

## ASSESSING DELHI'S TRANSPORTATION SYSTEM FOR SUSTAINABLE DEVELOPMENT: A FRAMEWORK-BASED ANALYSIS ALIGNED WITH THE SDGS

Utkarsh Chaudhari<sup>1,\*</sup>, Ranganath M Singari<sup>1</sup>, S L Bhandarkar<sup>2</sup>

<sup>1</sup>Department of Design, Delhi Technological University, Delhi, India

<sup>2</sup>Controller of Examination, GGSIPU, Delhi, India

\*Email: [utkarshchaudhri\\_2k21phddes502@dtu.ac.in](mailto:utkarshchaudhri_2k21phddes502@dtu.ac.in)

**Abstract:** Urban transportation systems play a critical role in shaping the environmental, economic, and social landscape of cities. In the context of India's capital, Delhi, multiple transportation frameworks have been introduced over the years to address mobility issues while aiming for sustainability. This study evaluates the major transportation frameworks of Delhi through the lens of the Sustainable Development Goals (SDGs), particularly using a 5P-based sustainability evaluation model. Expert opinion was gathered through a structured questionnaire using a 5-point Likert scale to assess each framework's alignment with People, Planet, Prosperity, Peace, and Partnership dimensions. The results identified the Delhi Master Plan 2041 as the most sustainable transportation framework. The study further proposes modifications to this plan to enhance its alignment with sustainable development objectives and provides strategic recommendations for policymakers.

**Keywords:** Sustainable Development Goals, Transportation policy evaluation, Public transportation, Multimodal integration, Traffic congestion.

### 1. Introduction

Urban transportation plays a pivotal role in shaping the quality of life, economic development, and environmental sustainability of modern cities. In rapidly urbanizing regions, particularly in the Global South, transportation systems are not only critical for mobility but also serve as catalysts for inclusive growth, environmental resilience, and social equity. Delhi, the capital city of India, exemplifies both the promise and challenges of urban mobility in the 21st century. With a population exceeding 30 million and growing, the city's transportation ecosystem is under immense pressure to cater to rising demand while simultaneously aligning with national and global sustainability goals (MoUD, 2014).

A mix of progress and persistent challenges marks the current trajectory of urban transport in Delhi. While significant investments have been made in metro rail, bus rapid transit (BRT), and non-motorized transport infrastructure, the city continues to grapple with traffic congestion, vehicular emissions, poor last-mile connectivity, and rising road fatalities (EPCA, 2019). According to the Centre for Science and Environment (CSE, 2021), transport emissions contribute to nearly 30% of the city's air pollution during peak winter months. This trend underscores the urgent need for a re-evaluation of existing transportation policies through a sustainability lens.

Sustainable transport is now widely recognized as a core enabler of the **United Nations Sustainable Development Goals (SDGs)**, which aim to address global challenges across economic, social, and environmental dimensions by 2030. Specifically, **SDG 11** (Sustainable Cities and Communities) emphasizes the need for inclusive, safe, resilient, and sustainable urban areas—where transport accessibility, affordability, and safety are central (UN DESA, 2016). **SDG 13** (Climate Action) calls for urgent measures to combat climate change, including mitigation of greenhouse gas emissions from transport systems, which are a major global contributor to carbon footprints (UNFCCC, 2020). Furthermore, **SDG 9** (Industry, Innovation, and Infrastructure) supports the development of quality, reliable, sustainable infrastructure—including transport networks—that foster innovation and equitable development (UNDP, 2020).

Beyond these specific goals, the SDGs are structured around five interconnected pillars known as the **5Ps—People, Planet, Prosperity, Peace, and Partnership**—which serve as a holistic blueprint for achieving sustainability at multiple levels (UN, 2015). These pillars recognize that transportation systems, when designed through a sustainability lens, can significantly improve social inclusivity (People), mitigate environmental impact (Planet), promote economic productivity (Prosperity), strengthen governance mechanisms (Peace), and build intersectoral collaboration (Partnership). Evidence suggests that sustainable transportation supports not only environmental health and energy efficiency but also reduces social inequality, facilitates access to services and employment, and enhances urban safety (ITDP, 2020; SLoCaT, 2018).

