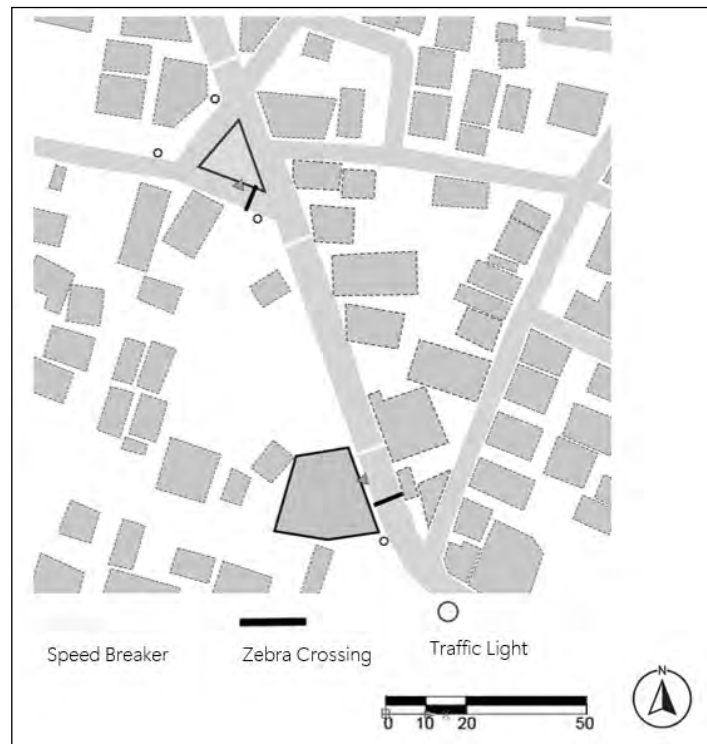


Figure 28: Enhancement of safety and security in the study area

Source: Authors

Comfort and Amenities

Comfort parameters include thoughtful integration of ergonomic seating, shaded resting areas, and accessible sanitation facilities to enhance user experience in public spaces. Seating should follow ergonomic standards with appropriate height, depth, and armrest dimensions to support comfort, especially for the elderly. Shaded areas using natural elements like trees provide thermal relief and encourage prolonged use of open spaces. Additionally, toilet design must ensure adequate clear space for movement, promoting accessibility and ease of use for people with varying mobility needs. These elements together define the core of comfort and amenity planning in inclusive urban environments.

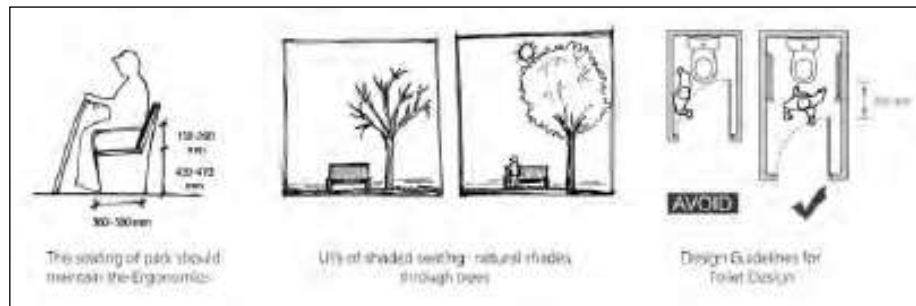


Figure 29: Enhancement of Comfort in the study area

Source: Authors

Social Interaction

As a social interaction parameter, the spatial layout of the park and temple plinth plays a vital role in encouraging community engagement. The three main corners of the triangular park serve as social seating zones, improving visibility and accessibility for elderly users. The temple plinth and adjacent green areas naturally function as informal gathering spots. Face-to-face seating arrangements further support comfortable interaction, helping foster belonging and regular social contact.



Figure 30: Enhancement of Social Interaction in the study area

Source: Authors

Conclusion

The study focuses on the concerns of the elderly in familiar neighborhood public spaces most used by seniors in India. While other user groups were noted, elderly needs remain central due to their unique spatial and social requirements. The study shows how neighborhood-level urban design guidelines can enhance public spaces in metropolitan Indian cities. Key parameters -Accessibility, Safety, Comfort & Amenities, and Social Interaction, are essential for age-friendly environments that support active engagement and community participation.

Furthermore, the research emphasises recognising and supporting the elderly by promoting their inclusion rather than leaving them isolated. Designers and planners must create public spaces that are safe, accessible and socially engaging. Well-designed social areas with appropriate infrastructure improve how seniors perceive themselves and their surroundings, strengthening belonging and contributing to positive, inclusive neighborhoods and overall societal well-being.

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Ecology and Resilience: Role of Gender in Indian Context

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Vinita Yadav* and Renuka Gajanan Oka**

Abstract

Environmental governance is important for fostering socio-ecological resilience. Ecofeminism is rooted in women's struggles for survival and sustenance. The paper studies intersection of ecofeminism and socio-ecological resilience as gender equality and women's representation has been central to environmental governance. The objectives are to understand foundations of ecofeminism, assess contributions of women in restoring ecology and formulate strategies for women's participation in environmental governance. An intensive literature review is carried out on ecofeminism and Socio Ecological Resilience (SER) framework. Chipko Movement and Narmada Bachao Andolan (NBA) are considered as case-studies. These exemplify women's agency in grassroots resistance in India's environmental activism. They are analysed for women's participation at an intersection of actor interventions and ecosystem services through SER framework. Women's traditional knowledge and leadership plays a decisive role in sustainable resource management and environmental conservation. The research addresses ecofeminism struggles and recommends adoption of a collective framework for women-led environmental governance.

Keywords

Ecofeminism, Ecological Justice, Environmental Governance, Socio-ecological Resilience, Sustainable Development.

Introduction

Local subsistence economies emphasise a symbiotic relationship to foster the interdependence rather than exploitation (Agrawal, 2021). It is based on the premise of interconnectedness between the traditional ecological knowledge and their roles as

* Prof. Dr. Vinita Yadav, Professor, Department of Regional Planning, School of Planning and Architecture, 4, Block B, IP Estate, New Delhi.

Email: v.yadav@spa.ac.in

** Renuka Gajanan Oka, Research Scholar, Department of Regional Planning, School of Planning and Architecture, 4, Block B, IP Estate, New Delhi, & Associate Professor, School of Architecture, CMR University.

Email: renuka.g@cmr.edu.in

primary resource managers. Women create inclusive institutional structures that reduce structural inequalities through multiple interconnected mechanisms (Andrijevic et al., 2020). In South Asia, studies show that women's access to microfinance and self-help groups such as Kudumbashree in Kerala and SEWA in Gujarat has enhanced both the economic empowerment and community-level environmental stewardship (Rajagopal, 2020). In Sub-Saharan Africa, research indicates that women's participation in community-based natural resource management increases both conservation effectiveness and household resilience to climate shocks (Tantoh et al., 2025). Latin American experiences with gender quotas in local governance have resulted in increased public spending on social services and stronger environmental protection policies (Sacchet 2008). These empirical evidences demonstrate that gender representations have enhanced women's participation in governance, participatory planning and decision-making bodies (Andrijevic et al., 2020; Tamuli & Mishra, 2023, Kawarazuka, et. al. 2017). However, these positive outcomes are dependent upon addressing structural barriers. Inclusive governance frameworks recognise the intersection of environmental sustainability and social justice. Gender-inclusive governance structures enhance institutional legitimacy by ensuring that resource management decisions reflect the needs and priorities of all resource users. Research demonstrates that participatory governance mechanisms that actively include women result in more equitable resource distribution and improved conservation outcomes. Gender is a key dimension of diversity (Anjum & Aziz, 2021). The capabilities of women are central for achieving SER. SER is a multi-actor concept and recognises diversity as a key aspect. Ecofeminism questions "progress for whom?" especially when exploitation of natural resources happens and strips agency from nature. Empowerment of women strengthens their agency to foster SER and ensures justice (Agrawal, 2021; Jaspers & Bouwen, 2024). It enhances the synergies between gender equality and sustainable development outcomes. The importance of gender equality in achieving SER is reinforced in international events. These include Principle 20 of the Rio Declaration on Environment and Development (1992), the Beijing Declaration and Platform for Action (1995), and the UN Conference on Sustainable Development titled 'The Future We Want' (2012). UN Sustainable Development Goal (SDG) 5 emphasises on gender equality and women's empowerment. Women's participation is considered important across economic, social and environmental dimensions to achieve a resilient framework for sustainability.

Literature Review

This section explores framework of socio-ecological resilience in urban contexts. It also studies the Western and Indian perspectives of ecofeminism. As the existing research on ecofeminism focuses heavily on rural, subsistence economies in Indian contexts; the urban intersection of ecofeminism with SER remains underexplored. Through literature review, the section identifies opportunities for integrating ecofeminism into urban SER frameworks.

Urbanisation & Socio-Ecological Resilience: an Ecofeminism Perspective

Urbanisation has disregarded ecology and created socio-economic disparities. The western ecofeminism constructs place urbanisation responsible for the subjugation of women and equate it to ecological degradation (Gaard, 2017; Merchant 2006; Warren, 1990). Urban areas are responsible for 70 per cent of global CO² emissions, with transport and buildings being largest contributors (IPCC, 2022). Rapid urbanisation results in shrinking of water bodies, reduction in biodiversity and lessening of the urban green cover. Compared to men, women's attunement to local ecosystem comes from a relational and care centred ethics (Shiva, 2016). There is no biological inclination that makes women more conservative than men. Yet, their everyday reliance on environmental commons and cooperative practices drive their active engagement in environmental activism (Agrawal, 2016). The literature on ecofeminism puts forth systemic barriers belonging to rural subsistence economies for women. Agrawal (2016, 2021), Anand, Mallick & Krishna (2024), Chopra (2019), Gadgil & Guha (1994), Shiva (2016) consider Narmada Bachao Andolan (NBA) and Chipko Movement as pioneering examples of women-led act of defiance and environmental activism. These movements position women as central actors to fight environmental destruction happening as a result of economic primacy. The women are successful in showing resistance to economic development induced ecological destruction. They are conservators of the ecology for their own sustenance and manage the environment quite well. UN (2015) states that 27 to 30 per cent of increase in biodiversity in ecologically sensitive areas is due to women's efforts.