Over the years, Delhi has introduced multiple transport-related frameworks and policies, including the Delhi Transport Policy 2018, the Unified Traffic and Transportation Infrastructure (Planning & Engineering) Centre (UTTIPEC) Guidelines, the Comprehensive Mobility Plan (CMP), and successive iterations of the Delhi Master Plan (DMP). While these frameworks contain valuable strategies and action plans, their alignment with sustainability goals, particularly across the 5Ps of the SDG framework, has not been systematically evaluated. Moreover, the overlapping mandates and fragmented governance structures often lead to policy inertia and implementation gaps (Singh & Sharma, 2022).

To address this gap, the present study proposes a comprehensive evaluation of Delhi's major transportation frameworks using a 5P-based analytical model aligned with the SDGs. A structured expert-based assessment was conducted using the Delphi method, wherein urban planners, transport experts, and policy analysts were invited to rank the selected frameworks on a 5-point Likert scale for each of the 5Ps. This participatory approach enables a more nuanced understanding of how well each framework addresses issues of social inclusivity (People), environmental sustainability (Planet), economic growth (Prosperity), governance (Peace), and collaboration (Partnership).

Preliminary findings from the expert evaluation revealed that the Delhi Master Plan 2041 (Draft) stands out as the most sustainability-aligned framework. It scored highest in terms of environmental responsibility, infrastructure foresight, and institutional coherence. However, even this document shows gaps, particularly in stakeholder engagement mechanisms and implementation scalability. Therefore, based on expert feedback and comparative insights, this research develops a Modified Sustainable Transportation Framework that enhances the Delhi Master Plan 2041 by embedding stronger sustainability indicators and global best practices.

The second component of this study involves benchmarking the enhanced framework against successful global transportation models in cities such as Copenhagen, Singapore, and Bogotá. These cities have been globally acknowledged for implementing effective sustainable urban transport systems through interventions like transit-oriented development (TOD), cycling infrastructure, low-emission zones, and citizen-centric governance (GIZ, 2020; UITP, 2018). By mapping the Delhi framework against these models, this study demonstrates the global relevance and adaptability of its recommendations.

This research is both timely and policy-relevant. As India prepares for major infrastructure investments under national missions like the Smart Cities Mission and Gati Shakti, there is a critical opportunity to mainstream sustainability in transport planning. By evaluating and enhancing the most promising local framework—Delhi Master Plan 2041—this study contributes practical insights that can influence future policy decisions not only in Delhi but across Indian cities facing similar urban mobility challenges.

In summary, this paper aims to:

1. Evaluate the sustainability alignment of existing Delhi transportation frameworks using a 5P-based model.
2. Identify the most sustainable framework through expert consensus.
3. Enhance the selected framework to improve sustainability impact.
4. Benchmark the modified framework against international best practices.

Through this multi-pronged approach, the study offers a replicable method for sustainability-focused urban transport planning in complex megacities like Delhi.

## 2. Methodology

This research adopts a mixed-methods approach to assess and enhance the sustainability of transportation frameworks in Delhi. The study is structured in two primary stages: (1) a systematic expert-based evaluation using the Delphi method, grounded in the Sustainable Development Goals (SDGs) through the 5P framework (People, Planet, Prosperity, Peace, and Partnership); and (2) a benchmarking exercise comparing the most sustainable framework with global best practices. This section outlines the rationale, design, data collection procedures, and analysis methods used to ensure the robustness, transparency, and academic validity of the research process.

## 2.1 Research Design

The research follows a two-phase design:

- **Phase I:** Evaluation of key transportation policy frameworks in Delhi using expert opinions collected via a structured Delphi process.
- **Phase II:** Global benchmarking of the most sustainable framework (identified in Phase I) against leading international case studies in sustainable urban transportation.

The integration of expert consensus with comparative international analysis ensures that the proposed modifications to Delhi's framework are both contextually relevant and globally informed.