A structured documentation exists of women-led environmental activism in rural context. However, similar records illustrating urban women's perspectives on environmental activism are rarely studied in the Indian context. There are examples of ecofeminist cases such as the Pani Panchayats (Pune), Self-Employed Women's Association (SEWA, Ahmedabad) and Mahadevpura Parisara Samrakshane Mattu Abhivrudhi Samiti (MAPSAS, Bengaluru). Pani panchayats create localised clean drinking water sources in collaboration with the local municipal body. The non-profit organisation 'SEWA' in Ahmedabad is working on solar power solutions for slums in the city. The MAPSAS is an urban women's collective, working to improve the water quality, biodiversity and rejuvenate lakes in Bengaluru. Yet, there is a lack of structured information suggesting the actual amount of impact these interventions make in achieving SER. These interventions rarely receive a mention in urban governance institutions. This results in limited or no representation of women in decision making in urban environmental governance (Prakash et al., 2024). The research attempts to answer the following questions. How can women-led environmental activism in urban context be understood? Are dimensions of rural-ecofeminism helpful in positioning urban women's efforts in environmental activism? How one can integrate activism and governance strategies?

Socio-Ecological Resilience (SER): Definition & Structure

Socio-Ecological Resilience (SER) recognises the interdependence of social and ecological systems (Ostrom, 2009). It has multifaceted applications ranging from resilience approach to assessment framework for urban systems to address SER features (Sarami, et. al. 2024). The development research interprets environment as one of the factors contributing to human well-being (WCED, 1987). According to Millennium Development Goals (MDGs) of 2000, the socio-ecological research tends to approach resilience to focus on one natural resource at a time (Folke et. al., 2016). The Millennium Ecosystem Framework (2001) contributes to a paradigm shift in the perspective of the human-nature relationship. The framework recognises agency as multi-actor arrangement for successful decentralised collective action (Rockström & Sukhdev, 2014). The access to ecosystem services and environmental commons is fundamental to human wellbeing as economy and society are nested in biosphere (Rockström & Sukhdev, 2014). Sustainable Development Goals give a comprehensive understanding of contemporary issues identified in ecology (UN, 2015).

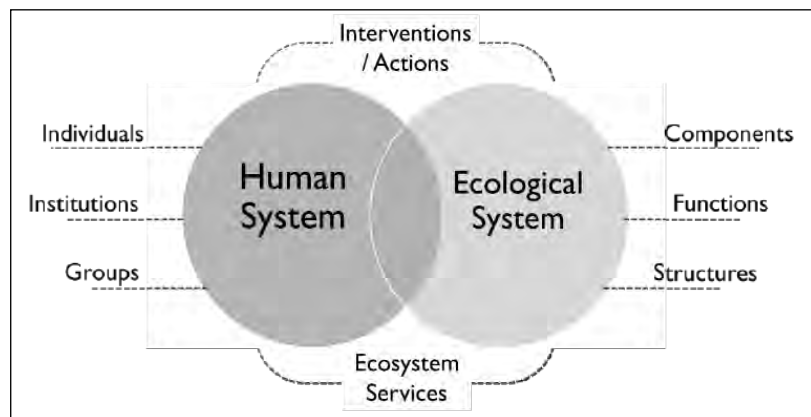


Figure 1: Socio-Ecological Resilience (SER): Interventions and services

Source: Adapted from McGinnis and Ostrom, 2014

The SER framework (Figure 1) offers a critical lens for understanding how gender dynamics interact with environmental resources. While SER frameworks have made valuable contributions to integrating social dimensions into natural resource management, they have demonstrated limited success in effectively integrating gender equity considerations (Manyani, et al., 2024). The fundamental challenge lies in epistemological differences of gender analysis and inequality requiring redress (Nagel & Partelow, 2022). SER analysis emphasises complex causal explanation and system dynamics (Sarami, et. al. 2024, Lwamba E, et. al. 2022, Kawarazuka, et. al. 2017). Research shows that greater female representation in national parliaments correlates positively with improved access to electricity and potential increases in sustainable energy consumption. However, even when women manage to exert agency at local levels,

they often remain marginal actors with limited decision-making authority. Institutional and cultural factors can either accelerate or mitigate gender gaps in participation. Studies from Mexico and India demonstrate how large-scale renewable energy projects can both empower women through new opportunities and simultaneously reproduce prejudices against women as incapable leaders (Anjum, Aziz. 2021). While research increasingly recognises that gender intersects with other social categories (socio-economic status, ethnicity, age), comprehensive intersectional analyses remain limited. Women from low-income households, indigenous communities, and minority groups face multiple layers of disadvantage, yet research capturing these complex interactions is insufficient.

Ecofeminism: Western & Indian Perspective

Ecofeminism emerged in the 1970s with an increasing consciousness of the connections between women and nature. French writer Françoise d'Eaubonne coined the term “*écoféminisme*” in the year 1974. He called upon women to lead an ecological revolution to save the planet (Merchant, 2006). Ecofeminism embodies a trait, reflecting a sensitivity toward nurturing and protecting the environment. Feminist values often emphasise care, equity, and interconnectedness. It aligns with the qualities needed to protect and nurture the environment (Merchant, 2005). Similarly, feminine qualities are often associated with sensitivity, empathy, and care. There is a natural inclination towards ecological stewardship. Hence, the perspective traditionally associated with feminism and femininity is valuable in addressing ecological challenges. They prioritise harmony, protection, and sustainability. According to Warren, “*An ecofeminist perspective is structurally pluralistic, inclusivist, and contextualist*” (quoted from Merchant 2005).

Ecofeminism in the Indian context differs significantly from its Western counterpart. While Western ecofeminism often emphasises patriarchal structures, labour exploitation and binaries of dominance and production, Indian ecofeminism is deeply embedded in indigenous knowledge systems, spiritual ecologies, grassroots movements and subsistence-based economies (Shiva, 2016). It is also intertwined with caste, land rights, and the struggles of marginalised communities (Agrawal 2016). Indian ecofeminism critically engages with caste and class, recognising that ecological degradation disproportionately affects *Dalit and Adivasi* women (Agrawal, 2021). It is closely tied to grassroots ecological movements such as the Chipko Movement (1973 to 1981), National Biodiversity Authority (1985 till date). The Indian perspective often incorporates sacred ecology, drawing upon the worship of nature-linked deities (Shiva, 2016). For example, River Ganga, Mother Earth as *Prithvi Mata*, tree spirits and animistic traditions in tribal cultures. While there is no biological inclination that makes women more conservationist than men, their everyday reliance on environmental commons and cooperative practices drive grassroots activism (Agrawal, 2016). SER ensures women empowerment, strengthening their agency to enhance QoL (Azizi

& Kouddane, 2024). The declarations include Principle 20 of the Rio Declaration on Environment and Development (1992), the Beijing Declaration and Platform for Action (1995), and the UN Conference on Sustainable Development's outcome document, "The Future We Want" (2012). UN Sustainable Development Goal (SDG 5) 'Gender Equality and Women's Empowerment', emphasises women's leadership across economic, social and environmental dimensions of QoL frameworks.

Methodology

The methodological approach is grounded in literature review and case-specific empirical research. It draws upon foundational texts and studies on ecofeminism and socio-ecological resilience. Discussion on ecofeminism, SER, and sustainable practices has been reviewed with the help of rich literature review from international scopus-indexed journals and books. Women's role in traditional knowledge creation and sustainable practices is reviewed from international journals. Multiple definitions have been reviewed and Ostrom (2009), McGinnis and Ostrom (2014) were found most useful. Rural women are exercising their power to conserve and preserve the ecology. NBA and Chipko Movement are two of the successful grassroot movements emerging from Gujarat and Uttarakhand (erstwhile part of Uttar Pradesh) respectively. Chipko movement started in the Himalayan region in year 1970. NBA is reviewed from media reports and academic publications. The literature review helps to contextualise women as integral part of the collective actions to achieve socio-ecological resilience. It documents the cases of Chipko Movement and NBA from the lens of SER. While doing so the literature compares the two movements with help of parameters chosen from SER framework. Complementing this, secondary data is systematically collected from diverse sources, including government reports, non-governmental organisation data, media articles, and academic studies. The two chosen cases are studied with respect to indicators drawn from Ostrom's SER framework. It analyses the intersection of gender, environmental activism and resilience outcomes. The SER framework provides a systematic approach to diagnosing complex social-ecological interactions by examining four core subsystems: Resource Systems, Resource Units, Governance Systems and Actors (Ostrom 2009). Each subsystem comprises multiple second-tier variables that influence sustainability outcomes. The SER framework consists of three primary dimensions, each operationalised in this study as shown in the flowchart diagram 1.

Following McGinnis and Ostrom (2014), this study examines 12 analytical variables derived from Ostrom's framework. These are tailored to analyse gender dimension. Resource system characteristics, resource unit characteristics, governance system structure, actor composition and attributes with emphasis on gender, collective action mechanisms, social trust and bonding leadership character particularly women's leadership, conflict resolution mechanisms, institutional fit across governance scales, polycentric governance and adaptability, ecosystem stewardship practices and

resilience to external shocks. Gender is integrated into the SER framework at three levels: The first level gender is considered as a structural variable. It shapes access to resources, participation in governance and distribution of benefits and burdens from environmental change. In level 2 gender relations influence power dynamics within households, communities and governance institutions, affecting collective action capacity. The level 3 studies gender and its intersection with caste, class, ethnicity and age to create differentiated vulnerabilities and capacities within social-ecological systems. Following this the study employs a structured comparative case study approach to analyse the Chipko Movement and Narmada Bachao Andolan through the gender-integrated SER lens. The analytical framework systematically compares both movements across the 12 SER variables (Table 1), examining the similarities and differences. Shared characteristics in women's leadership, grassroots mobilisation, resistance to state-led environmental destruction are similarities identified. The difference is the scale of environmental threat, organizational structure, outcomes, and institutional impacts.