## 2.2 Selection of Frameworks for Evaluation

A total of **14 major transportation-related frameworks** implemented or proposed for Delhi were selected for evaluation based on their policy relevance, recency, and strategic influence on urban mobility:

1. National Urban Transport Policy (2006)
2. National Electric Mobility Mission Plan (2020)
3. Delhi Transport Policy (2018)
4. Unified Traffic and Transportation Infrastructure Planning & Engineering Centre (UTTIPEC) Guidelines
5. Comprehensive Mobility Plan (CMP)
6. Delhi Master Plan 2021
7. Delhi Master Plan 2041 (Draft)
8. Delhi Electric Vehicle Policy (2020)
9. Delhi Non-Motorized Transport Policy
10. Gati Shakti Master Plan (Delhi Chapter)
11. Delhi Metro Rail Policy (2017)
12. Smart Cities Mission (Delhi Initiatives)
13. National Transit Oriented Development (TOD) Policy
14. Street Vending Policy (Delhi Implementation)

These frameworks were chosen because they represent the key strategic documents guiding transportation and mobility-related planning, governance, and infrastructure investment in Delhi. The evaluation focused on how well each framework aligns with the 5P model of the SDGs.

## 2.3 The 5P Framework for Evaluation

The 5P framework is derived from the United Nations' Agenda 2030 and the 17 Sustainable Development Goals. The 5Ps—People, Planet, Prosperity, Peace, and Partnership—are conceptual pillars that organize the SDGs into interconnected themes (UN, 2015). This framework provides a holistic lens through which transport frameworks can be evaluated, ensuring a balanced emphasis on social equity, environmental responsibility, economic growth, governance, and collaboration.

Each framework was assessed across the following five dimensions:

- **People:** Accessibility, inclusivity, affordability, safety
- **Planet:** Environmental impact, carbon emissions, energy use, land conservation
- **Prosperity:** Economic viability, infrastructure investment, employment generation, innovation
- **Peace:** Institutional coordination, governance mechanisms, transparency, policy coherence
- **Partnership:** Inter-agency collaboration, stakeholder participation, public-private engagement

Each of these dimensions was further subdivided into 3–5 sub-criteria to allow for a comprehensive evaluation during expert consultation.

## 2.4 Phase I: Expert Evaluation Using Delphi Method

### 2.4.1 Rationale for Delphi Method

The Delphi method was employed in this study to obtain structured expert insights on the sustainability alignment of various transportation policies and projects in Delhi. Given the multi-dimensional and context-specific nature of sustainable transport, expert evaluation is critical to assess the practical relevance, feasibility, and impact of each initiative. The method's iterative nature allows for refinement and consensus-building, especially valuable in complex systems involving policy, environment, and infrastructure (Linstone & Turoff, 2002).

### 2.4.2 Questionnaire Design and Evaluation Framework

The questionnaire used in this study (attached as Annexure I) was designed to capture expert assessments across the five pillars of sustainability (5Ps): People, Planet, Prosperity, Peace, and Partnership, derived from the United Nations' SDG framework (UN, 2015). Each policy or project was evaluated on its perceived contribution to each pillar using a 5-point Likert scale, where:

- **1 = Very Low Contribution**
- **2 = Low Contribution**
- **3 = Moderate Contribution**
- **4 = High Contribution**
- **5 = Very High Contribution**

The evaluation included 14 policies and initiatives, ranging from legacy plans like the Delhi Master Plan 2001 to recent developments such as the Delhi EV Policy 2020, TOD Guidelines, and Unified Mobility Card. Experts were asked to provide scores for each initiative across all 5Ps, ensuring a comprehensive evaluation of their sustainability dimensions.

Sections of the questionnaire included:

- Section A: Expert profile (years of experience, domain expertise)
- Section B: Quantitative evaluation of 14 transport policies/projects using the 5P-Likert matrix

- Section C: Open-ended qualitative feedback on additional initiatives, implementation challenges, and suggestions for improvement

This structure ensured both quantitative scoring and qualitative insights, allowing for triangulation in data analysis.

### **2.4.3 Expert Panel Selection**

A total of 30 experts were invited to participate in the Delphi rounds. Participants were selected using purposive sampling based on their expertise and practical experience in urban planning, public transportation, electric mobility, and SDG-related governance. They represented a cross-section of institutions, including:

- Delhi Development Authority (DDA)
- Centre for Science and Environment (CSE)
- Transport Research and Injury Prevention Programme (TRIPP), IIT Delhi
- Private planning consultancies
- Non-governmental organizations (NGOs)
- Academic institutions and think tanks

Minimum criteria for participation included 7+ years of experience in the transportation or sustainability domain and familiarity with Delhi's transport ecosystem.

### **2.4.4 Delphi Round I: Initial Evaluation and Thematic Analysis**

In the first round, experts were provided with the questionnaire and policy summaries. They rated each transport initiative using the Likert scale and provided qualitative responses in open-ended fields (Section C). This round enabled the collection of:

- Baseline ratings for each initiative across the 5Ps
- Identification of gaps, redundancies, or inconsistencies in policy implementation
- Expert-recommended additional projects (e.g., green freight corridors, non-motorized transport promotion)

The open-ended responses were analysed using thematic coding (Miles & Huberman, 1994), grouping insights under the 5P framework to inform subsequent analysis and framework modification.

### **2.4.5 Delphi Round II: Consensus Evaluation**

After analysing responses from Round I, a second round was initiated to refine the assessments and move towards consensus. Experts were shown aggregated average scores and thematic summaries from Round I, and asked to confirm, revise, or justify their evaluations. This feedback loop helped in:

- Strengthening consensus on the most impactful policies (e.g., Delhi Master Plan 2041, Delhi EV Policy)
- Discarding or reclassifying weakly supported initiatives
- Validating proposed enhancements to the Delhi Master Plan 2041

## 2.4.6 Analysis of Responses

Quantitative responses were processed using descriptive statistics, calculating:

- Mean and median scores for each initiative under each 5P
- Composite sustainability score per framework (average of all five dimensions)

Initiatives scoring  $\geq 4.0$  on average were classified as highly sustainable, 3.0–3.9 as moderately sustainable, and  $< 3.0$  as less sustainable.

The Delhi Master Plan 2041 (Draft) emerged as the highest-rated initiative, scoring consistently across all five pillars, particularly in the Planet, Prosperity, and Peace dimensions.

The table 1 below presents the evaluation scores of 14 transportation-related policies and frameworks in Delhi, assessed across the five dimensions of sustainable development (People, Planet, Prosperity, Peace, and Partnership). Each score reflects expert assessments based on a 5-point Likert scale.

**Table 1:** Sustainability Scores of Delhi Transportation Frameworks Aligned with the SDGs.

Framework	People	Planet	Prosperity	Peace	Partnership	Total Avg
National Urban Transport Policy (2006)	3.6	3.8	4.0	3.5	3.2	3.6
Nat. Electric Mobility Mission Plan (2020)	3.9	4.3	4.1	3.4	3.5	3.8
Delhi Transport Policy (2018)	3.8	4.1	4.0	3.6	3.7	3.8
UTTIPEC Guidelines	4.2	4.3	4.2	3.9	4.0	4.1
Comprehensive Mobility Plan (CMP)	3.4	3.5	3.7	3.2	3.1	3.4
Delhi Master Plan 2021	3.7	3.8	3.9	3.5	3.3	3.6
Delhi Master Plan 2041 (Draft)	4.4	4.5	4.6	4.2	4.1	4.4
Delhi Electric Vehicle Policy (2020)	3.9	4.4	4.2	3.5	3.5	3.9
Non-Motorized Transport (NMT) Policy	4.2	4.5	4.0	3.5	3.8	4.0
Gati Shakti (Delhi Chapter)	3.5	3.7	4.3	3.3	3.4	3.6
Delhi Metro Rail Policy (2017)	3.8	3.9	4.1	3.7	3.3	3.8
Smart Cities Mission (Delhi)	3.9	3.8	4.0	3.6	3.9	3.8
TOD Policy (National Guidelines)	4.0	4.1	4.3	3.7	3.6	3.9