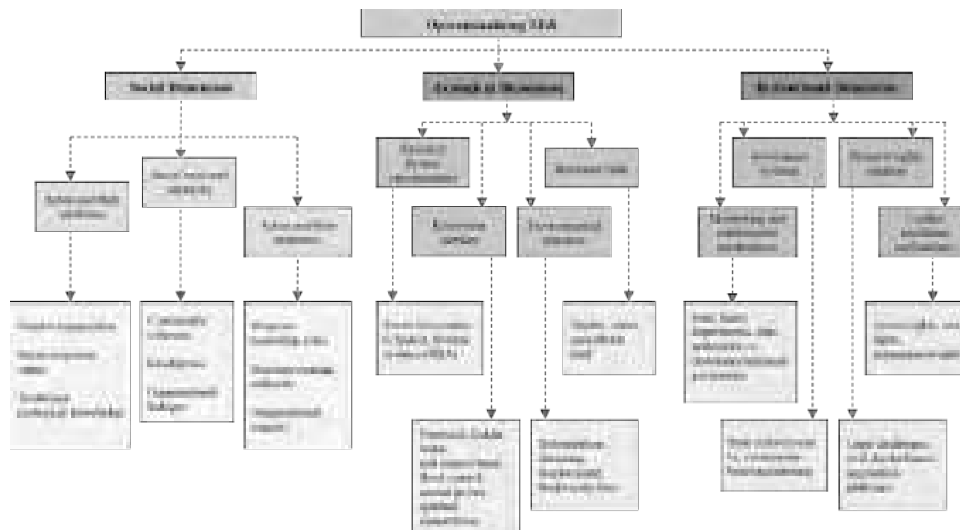


Diagram 1: Operationalising SER Framework

Source: Author (2025)

The research synthesises insights on gender dynamics within each movement contributed to or constrained socio-ecological resilience outcomes. The comparative analysis moves beyond descriptive comparison to identify causal mechanisms linking women's participation, collective action, and resilience outcomes, thereby generating transferable lessons for integrating gender into urban environmental governance frameworks. The methodology contextualises the process of women becoming an integral part of the collective actions while achieving socio-ecological resilience.

Resistance through Grassroots Movements: Role of Ecofeminism

India grapples with urban environmental degradation, climate change and unsustainable development practices and experiences environmental challenges such as air pollution, water scarcity and loss of green spaces. In Indian cities, women are spearheading the cause of sustainable development, environmental justice, and equitable governance through collective action, advocacy, and institutional engagement. The Chipko Movement (1973 to 1981) and the Narmada Bachao Andolan (1985 till date) are two such landmark initiatives in the history of socio-ecological justice. These movements draw from India's long-standing tradition of ecological harmony, emphasising the interconnectedness between nature, culture, and community (Shiva, 2016).

Chipko Movement

Traditionally, Indian forests are serving as resources managed through community practices for conservation. However, colonial policies and post-independence economic strategies deprived local population to access the forest products essential for their survival. They commercially exploited the resources for economic good (Gadgil & Guha, 1994). Resource-intensive industrial activities are the sites of socio-ecological struggles (Dwivedi 1997). Emerged in the Garhwal Himalayan regions of India in the early 1970s, the Chipko (means 'to hug' in hindi) movement is one of the most significant environmental movements in India. The government allocated approximately 1200 sq. km of forest land resource for commercial logging industry (Prakash et al, 2024). The permission for logging was given to a private sports manufacturing company in the Reni Forest of Uttarakhand. This severely impacted the sustenance of local communities as they were denied the access to forests resources, resulting into widespread resentment and resistance. Forest loss was estimated at approximately 1.3 million hectares per year during 1973 to 1981 (Shiva, 2016). Chipko, grassroots level movement, arose in response to this. Villagers, particularly women, physically clung to the trees forming a human shield to prevent the felling of trees from loggers. Chipko's organisational structure was decentralised, with local communities leading protests in their respective regions. Male activists such as Sunderlal Bahuguna and Chandi Prasad Bhatt provided intellectual leadership and broader mobilisation. Gauri Devi, a local activist, led the protest alongside other women (Chopra, 2019). The women were the backbone of the movement. As the primary users of forest resources, they relied heavily on forest resources such as fuel wood, fodder, food, and water. Their dependence on forest goods made them natural defenders of the ecosystem. Awareness campaigns were organised through public meetings in which matter was put forth with the help of folk songs and storytelling practices. The campaign aimed to educate communities about impact of deforestation on soil and water. The absence of forest cover leads to soil erosion and floods. Scientists' environmentalists' and political leaders support to the movement resulted into policy formulation at both at national and state level.

Chipko reinforced the argument that environmental degradation disproportionately affects women. It makes women's participation in ecological movements essential for sustainable development (Benabou, 2021). The movement positioned women as environmental leaders and challenged their traditional gender roles. This provides a contrary opinion to the notion that decision-making in resource management is predominantly a man's domain. Chipko serves as a symbol of resistance, ecofeminism and community-led environmentalism. It offered valuable lessons for socio-ecological resilience strategies. The movement laid emphasis on forest conservation, ecological justice and gender equity. It led to the imposition of 15 years ban on commercial logging in the Himalayan region in the year 1980. The Prime Minister imposed a moratorium on felling trees in Uttarakhand's Himalayan forests. The movement brought a change in India's forest policy in the year 1988 with the introduction of Joint Forest Management (JFM) system (Gadgil and Guha, 1994). The policy focused on restoration of ecological balance through decentralised forest management. The authors like Agrawal (2021), Chopra (2019), Gaard (2017) argue that Chipko did not fully address caste inequalities, as many lower-caste forest dwellers had different resource priorities compared to middle-class activists. Chipko was successful in halting deforestation, but did not provide an alternative livelihood for the people dependent on logging for income.

The movement highlighted the importance of protecting the local ecosystems. Chipko movement remains one of the most influential grassroots environmental movements that shaped India's environmental policies and inspired global conservation efforts. The movement provides key lessons in grassroots environmental activism, community-driven conservation and gender-inclusive governance. It emphasised direct action and community resistance against deforestation. It reshaped urban landscapes to be more inclusive, ecologically resilient, and socially just.

Narmada Bachao Andolan (NBA)

Centre formulates development plans in consultation with the people of the place. Yet, there are examples of non-agreement between government and citizens on a few aspects of a project. The construction of Sardar Sarovar Dam along the Narmada River is one such example. Narmada is the largest west-flowing river, which traverses through the states of Gujarat, Madhya Pradesh, and Maharashtra. The government implemented Narmada Valley Development Project with the support of a loan of US \$550 million from World Bank (Chaplin, 1997). The development paradigm prioritised large-scale infrastructure projects. The project aimed to generate 1,450 megawatts of electricity and provide clean drinking water to the citizens. Such projects meant to improve the well-being of local communities. On one hand, dam on the Narmada River projected to bring significant benefits, such as increased electricity generation, improved water supply and spur in revenue generation. On the other hand, it threatened to displace more than 250,000 indigenous and rural population and flood of thousands of acres of

forests and agricultural lands (Anand et al., 2024). The resettlement and rehabilitation of displaced population, mainly *adivasis*, small farmers, and rural women, became a contentious issue. Profound disruption paralleled the socio-ecological and cultural cost. Many critics argued that the plan would lead to environmental devastation, social dislocation and lack of ecological integrity. Shivhare (2018) questioned the costs of progress in Narmada project and provided a powerful critique of the patriarchal systems that perpetuate environmental degradation. The project inflicted irreversible damage on local ecosystems and displacement of vast numbers of people (Seema, 2014). The affected communities had little say in decisions altering their lives even when the project threatened their physical survival and jeopardised their cultural and social fabric (Shiva, 2016). The environmental impact reports revealed a grim picture of extensive flooding of forests, destruction of agricultural land, and the consequent loss of biodiversity.

In 1985, the Narmada Bachao Andolan began as a mass movement centred on the experiences of *adivasis*, rural farmers, and women. The movement successfully engaged local community to organise hunger strikes, massive rallies and solidarity marches spanning over 36 days in the Narmada Valley of Gujarat and Maharashtra State. The campaign against the Sardar Sarovar Dam in Gujarat marked the initial spark in the field of ecofeminism as Medha Patkar, a social activist, was at the forefront of the movement. She questioned the technocratic development model and brought spotlight on the human cost of such projects. She emerged as a powerful ecofeminist figure. The movement positioned women as key resisters to state-driven environmental destruction. From a socio-ecological resilience perspective, the NBA opposed the state's top-down development approach. It illustrates intertwining of environmental degradation and gender injustice. NBA provided a blueprint for an alternative approach to development, integrating environmental stewardship with social justice. Sardar Sarovar Dam was inaugurated in 2017, a development that many viewed as a partial victory for the State.

Integrating SER & Ecofeminism

Social-ecological systems achieve greater adaptive capacity when they integrate diverse forms of knowledge (Yanget al., 2018, Kawarazuka, et. al. 2017). Women and men often possess different ecological knowledge based on their distinct resource-use patterns and livelihood activities. Gender equality contributes to social cohesion, which is fundamental to collective action for resource management. The collective organising of women through structures like Self-Help Groups (SHGs), Water User Associations (WUAs), and Forest Management Committees creates a foundation of social capital that significantly enhances community resilience beyond environmental governance. By participating in these groups, women develop leadership, technical skills, and social networks that allow them to address broader socio-economic challenges. This social cohesion enables communities to respond more effectively to environmental shocks

and stressors. Women's representation in local governance bodies is associated with better management of common-pool resources, increased investment in sustainable infrastructure, and stronger climate adaptation policies. This is not due to innate gender differences, but rather to women's positional knowledge, their stakes in environmental sustainability for household provisioning, and their tendency to prioritise long-term community well-being. Figure 1 gives the different parameters affecting SER adopted from Ostrom (2009). These parameters are further broken down into 12 second tier parameters. These are resource system characteristics, resource unit characteristics, governance systems, actors, collective actions, social trust, leadership character, conflict resolution mechanism, adaptability, ecosystem stewardship and resilience to external shocks. The authors found these parameters relevant as both the case studies present a clear understanding and data on these parameters. At the same time, they originate from Ostroms' (2009) SER framework as indicated in Table 1.