Street Vending Policy (Delhi)	4.1	3.5	3.6	3.4	3.3	3.6
----------------------------------	-----	-----	-----	-----	-----	-----

### 2.4.7 Open-Ended Findings

The qualitative feedback revealed key themes:

- Need for improved last-mile connectivity under the People dimension.
- Lack of data transparency and accountability mechanisms under the Peace.
- Weak integration of stakeholder and community partnerships, suggesting a gap in Partnership.
- Strong support for e-mobility and TOD, validating their emphasis in Delhi's evolving framework.

These findings directly informed the development of the Modified Sustainable Transportation Framework, enhancing the Delhi Master Plan 2041 with globally aligned, locally relevant strategies.

## 3. Results and Discussion

To evaluate the alignment of Delhi's transportation planning with the Sustainable Development Goals (SDGs), fourteen key policy frameworks were systematically analysed through expert responses collected via a structured questionnaire. Experts assessed each framework across the five dimensions of SDG implementation—People, Planet, Prosperity, Peace, and Partnership—using a 5-point Likert scale (1 = Very Poor, 5 = Excellent). The frameworks represent a mix of central, state, city-level, and institutional policy initiatives that influence transport planning in Delhi.

A total of 25 experts participated in the study, comprising urban planners, transport engineers, policy researchers, environmentalists, and senior professionals from government and academia. The quantitative responses were averaged to determine each framework's score across the 5Ps, followed by a comparative analysis to identify the most sustainability-aligned framework.

### 3.1 Overview of Frameworks Evaluated

The following 14 frameworks were analysed:

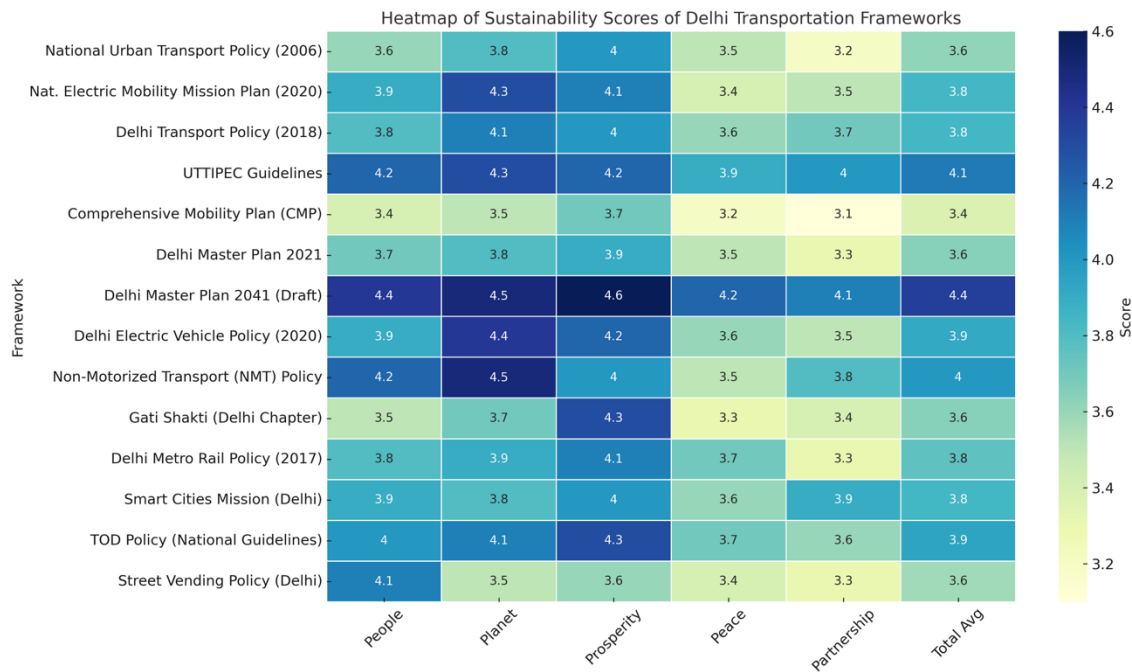
15. National Urban Transport Policy (2006)
16. National Electric Mobility Mission Plan (2020)
17. Delhi Transport Policy (2018)
18. Unified Traffic and Transportation Infrastructure Planning & Engineering Centre (UTTIPEC) Guidelines
19. Comprehensive Mobility Plan (CMP)
20. Delhi Master Plan 2021
21. Delhi Master Plan 2041 (Draft)
22. Delhi Electric Vehicle Policy (2020)



23. Delhi Non-Motorized Transport Policy
24. Gati Shakti Master Plan (Delhi Chapter)
25. Delhi Metro Rail Policy (2017)
26. Smart Cities Mission (Delhi Initiatives)
27. National Transit Oriented Development (TOD) Policy
28. Street Vending Policy (Delhi Implementation)

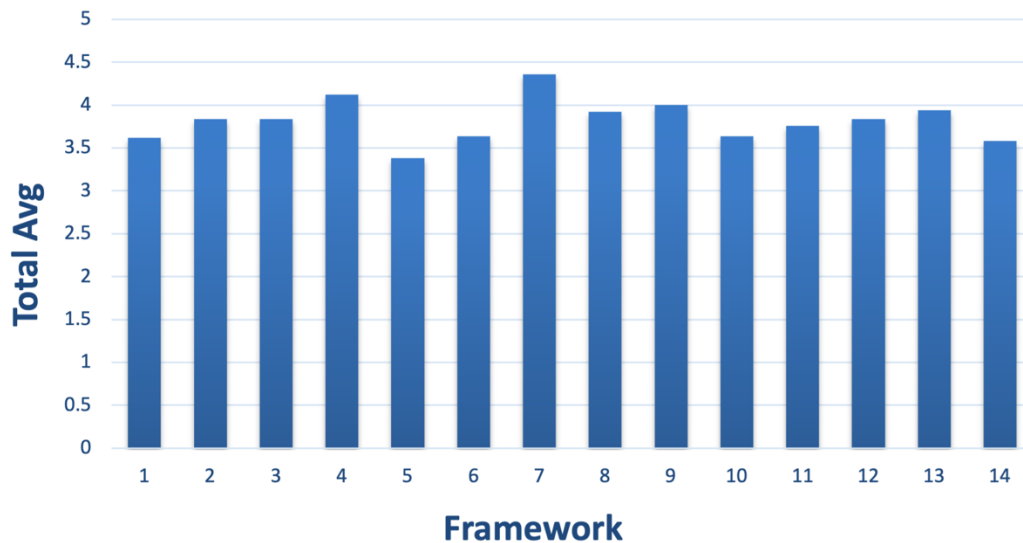
### 3.2 Aggregated Scores by Framework

To visualize the comparative performance, a **heatmap** was generated showing the average scores of each framework across all evaluated indicators. This helped in quickly identifying patterns of strengths and weaknesses for each framework (see **Figure 1**).



**Figure 1:** Heatmap showing the average score distribution of 14 transportation frameworks based on expert evaluations.

In addition to the heatmap, a **bar chart** was created to illustrate the total average score for each framework, consolidating all indicators into a single mean value. This visualization identifies the most and least sustainable frameworks overall. As depicted in **Figure 2**, *Delhi Master Plan 2041* (Framework 7) emerged as the most sustainable, with a total average score exceeding 4.3, followed closely by *UTTIPEC* (Framework 4) and *NUTP* (Framework 9). In contrast, Framework 5 received the lowest score, pointing to its limited alignment with sustainability goals.



**Figure 2:** Bar chart depicting the total average scores (on a 1–5 scale) of each transportation framework.

These visual summaries offer a clear overview of how each policy performs and set the foundation for deeper framework-specific analysis presented below.