The comparative analysis of the Chipko Movement and Narmada Bachao Andolan reveals both convergent patterns and significant divergences in women's participation and socio-ecological resilience outcomes. The first similarity is that both the movements demonstrate women's environmental activism. Chipko Movement depicts that it was women's dependence on forests for firewood, fodder and water which drove them to resist to commercial logging. Similarly, in NBA Movement, displacement threatened women's access to agricultural land, forest resources and riverine ecosystems essential for their daily sustenance. This confirms that gender roles in subsistence economies create specific stakes in environmental conservation that motivate women's collective action (Kawarazuka, et. al. 2017). Secondly, both movements employed direct action strategies such as tree-hugging, hunger strikes, civil disobedience as responses to systematic exclusion from formal decision-making processes. This pattern illustrates a critical gap in institutional fit within the SER framework. When state-led governance systems fail to incorporate local communities, particularly women, the people over there are forced to resort to extra-institutional resistance (Lwamba E, et. al. 2022, Jaspers, & Bouwen, 2024, Andrijevic, Crespo, Lissner, 2020). The third observation showcased women's visible activism during crisis moments. It did not translate into sustained representation in formal governance institutions post-movement (Lwamba E, et. al. 2022, Kawarazuka, et. al. 2017). This reveals a critical limitation of episodic resistance. Without institutionalisation, such events may not produce enduring gender-transformative change (Agrawal 2021, Anand et al., 2024). Pointing out the divergent characteristics, Chipko operated at a local-regional scale with a decentralised, village-based organisation, whereas NBA mobilised across multiple states with more formalised organisational structures and international networks. This scalar difference influenced their respective abilities to leverage different types of social capital and political pressure. Chipko's leadership drew primarily on local women's experiential ecological knowledge and moral-spiritual arguments about forests as mothers. NBA, while prominently featuring women's participation, also mobilised scientific-technical

expertise, legal arguments and human rights frameworks. Chipko emphasised traditional ecological knowledge while NBA combined grassroots activism with professional advocacy. Chipko achieved tangible policy victory of 15-year logging moratorium, Forest Policy 1988, Joint Forest Management. NBA, despite sustained activism, achieved only partial success. The movement successfully raised global awareness about development-induced displacement and influenced World Bank environmental safeguards. This divergence highlights that movement “success” in SER terms encompasses both tangible resource protection and broader institutional/normative shifts. Both movements demonstrated that women’s ecological knowledge complemented and sometimes contradicted state-technical knowledge systems. When this knowledge is excluded, adaptive capacity diminishes. The SER framework benefits from explicitly recognising gendered knowledge systems as distinct but equally valid information sources for ecosystem management. This comparative analysis generates implications for operationalising and refining the SER framework. The current SER framework application often treats gender as a secondary characteristic of “actors.” The comparison highlights that SER assessment must consider temporal dynamics—Chipko’s outcomes materialised over decades, while NBA’s impacts remain contested. Resilience is not a static state but an ongoing process of adaptation, and gender relations within that process evolve over time.

Table 1: Ostrom’s SER framework: Chipko Movement and Narmada Bachao Andolan

S. No	Ostrom Indicator	Chipko Movement	Narmada Bachao Andolan (NBA)
1	Resource System Characteristics	Forest ecosystems in the Garhwal Himalayas – local, bounded, regenerable forest resources.	Riverine ecosystem (Narmada River), large-scale water resource system with interstate impacts due to damming.
2	Resource Unit Characteristics	Timber, non-timber forest products essential for subsistence. Small-scale extractive use.	Water, floodplain ecosystems, agricultural land, fisheries. Large-scale infrastructure altered hydrological units.
3	Governance System	Local customary forest use disrupted by state-controlled forest governance. Resistance from village communities, especially women.	Centralised state and international financing (World Bank). Lack of local consultation and weak participatory governance.
4	Actors (Resource Users)	Primarily local women, villagers dependent on forests for firewood, fodder, food.	Farmers, fisherfolk, tribal and marginalised communities relying on the Narmada’s ecosystem for livelihoods.

S. No	Ostrom Indicator	Chipko Movement	Narmada Bachao Andolan (NBA)
5	Collective Action	Community-led, spontaneous, place-based direct action ("tree hugging")	Organised activism, institutional formation (NBA), legal challenges, public campaigns, non-violent protest.
6	Social Trust	Strong local knowledge, kinship ties, and ecological bonding. Gendered leadership enhanced cohesion.	Widespread network-based mobilisation (grassroots to global), alliances with NGOs, academics, journalists (e.g., Arundhati Roy).
7	Leadership	Local leaders, drawing from lived ecological knowledge.	Used scientific, legal, and economic arguments. Knowledge was multi-scalar.
8	Conflict Resolution Mechanisms	Non-violent physical obstruction; Eventual government recognition led to a moratorium on tree felling.	Civil disobedience, legal activism, international lobbying. Partial success: World Bank withdrew but dams were built.
9	Institutional Fit (Cross-Scale Linkages)	Initially limited. Movement triggered broader debates on forest governance; led to the formation of Environment Ministry in India	Strong vertical linkages from local to global. Triggered global institutional debates on aid, development, and environmental justice.
10	Polycentric Governance and Adaptability	Movement initiated calls for decentralisation of forest management. Influenced forest protection policies and local governance reforms.	Advocated for democratisation of planning processes, environmental review mechanisms, and decentralised decision-making.
11	Ecosystem Stewardship	Forest as mother—symbolic and material connection to sustainability. Community-led preservation ethic.	Emphasis on environmental justice, loss of biodiversity, displacement ethics. Less emphasis on stewardship, more on rights.
12	Resilience to External Shocks	High resilience—community adapted to changes through local resistance. Gained international attention.	Medium resilience—external support bolstered visibility, but local systems suffered displacement and ecological disruption.

Source: Authors, 2025

Recommendations

The framework of Ostrom's SER to be extended to urban socio-ecological challenges. The role of local communities shall be acknowledged in the field of eco-restoration,

sustainability planning and environmental governance. The stakeholders' engagement mechanism needs to be streamlined to enhance their participation in decision-making processes. Gender-sensitive environmental policies and equitable access to resources are the need of the hour. Women shall be recognised as vital stakeholders for resource management. The research acknowledges ecofeminism to complement a collective framework for socio-ecological resilience. There must be an institutional recognition of women's role as environmental agents. This requires creating inclusive governance structures that integrate women's perspectives into resource management and climate resilience. It also demands policy interventions that secure access to environmental commons, recognise community-driven efforts and address gender disparities in environmental leadership. Bridging rural and urban ecofeminist struggles, a collective framework for socio-ecological resilience can be built to ensure women's leadership in environmental governance across landscapes. There has to be an institutional support for women-led initiatives for establishing environmental integrity and social equity. Such a stance was also encapsulated in the movement's resonant slogan, "*Vikas Chahiye, Vinash Nahin*" (Development Wanted, Not Destruction).

Conclusion

Development-induced displacement disrupts both ecological systems and socio-economic stability (Agrawal, 2016). The ecofeminist perspective is pertinent when global challenges, such as, climate change and ecological degradation are on the rise. The research demonstrates women's traditional knowledge and leadership role in fostering sustainable resource management and environmental conservation. Ecofeminism advocates for women's recognition as equal stakeholders in environmental justice, resilience, and participatory governance. It demands a gender-inclusive approach in planning and governance. The legacy of the Chipko movement and NBA inspires people to fight for a future where development is synonymous with justice, and socio-ecological resilience. It demonstrates an intersection of SER with ecofeminism to achieve an improved understanding of environmental governance. Movements such as the Chipko Movement and NBA illustrate how women's agency in grassroots resistance, direct action and acts of defiance have historically shaped India's environmental activism. Chipko Movement focused on preserving local forest resources whereas NBA broadened the discourse to challenge the entire model of development. These movements emerged in response to environmental degradation, displacement, and the commodification of natural resources. They highlight women's intrinsic role in local ecosystems and their direct dependence on forests, rivers, and agricultural lands for survival. Women played an active role in conservation and eco-restoration. Rapid urbanisation is altering the landscape of environmental activism and affecting the interconnections between nature and culture. Urban expansion prioritises economic growth, infrastructure development and industrialisation, often at the cost of ecological balance. The framework of SER recognises the interdependence of socio-

ecological systems while considering the roles of gender, equality and collective action. Its relevance to ecofeminism lies in its ability to examine the interactions between human and ecological systems.

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Assessment of Public Bus Transport Service Quality Attributes in Delhi using Importance - Performance Analysis

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Sahil Yadav*

Abstract

The quality of public transport services plays a crucial role in determining their ridership. This study evaluates the service quality of public bus transportation in Delhi through Importance-Performance Analysis (IPA), aiming to identify key attributes that influence passenger satisfaction. Using primary survey data and secondary sources, the study assesses 13 service attributes, including affordability, cleanliness, and others. Inferential tests were applied to examine demographic and travel-related variations in perceived importance. The analysis reveals that while affordability and punctuality are well-performing, critical gaps exist in seating availability, luggage provision, information systems, and driving quality. The Passenger Satisfaction Index (PSI) indicates an overall satisfaction level of 67.64 per cent. Socio-demographic variations reveal that women prioritise safety and cleanliness, younger and employed users emphasise punctuality, while older passengers value comfort and the behaviour of staff. The study recommends fleet expansion, improved infrastructure, better information systems, and gender-sensitive training. Enhancing these attributes could increase ridership and promote sustainable urban mobility in Delhi.

Keywords

Public transport service quality, Importance Performance analysis, Passenger satisfaction, Sustainable urban mobility.

Background

There is a huge pressure on the transportation sector in Delhi, as it has undergone unplanned urbanisation and experienced unparalleled growth in motorisation. Delhi, with 1.3 per cent of the Indian population, holds about 16 per cent of the privately owned

* Sahil Yadav, Research Scholar, Jawaharlal Nehru University, New Delhi.
Email: yadavsahil005@gmail.com

cars in India (Ministry of Road Transport and Highways [MORTH], 2019). In order to reduce the negative externalities of personal motorised transport, the sustainable use of public transit systems like metro rails and bus transportation has witnessed the focus of the Delhi government. Public bus services are efficiently functioning as the major transport mode for inter- and intra-city travel in many of India's metro cities, such as Kolkata, Ahmedabad, Delhi, and Chennai. In Delhi, 54 per cent of the total passenger-kilometres and 76 per cent of total public transport passenger kilometres travelled are constituted by bus transport (Suman et al., 2017). Additionally, buses are more viable compared to metro services in Delhi, as 80 per cent of the trips here are made for distances of less than 10 km, for which buses are the most suitable mode of transportation (Jain & Tiwari, 2016). Thus, buses in Delhi hold significant importance in meeting the travel demands of the city, and user-centred improvements in service quality can further increase ridership of this mode.

However, due to an implicit understanding of what service quality attributes are most important, proper quality maintenance is often not performed, resulting in a reduction in satisfaction levels and, consequently, ridership among users. To solve this issue, service quality should be improved to meet public expectations regarding the quality (Randheer et al., 2011; Grujić et al., 2014). There is a rising trend of measuring commuters' perceptions and related trip satisfaction in the field of transport planning and research. Identifying the determinants of trip satisfaction can help city administration adopt suitable policy measures to reduce discomfort, increase productivity, and improve the quality of life for individuals by providing a better travel experience (Beirão & Cabral, 2009). Hence, this paper focuses on identifying the service quality attributes that are most important from the users' perspective and evaluates the performance of buses in Delhi based on these attributes.

Literature Review

There is a positive relationship between public transport service quality and perceived accessibility. Attributes such as reliability and safety significantly influence perceived accessibility across income groups (Friman et al., 2020). The importance of service quality is the reason that CNG buses in Delhi are equipped with low floors, making them easily accessible to the elderly and persons with walking disabilities (Majumdar et al., 2021). However, the modal share of buses is declining due to poor service quality, with buses often perceived as slow, overcrowded, unreliable, and poorly maintained (Suman et al., 2017). Studies also show that service quality perceptions vary across age, gender, and socio-economic groups (Singh, 2016; Das & Pandit, 2013; Hernandez et al., 2016).

Public transport service quality comprises several internal and external factors influencing perception. Internal factors include service standards, monitoring, management commitment, and grievance redressal, while external factors include alternative modes, travel patterns, comfort, convenience, and user characteristics

(Randheer et al., 2011). Beyond onboard services, offboard aspects such as intermodal integration, walkability, and bus stop conditions are also important (Singh, 2016). The Transit Cooperative Research Program (TCRP), 47 identifies about 48 such service attributes, including availability, affordability, information, comfort, and responsiveness (Morpace & Cambridge Systematics, 1999).

Various methods have been used to assess service quality. SERVQUAL analysis given by Parasuraman (1988), based on tangibility, reliability, responsiveness, assurance, and empathy, has been used widely in such studies. Randheer et al. (2011) have slightly modified the SERVQUAL analysis to apply it to public transportation and added a culture factor to it. Importance-Performance Analysis (IPA), introduced by Martilla and James (1977), is another such widely used measure to evaluate user perceptions (Beirão & Cabral, 2009; Grujić et al., 2014; Sinha et al., 2020). However, this traditional IPA has some limitations, such as its assumptions of an independent and symmetric relationship between attribute importance and performance. Kano et al. (1984) used a model to demonstrate that not all attributes contribute equally and that their presence/absence alone can cause satisfaction/dissatisfaction. Building on Kano's insights, Matzler et al. (2003) proposed the 'Three-Factor Theory', a quantitative extension that divides service attributes into basic, performance, and excitement factors based on their asymmetric effects on satisfaction and dissatisfaction. These asymmetric models provide richer diagnostic insights than traditional IPA by highlighting how improvements in certain attributes may result in disproportionate gains—or losses—in satisfaction. However, both these, classical and revised IPA methods, are used extensively for service quality assessment.

Sinha et al. (2020), after performing IPA has concluded that apart from onboard factors of service quality, off-board factors such as ease of transfer, access-egress time, etc. should also be focused, especially in a country like India, where government funding in transportation is mostly spent in acquiring more fleets. Focusing on off board attributes will improve the last-mile connectivity and reduce service headways (Singh, 2016). Suman et al. (2020) have used non-parametric sign tests and a multinomial logistic model to analyse the performance of these attributes. They conclude that in comparison to Mumbai, buses in Delhi are perceived as less reliable, less punctual, and time-consuming by non-captive users. Sharma et al. (2020) used the Zone of Tolerance—the range of tolerable service quality—to analyse satisfaction. They found that expectations varied among different socio-economic groups for attributes such as delay and cleanliness. Whereas the difference between the expectation of service level is minimum for some attributes, such as service hours, crowding level, and hours of operation. Similar studies show that people from different socio-demographic conditions perceive different service quality differently, and their expectations also vary (Beirão & Cabral, 2009; Das & Pandit, 2013; Majumdar et al., 2021). Hence, to shift towards public transport and attract ridership, a study of bus service quality is necessary in Delhi.

Research Objectives

- To identify those service quality attributes that are most important from the public bus users' perspective.
- To examine variations in attribute importance based on socio-demographic conditions and frequency of travel through buses.
- To evaluate the performance of public bus services in Delhi on these service quality attributes on the basis of users' perception.
- To provide recommendations to improve the passenger satisfaction level with the public bus services in Delhi.

Methodology

The research has been carried out in both qualitative and quantitative ways. A list of the most significant factors determining the service quality of public transport has been derived from a literature review. Based on these service attributes, an on-board passenger survey was conducted to gauge users' perceptions of the service quality attributes. A total of 74 samples were collected using a stratified random sampling method, comprising 34 females and 40 males. Although the sample size is modest compared to Delhi's overall bus-riding population, it is suitable for an exploratory, perception-based assessment. At a 95 per cent confidence level, the sample corresponds to a sampling error of approximately ± 11 – 12 per cent which is acceptable for a preliminary study aimed at identifying key service quality issues. The respondents' socio-demographic profile is presented in Figure 1.

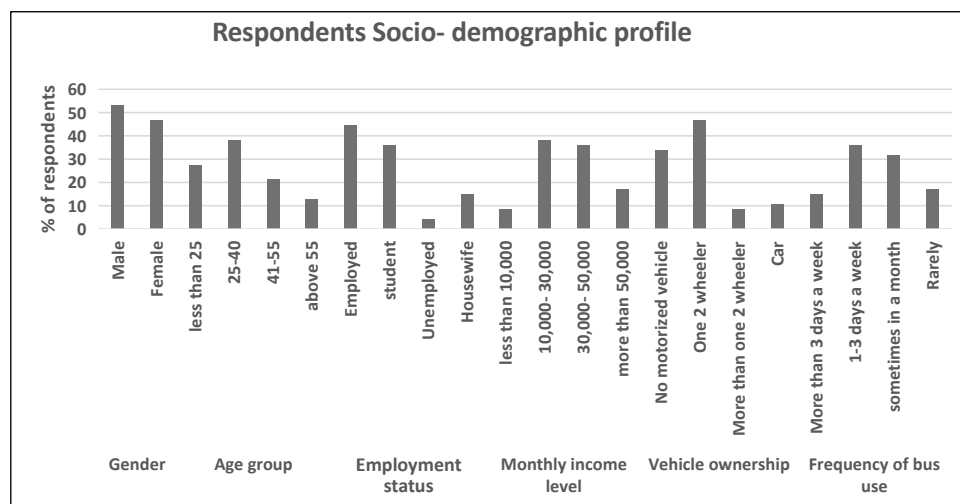


Figure 1: Respondents Socio-demographic Profile

Source: Primary Survey

Importance-Performance Analysis (IPA) is conducted based on two aspects of service attributes: perceived importance and performance level, which are obtained by asking relevant questions of the respondents. The responses are compiled to form an Importance-Performance grid, and then quadrant analysis is done. Revised IPA methods (such as the three-factor theory) have not been used in the study because of data limitations and to keep the analysis simple, transparent, and easy to interpret.

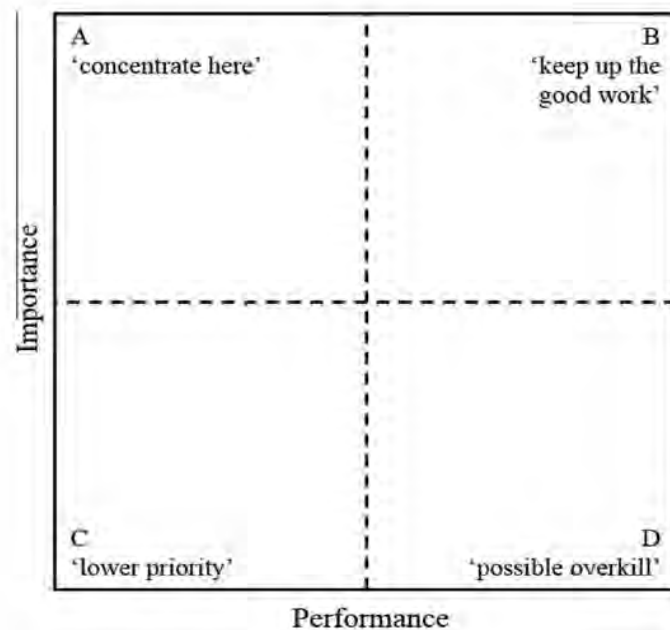


Figure 2: Importance - Performance Quadrant Analysis

Source: Martilla and James, 1977

In the Importance-Performance grid (see Figure 2), the X and Y axes represents the mean performance and mean importance ratings of the service attributes respectively. This results in four quadrants, such as High Importance–Low Performance, High Importance–High Performance, and so on. Apart from this, a composite index, i.e., “Passenger Satisfaction Index,” has been prepared, which summarises the overall satisfaction from all the attributes to a single score (Eboli & Mazzulla, 2009).

$$\text{Passenger Satisfaction Index (PSI)} = \sum (P_i * W_i)$$

$$W_i = I_i / \sum I_i,$$

Where, W_i = Weighted importance score of attributes, I_i = average importance score of attributes i , P_i = average satisfaction score of attribute i .

Furthermore, simple inferential tests, including the independent-samples t-test and one-way ANOVA, were conducted to determine whether the observed differences

in importance ratings across various demographic and travel-related groups are statistically significant.

Public Bus Services in Delhi

Bus services in Delhi are managed by two agencies, Delhi Transport Corporation (DTC) and Delhi Integrated Multimodal Transit System Limited (DIMTS). DTC, coming under the Government of the NCT of Delhi, is the largest CNG bus service in the world and also has the largest fleet of electric buses in India. Whereas DIMTS manages the cluster bus services in Delhi. Cluster buses are run by private players as a part of a government scheme under the Public-Private Partnership model. The Delhi government launched this scheme for the Corporatisation of Private Stage Carriage services in 2011. The performance statistics and fleet strength of both DTC and DIMTS buses can be seen in Table 1. In 2017, the Transport Department of Delhi reported that DIMTS buses outperformed DTC buses. DTC lags behind DIMTS on factors such as operating costs, revenue realisation, load factor, capacity utilisation, and others.

Table 1: Performance of DTC and cluster buses

Performance of DTC and Cluster buses				
	2017-18		2022-23	
	DTC	Cluster buses	DTC	Cluster buses
Fleet (in numbers)	3,951	1,744	3937	3293
Fleet utilisation (in per cent)	85.69	97.16	83.42	97.18
Vehicle Utilisation (Km/Bus/Day)	191	205.15	194	204.82
Load factor (in per cent)	83.83	81	81.67	81
Passenger Carried per bus daily (In numbers)	878	753	756	513
Daily Average Passengers (in lakh)	29.86	11.65	25.02	16.39

Source: Economic Survey of Delhi, 2023-24.