### 3.3 High-Performing Frameworks

#### Delhi Master Plan 2041

With the highest overall average score of **4.36**, the Delhi Master Plan 2041 emerged as the most sustainability-aligned framework. It scored consistently high across all five dimensions, particularly excelling in:

- **Planet (4.5):** Strong focus on environmental sustainability, with strategies for EV integration, green corridors, and urban greening.
- **Prosperity (4.6):** Emphasis on Transit-Oriented Development (TOD), infrastructure modernization, and economic decentralization.
- **Peace (4.2):** Institutional mechanisms like Unified Command Centres and digital dashboards reflect improved governance.

Experts appreciated the plan’s futuristic orientation and its systemic integration of environmental and equity-based considerations.

#### UTTIPEC Guidelines

Scoring an overall **4.12**, the UTTIPEC guidelines were rated highly for:

- **People (4.2):** Prioritization of walkability, universal design, and gender-inclusive infrastructure.

- **Planet (4.3):** Encouragement of NMT and land-use zoning for decongestion. The framework was seen as a benchmark for street design and inclusive planning in the Indian context.

### **Delhi Electric Vehicle Policy (2020) and NMT Policy**

Both policies performed well in the **Planet** dimension (4.4 and 4.5, respectively), indicating their strong environmental focus. However, scores in **Peace** and **Partnership** were slightly lower, reflecting concerns about policy coordination and stakeholder engagement.

## **3.4 Detailed Analysis of Delhi Master Plan 2041**

### **3.4.1 Strengths of Delhi Master Plan 2041**

The *Delhi Master Plan 2041* distinguishes itself by offering a comprehensive vision for sustainable urban transport. One of its notable strengths lies in its emphasis on **multimodal integration**, where public transport systems such as buses, metros, and non-motorized transport (NMT) are planned to be seamlessly interconnected. This ensures last-mile connectivity, reduces dependency on private vehicles, and fosters modal shift.

The plan also emphasizes the promotion of **non-motorized transport** such as walking and cycling, through the development of dedicated infrastructure, green corridors, and pedestrian-friendly streetscapes. Such initiatives enhance accessibility, especially for vulnerable groups, including the elderly, women, and children.

Another key strength is its explicit focus on **pollution control and green mobility**. The plan includes strategies to curb vehicular emissions, increase electric vehicle adoption, and promote clean energy-based transport solutions. Environmental sustainability is a cross-cutting theme across its objectives.

In terms of social sustainability, the plan addresses **inclusivity and affordability** by proposing equitable access to public transportation and targeting underserved areas. It also calls for gender-sensitive design and accessibility for people with disabilities, ensuring a people-centred mobility approach.

### **3.4.2 Identified Gaps**

Despite its strengths, experts identified several critical gaps in the *Delhi Master Plan 2041* that may hinder its effective implementation. A major concern is the **absence of robust implementation and monitoring mechanisms**. While the plan is comprehensive in vision, it lacks clearly defined Key Performance Indicators (KPIs), timelines, and institutional responsibilities, which are crucial for tracking progress and ensuring accountability.

Another limitation is the **inadequate integration of smart mobility technologies**. Although the plan mentions modernization, it does not fully incorporate intelligent transport systems (ITS), real-time data sharing, or mobility-as-a-service (MaaS) platforms that are increasingly essential in today's digital urban environment.

Furthermore, the plan lacks effective **strategies for addressing the transportation needs of informal settlements and low-income groups**. While inclusivity is mentioned, there is a lack of detailed action plans and funding mechanisms targeted toward these communities.

Finally, the plan offers **limited provisions for public-private partnerships (PPPs)**. Given the resource-intensive nature of transportation infrastructure, leveraging PPPs is essential for innovation, efficiency, and scalability. The plan would benefit from clearer strategies for engaging private stakeholders in project development and service delivery.