Transport Department of Delhi has acknowledged that there is a requirement of about 11,000 buses in Delhi, indicating a shortage of buses in Delhi. Although the fleet strength has increased in recent years, a sharp decline in ridership has been observed.¹ Additionally, vehicle utilisation has increased over the period, while the load factor has decreased, meaning that more kilometres are being travelled now with fewer passengers. Thus, service quality needs to be focused for attracting riders (Nesheli et al., 2017).



Figure 3: Map of bus routes in Delhi

Source: Prepared by Author

Passenger Satisfaction Index

From the literature review, a total of 13 service quality attributes have been selected for further study. Table 2 shows all these 13 attributes, their average importance and performance score, weights (out of 100), and weighted score. The overall Passenger Satisfaction Index obtained is 3.3824, which means that bus services in Delhi are 67.64 per cent (obtained by dividing the PSI by 5) successful in satisfying their passengers. From Table 2, we can see that service attributes, such as affordable fares and seat availability on the bus, which have grey cells indicating importance, have higher-than-average importance. Whereas, attributes with green cells, such as affordable fares and cleanliness at the bus stop, have better-than-average performance. It should be noted that, except for a few services, such as information systems, provision of space for luggage, seating arrangements, and leg space, all other service attributes have performance scores greater than three, indicating that bus passengers are generally satisfied with the overall service quality of the buses in Delhi.

Table 2: Passenger Satisfaction Index

Attribute	Average Importance score	Average Performance score	Importance weights(Wi) (out of 100)	PSI (weighted score)
Affordable fare	4.83	3.94	9.40	0.37
Availability of seats at bus stops	3.91	3.62	7.62	0.28
Availability of seats (bus)	4.98	3.26	9.69	0.32
Cleanliness (bus stop)	3.30	3.53	6.42	0.23
Cleanliness (bus)	3.38	4.04	6.59	0.27
Driving quality	4.11	3.17	8.00	0.25
Information system	4.28	2.83	8.33	0.24
Provision of space for luggage	4.02	2.15	7.83	0.17
Passenger safety	3.85	4.00	7.50	0.30
Seating arrangement and leg space	3.94	2.98	7.66	0.23
Transfer time	2.83	3.38	5.51	0.19
Driver and conductor behaviour	3.34	3.19	6.50	0.21
Punctuality and reliability	4.60	3.89	8.95	0.35
Overall Average	3.95	3.3830	100	3.3824

Source: Primary Survey.

Importance-Performance Analysis

Each quadrant in the IPA (Figure 4) classifies service attributes. Quadrant 1 includes attributes with high importance and high performance; these require minimal improvement and should be maintained (Eboli & Mazzulla, 2009). Quadrant 2 comprises highly important but poorly performing attributes, leading to low passenger satisfaction; these demand priority improvement. Quadrant 3 includes attributes with low importance and poor performance; improvement is needed but is less critical. Quadrant 4 represents attributes of low importance but high performance; these require the least focus, and resources allocated here can be shifted to underperforming attributes to enhance overall satisfaction (Grujičić et al., 2014).

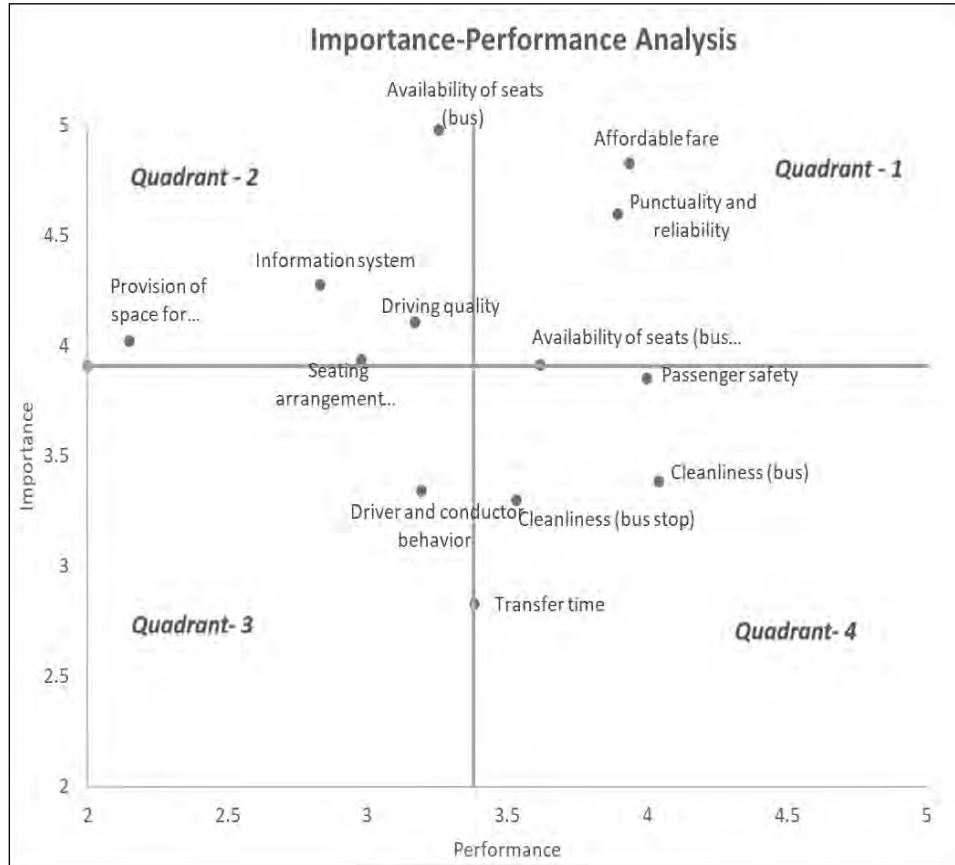


Figure 4: Quadrant plot for Importance – Performance Analysis of service attributes

Source: Prepared by Author

In this study, Quadrant 1 includes fare affordability, punctuality, reliability, and seat availability at bus stops—attributes that are highly important and associated with high satisfaction. Figure 5 shows Delhi's low fare structure: average fares are Rs. 1.41/km (ordinary), Rs. 2.16/km (AC), and Rs. 8.70/km (Airport Express), with maximum fares of Rs. 15, Rs. 25, and Rs. 100, respectively. Bus travel has been free for women since October 2019. The provision of green card enables unlimited daily travel at a reasonable cost (Table 3), and also the rate of monthly passes is very low, especially for students (Rs. 150). Suman et al. (2017) report that 84 per cent of passengers perceive fares as very low in Delhi in comparison to Mumbai. However, transport still constitutes a significant share of poor households' expenditure, so fare increases can affect their travel behaviour (Majumdar et al., 2021).

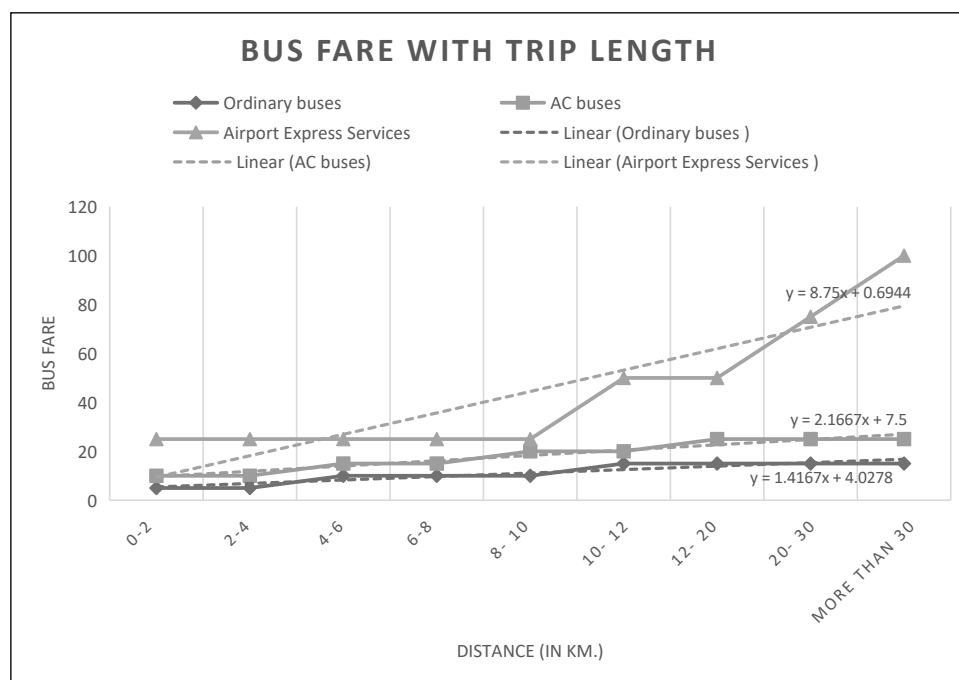


Figure 5: Bus fare in Delhi With trip Length

Source: Delhi Transport Corporation

Table 3: Bus pass charges in Delhi buses

Type of Bus Pass	Monthly Charge (in Rs.)	One day charge
Non-AC bus	800	-
AC bus	1000	-
Airport Express/Coaches AC and Non-AC bus (in NCT of Delhi only)	1400	-
Student concessional pass	150	-
Green card for ordinary bus	-	40
Green card for AC bus	-	50

Source: Delhi Transport Corporation

For reliability and punctuality, about 41 per cent of routes have headways below 15 minutes during morning peak hours (Centre for Science and Environment [CSE], 2017). Fleet utilisation is around 85 per cent for DTC and 99 per cent for cluster buses. Despite high perceived ratings, these figures suggest moderate actual performance. Cluster buses generally outperform DTC buses in fleet and vehicle utilisation and have fewer trip cancellations, indicating relatively better reliability.

Quadrant 2 in the IPA includes attributes such as luggage space, driving quality, information systems, seat availability, and seating arrangement/leg space. These are

highly important but underperforming, thus requiring priority improvement. The absence of luggage racks is a major issue across various user groups and is the poorest-performing attribute. As per Transport Department guidelines, only 15 kg per person is permitted, with additional tickets required beyond this limit. Limited leg space also causes discomfort, particularly for older passengers.

Driving quality is another concern, with many respondents reporting rash driving and high-speed arrivals at bus stops, posing safety risks. In 2021–22, Delhi buses were involved in 95 accidents (Economic Survey of Delhi, 2022–23); in 2022, 39 fatalities and 110 injuries were reported. One reason behind this is the pressure on the drivers to complete their trips. As cluster bus drivers incur a penalty of Rs. 783 if daily distance is below 100 km, while earning Rs. 5/km beyond 100 km.

Seat unavailability and overcrowding significantly reduce satisfaction, especially during peak hours. These also increase discomfort and theft risk (Das & Pandit, 2013; Majumdar et al., 2021). CSE (2017) reports that only 23 per cent of passengers perceive assured seating, and buses often skip stops when full. According to the Dialogue and Development Commission of Delhi (2018), around 11,000 buses are required in Delhi, whereas only about 7,000 are available. Despite this, 15 per cent of DTC buses remained unutilised in 2021 (Economic Survey of Delhi, 2022–23).

Information system—covering routes, stops, frequency, and real-time updates—are essential for improving user control, waiting time, and safety perception (Nesheli et al., 2017). Although apps like ‘One Delhi’ and ‘PoochoO’ provide such information, and a 2018 pilot introduced digital displays at bus stops, large-scale implementation is lacking. Currently, information provision is minimal, typically limited to bus numbers at stops and on buses.

Quadrant 3 includes only one attribute—driver and conductor behaviour—indicating low importance and performance. However, concerns remain significant. A report by Greenpeace India (2023) notes that 50 per cent of surveyed women faced discriminatory or derogatory remarks from bus staff and male passengers. Instances of harassment by staff further reduce performance. Moreover, women have reported cases of drivers not halting for female passengers, labelling them as free travellers.

Quadrant 4 comprises four attributes: passenger safety, cleanliness in the buses and at the stops, and transfer time. These are perceived as less important but perform relatively well. Importance of cleanliness is a highly debated issue among travel satisfaction surveys (Grujičić et al., 2014). In this study, it is not rated as highly important, though buses are perceived as cleaner than stops. Transfer time for switching to another form of public transportation shows average performance and low importance. Mainly because most of the bus routes are integrated with metro stops and corridors. Safety has moderate importance but good performance. Suman et al. (2017) found that while safety is a concern, it does not deter bus use in Delhi. Improved performance may

be attributed to CCTV cameras, GPS systems, panic buttons, and the deployment of marshals on buses since 2019 (Economic Survey of Delhi, 2022). Additional measures include gender sensitisation programmes, 25 per cent seat reservation for women, and operation of 30 women-only buses during peak hours on selected routes.

Service Attribute Importance according to Socio-Demographic Condition

Studies show that socio-demographic factors influence travel satisfaction (Beirão & Cabral, 2009; Das & Pandit, 2013; Friman et al., 2020). This study examines their effect on the perceived importance of service attributes. Table 4 presents t-test results by gender. Attributes such as information systems, cleanliness, safety, driving quality, fare affordability, and staff behaviour show significant differences (positive t-values indicate higher male ratings, and vice versa). In contrast, punctuality, seat availability, and transfer time show no significant gender difference, indicating similar valuation. Figure 6 indicates limited variation overall, except for cleanliness (buses and stops) and safety. High incidences of harassment in public spaces, particularly in Delhi, heighten women's sensitivity to safety, significantly affecting satisfaction (Majumdar et al., 2021; Singh, 2016; Suman et al., 2017). Tayal & Mehta (2021) note that women often prefer metro travel due to safer environments such as female coaches. Safety concerns in buses also affect women's perceived accessibility (Friman et al., 2020). Similarly, women prioritise hygiene and report lower satisfaction with cleanliness (Suman et al., 2017).

Table 4: T-test results showing gender-wise differences in the perceived importance of bus service attributes.

T – test results: Gender						
S. No.	Attribute	Mean (Female)	Mean (Male)	t value	p value	Significance
1	Punctuality and reliability	4.486	4.692	1.651	0.103026	Not significant
2	Information system	4	4.513	4.447	0.000031	Significant
3	Seating arrangement and leg space	3.743	4.103	2.697	0.009447	Significant
4	Provision of space for luggage	3.714	4.282	3.403	0.001095	Significant
5	Availability of seats at bus stops	3.686	4.051	1.495	0.140582	Not significant
6	Cleanliness (bus stop)	3.743	2.923	-5.182	0.000003	Significant
7	Passenger safety	4.314	3.359	-5.082	0.000005	Significant

T – test results: Gender						
S. No.	Attribute	Mean (Female)	Mean (Male)	t value	p value	Significance
8	Availability of seats (bus)	4.971	5	1	0.324375	Not significant
9	Driving Quality	4.229	3.949	-3.480	0.001047	Significant
10	Cleanliness (bus)	3.943	2.846	-10.114	<0.000001	Significant
11	Transfer time	2.886	2.692	-1.205	0.232168	Not significant
12	Affordable Fare	4.943	4.744	-2.452	0.017157	Significant
13	Driver & Conductor Behavior	3.086	3.667	3.088	0.00303	Significant

Note: Significance is based on two-tailed independent-samples t-tests at the 0.05 level ($p < .05$).

Source: Primary survey

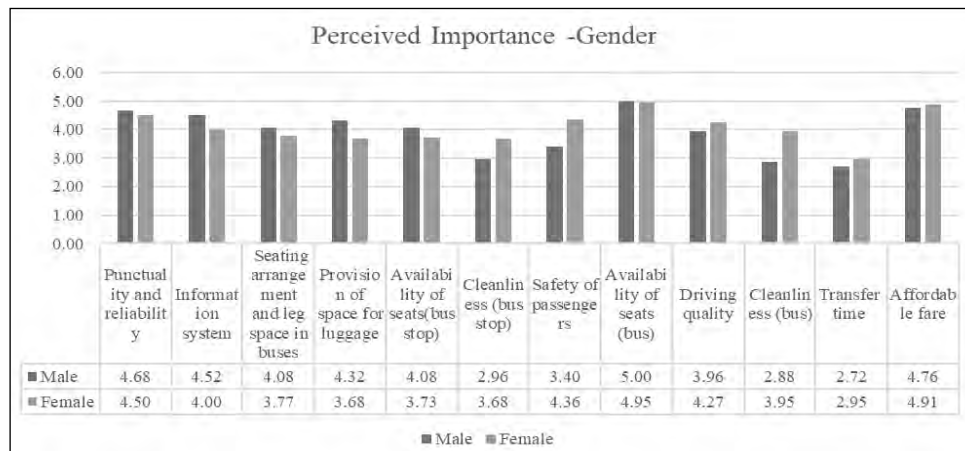


Figure 6: Perceived importance of service quality attributes according to gender

Source: Primary Survey

Table 5 presents ANOVA results across age groups. Only a few attributes—such as punctuality, cleanliness, and safety—show significant variation, while most do not. Figure 7 shows younger users prioritise punctuality and reliability due to time constraints (Sharma et al., 2020). Older users place greater importance on seat availability at stops, cleanliness, and staff behaviour, reflecting reduced mobility and greater dependence. Safety is also more important for older passengers due to higher perceived vulnerability (Beirão & Cabral, 2009).

Table 5: ANOVA results comparing the perceived importance of service attributes across age groups.

ANOVA results- Age group			
Attribute	F-value	p-value	Significance
Punctuality and reliability	13.291	0.000001	Significant
Information system	2.228	0.092457	Not significant
Seating arrangement and leg space	2.346	0.080155	Not significant
Provision of space for luggage	0.254	0.858321	Not significant
Availability of seats at bus stops	9.813	0.000017	Significant
Cleanliness (bus stop)	7.426	0.000218	Significant
Passenger safety	5.827	0.001298	Significant
Availability of seats (bus)	1.123	0.345615	Not significant
Driving Quality	0.665	0.576525	Not significant
Cleanliness (bus)	8.272	0.000087	Significant
Transfer time	0.779	0.509694	Not significant
Affordable Fare	6.333	0.000732	Significant
Driver & Conductor Behaviour	2.057	0.113790	Not significant

Note: One-way ANOVA results are reported with df = 3, 70. Significance was determined at $p < .05$.

Source: Primary Survey

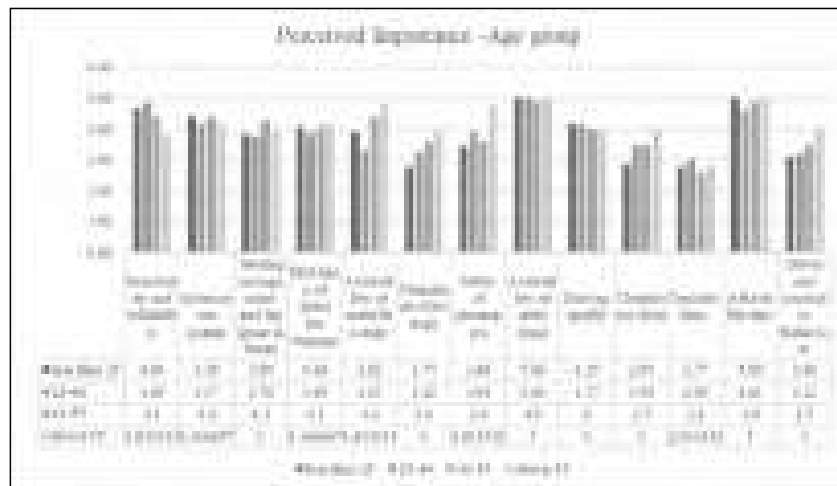


Figure 7: Perceived importance of service quality attributes according to age group

Source: Primary Survey

Table 6 presents the ANOVA results for the employment categories. Attributes such as punctuality, information, transfer time, affordability, etc., have statistically significant differences across various employment categories. Whereas other attributes, such as safety, driving quality, etc., show no meaningful variation, implying that these service aspects have more or less uniform importance across different employment

categories. From Figure 8, we can see that employed individuals and students place greater importance on the punctuality and reliability of the buses due to their busy schedules and low tolerance for delays (Singh, 2016). Again, from a gender perspective, housewives tend to give more importance to cleanliness and are more reliant on bus staff for boarding and stop information, and hence attribute considerable importance to their behaviour.

Table 6: ANOVA results comparing perceived importance of service attributes across various employment status categories

ANOVA results- Employment status				
S. No.	Attribute	F-value	p-value	Significance
1	Punctuality & Reliability	10.621	0.0000077	Significant
2	Information System	3.831	0.01336	Significant
3	Seating / Leg Space	1.65	0.18572	Not Significant
4	Luggage Space	3.728	0.01512	Significant
5	Seats at Bus Stop	16.517	0.000000032	Significant
6	Cleanliness at Bus Stop	7.179	0.000286	Significant
7	Safety of Passengers	1.072	0.36677	Not Significant
8	Seats in Bus	0.507	0.67889	Not Significant
9	Driving Quality	2.011	0.12028	Not Significant
10	Cleanliness Inside Bus	4.952	0.003557	Significant
11	Transfer Time	9.101	0.000036	Significant
12	Affordable Fare	4.173	0.008895	Significant
13	Driver & conductor behaviour	2.805	0.04594	Significant

Note: One-way ANOVA results are reported with df = 3, 70. Significance was determined at $p < .05$.

Source: Primary Survey



Figure 8: Perceived importance of service quality attributes according to Employment status

Source: Primary Survey

Table 7 shows the ANOVA results across income categories. Some attributes, such as Information system, luggage space, seats, etc., display significant variation in importance based on income, reflecting different needs and expectations among economic categories. From Figure 9, we can see that the ‘provision of space for luggage’ is a factor perceived as more important by the lower-income class. Additionally, safety concerns increase with income, as higher-income groups can afford safer options, such as taxis and subways. Additionally, very low-income groups tend to give less importance to punctuality and reliability, as Suman et al. (2017) note that more punctual and reliable modes of transport attract more non-captive travellers.

Table 7: ANOVA results comparing perceived importance of service attributes across various Income level categories

ANOVA results- Income level				
S. No.	Attribute	F-value	p-value	Significance
1	Punctuality & Reliability	0.606621	0.61291	Not Significant
2	Information System	7.392624	0.00023	Significant
3	Seating / Leg Space	3.012773	0.03575	Significant
4	Luggage Space	9.468718	0.000025	Significant
5	Seats at Bus Stop	3.553689	0.01863	Significant
6	Cleanliness at Bus Stop	10.94269	0.000006	Significant
7	Safety of Passengers	2.786304	0.04702	Significant
8	Seats in Bus	0.506757	0.67889	Not Significant
9	Driving Quality	8.547058	0.000065	Significant
10	Cleanliness Inside Bus	1.155096	0.33314	Not Significant
11	Transfer Time	11.53355	0.000003	Significant
12	Affordable Fare	1.664975	0.18243	Not Significant
13	Driver & Conductor Behaviour	2.063388	0.11291	Not Significant

Note: One-way ANOVA results are reported with $df = 3, 70$. Significance was determined at $p < .05$.

Source: Primary Survey

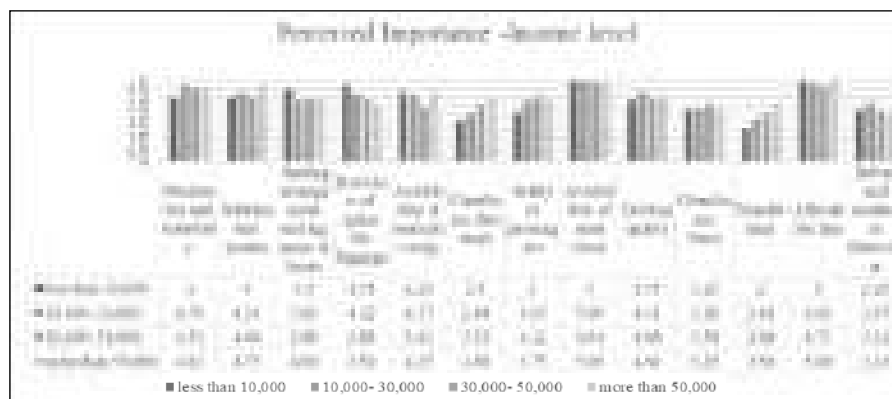


Figure 9: Perceived importance of service quality attributes according to Income level

Source: Primary Survey

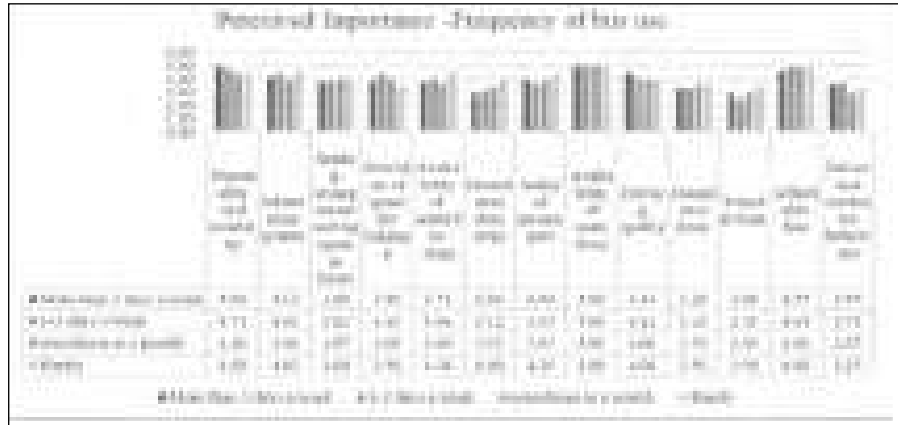


Figure 10: Perceived importance of service quality attributes according to Frequency of bus use

Source: Primary Survey

Table 8 shows the ANOVA results for different bus use frequency groups. Several attributes, such as cleanliness, affordability, driver and conductor behaviour, etc., show significant differences, indicating that frequent and non-frequent users prioritise service elements differently. However, some core attributes, such as seat availability, safety, and cleanliness in buses, do not differ significantly across frequency of bus use categories. From Figure 10, we can see that people who are more frequent users of buses give high importance to punctuality and reliability, and less importance to the cleanliness (bus stop), probably because they have been adapted to the attributes of comfort and safety. Most passengers in the “more than 3 days” and “1-3 days” categories are employed or students, prioritising punctuality and reliability due to daily travel needs. More frequent travellers experience more delays and unreliable behaviour from public buses, which further reduces their perceived accessibility and satisfaction with travel (Friman et al., 2020).

Table 8: ANOVA results comparing perceived importance of service attributes across different bus-use frequency groups.

ANOVA results- Frequency of Bus use				
S. No.	Attribute	F-value	p-value	Significance
1	Punctuality & Reliability	5.1616	0.00279	Significant
2	Information System	6.3038	0.000756	Significant
3	Seating / Leg Space	1.5482	0.209742	Not significant
4	Luggage Space	5.1744	0.002748	Significant
5	Seats at Bus Stop	1.0986	0.355608	Not significant
6	Cleanliness at Bus Stop	5.507	0.001872	Significant

ANOVA results- Frequency of Bus use				
S. No.	Attribute	F-value	p-value	Significance
7	Safety of Passengers	1.4592	0.233154	Not significant
8	Seats in Bus	1.6029	0.196501	Not significant
9	Driving Quality	3.0849	0.03276	Significant
10	Cleanliness Inside Bus	0.7801	0.50901	Not significant
11	Transfer Time	8.9084	0.000045	Significant
12	Affordable Fare	3.3852	0.022808	Significant
13	Driver & Conductor Behaviour	3.8167	0.013594	Significant

Source: Primary survey

Conclusion and Recommendations

The study shows that improving seating and leg space, seat availability, information systems, luggage space, and driving quality can yield the greatest gains in passenger satisfaction. Additionally, socio-demographic factors also impact the perception of importance of service attributes. Women prioritise safety and cleanliness; younger and middle-aged users emphasise punctuality and reliability; older users value seat availability at stops and staff behaviour. The Passenger Satisfaction Index indicates that bus services achieve about 67 per cent satisfaction. Moreover, Cluster buses outperform DTC buses on indicators such as fleet utilisation and load factor, supporting recommendations for greater private participation and PPP-based operations.

One of the most important factors, i.e., seat availability, can be improved by increasing fleet size and service frequency. Despite a decline in passengers per bus between 2017–18 and 2021–22, the average distance travelled per bus daily has increased by approximately 22 km, indicating lower load factors. This calls for route rationalisation based on demand. Fleet expansion is needed alongside better utilisation, as around 15 per cent of DTC buses remain idle. Policy recommendations also emphasise liberalisation and PPP models supported by strong information systems, including app-based services to enhance reliability.

Information systems require significant improvement. The provision of integrated information should be made to facilitate the ease of transfer between public transport modes (Nesheli et al., 2017). While apps exist, bus stops lack schedules and detailed route information. Earlier pilot projects for digital displays at shelters should be scaled up, and onboard displays of upcoming stops should be introduced. Overhead luggage racks should also be installed to address passenger inconvenience.

Driving quality can be improved by revising operational incentives, such as increasing the 100 km threshold and removing per-km incentives that encourage speeding. Dedicated bus lanes should be expanded to improve speed consistency and reduce waiting time (Singh, 2016). Congestion pricing can further discourage private

vehicle use (Majumdar et al., 2021). Although cleanliness is not a major concern, basic measures such as onboard trash bins can help. Suman et al. (2017) recommend increasing the service quality of AC buses by managing an increase in bus fares, whereas the fare of ordinary buses should remain unchanged.

Improving safety measures is essential to enhance women's satisfaction. Whereas for elderly travellers, the importance should be given to the crew members' behaviour and activeness in helping, as well as the provision of toilets near bus stations (Majumdar et al., 2021). Overall, targeted improvements in service quality can raise satisfaction, increase ridership, and encourage a modal shift towards public transport.

Limitations and Directions for Future Research

Although the study provides valuable insights into the importance and performance of bus service attributes in Delhi, certain limitations need to be acknowledged. Firstly, the study has been conducted with a relatively small sample size ($n = 74$), restricting the representativeness of the findings for a large metropolitan city like Delhi. Although adequate for a preliminary perception-based assessment, the results should be seen as indicative and serve as a foundation for larger, statistically representative future studies that can reduce sampling error and strengthen subgroup comparisons. Secondly, the study has used the traditional Importance–Performance Analysis (IPA) method, which is well-suited for understanding user needs and identifying attributes that require immediate attention. However, advancements in the methods, such as the Revised IPA approaches consisting of the Kano Model or Three-Factor Theory, capture asymmetric effects and can provide a better understanding of service attribute behaviour. Since these approaches require additional data and a larger dataset, they have not been utilised in the study. Incorporating such revised models in future research would offer deeper insights into passenger satisfaction and improvement strategies.

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Endnotes

- 1 Delhi Public Transport: Good news and bad news (downtoearth.org.in)