## 5. Recommendations for Improvement

To strengthen the sustainability of the *Delhi Master Plan 2041*, the following enhancements are recommended:

1. **Smart Technology Adoption:** Incorporate advanced smart mobility technologies to modernize Delhi's transportation ecosystem. This includes real-time mobility platforms for tracking buses and metro services, GIS-based planning tools for infrastructure optimization, and digital ticketing systems that promote cashless, contactless travel. Intelligent Transport Systems (ITS) can help in traffic management, incident response, and data-driven decision-making.
2. **Inclusive Planning:** Design transport systems that address the needs of marginalized communities, including those residing in low-income and informal settlements. This involves expanding transport networks to underserved regions, subsidizing fares, ensuring physical accessibility for persons with disabilities, and deploying last-mile connectivity options. Inclusive planning also requires active engagement with community representatives during the policy-making process.
3. **Green Transition Targets:** Establish clear, quantifiable targets to guide the transition toward sustainable transport. This includes setting measurable goals for the adoption of electric vehicles, reducing carbon emissions from the transport sector, and increasing the share of public and non-motorized transport. These targets should be time-bound, regularly reviewed, and integrated with Delhi's broader climate and air quality commitments.
4. **Stakeholder Involvement:** Strengthen the role of stakeholders in both planning and implementation. This involves creating formal mechanisms for collaboration between government agencies, private sector partners, civil society organizations, and local communities. Public-private partnerships can be leveraged for infrastructure investment, service delivery, and innovation in mobility solutions. Transparent stakeholder engagement will enhance trust and responsiveness.
5. **Monitoring Mechanisms:** Develop robust mechanisms for ongoing performance monitoring and evaluation. Key Performance Indicators (KPIs) should be defined for all major components of the plan, with data collection protocols and annual progress reports. Independent third-party evaluations can ensure objectivity and support mid-course corrections. A public dashboard or digital platform can enhance transparency and citizen oversight.

## 6. Conclusions

This research undertook a comprehensive assessment of various transportation frameworks governing Delhi's urban mobility landscape, employing a structured evaluation method aligned with the Sustainable Development Goals (SDGs). By analysing expert responses collected via a Likert-scale questionnaire based on sustainability criteria, the study successfully identified the relative strengths and weaknesses of each framework.

The analysis revealed that the *Delhi Master Plan 2041* emerges as the most sustainability-oriented framework among those evaluated. Its strengths lie in its integrated multimodal design, commitment to green mobility, promotion of non-motorized transport, and focus on inclusivity. However, significant challenges persist, particularly in terms of effective implementation, use of smart technologies, inclusion of informal sectors, and robust stakeholder engagement.

To address these gaps, the study proposed a set of detailed recommendations, including the adoption of smart mobility technologies, formulation of measurable green transition targets, and incorporation of participatory and third-party monitoring mechanisms. These enhancements aim to transform the Delhi Master Plan 2041 from a promising vision into an actionable and resilient roadmap for sustainable urban mobility.

Ultimately, if adopted, these recommendations could significantly strengthen the city's trajectory toward equitable access, reduced emissions, and long-term urban resilience, bringing Delhi closer to achieving both local development objectives and its international SDG commitments.

## References:

1. Akbar, P. A., Couture, V., Duranton, G., Ghani, E., & Storeygard, A. (2018). *Mobility and congestion in urban India*. World Bank.
2. CSE (2021). *Air Pollution and Urban Transport*. Centre for Science and Environment.
3. **CSE (Centre for Science and Environment)**. (2021). *Towards Clean and Low-Carbon Mobility: Policy Lessons from Delhi and Beyond*.
4. Davis, N., Joseph, H. R., Raina, G., & Jagannathan, K. (2017). *Congestion costs incurred on Indian roads: A case study for New Delhi*. *arXiv*.
5. **DDA**. (2021). *Draft Master Plan for Delhi – 2041*. Delhi Development Authority.
6. Delhi Development Authority (2021). *Delhi Master Plan 2041 - Draft*.
7. Delhi Development Authority. (2021). *Baseline Report — Enabling Strategic Plan: Master Plan for Delhi 2041 (Draft)*. DDA.
8. **Delhi Transport Department**. (2020). *Delhi Electric Vehicle Policy 2020*.
9. Down To Earth. (2021, July 28). *How Delhi Master Plan 2041 misses the bus in every aspect*.
10. Down To Earth. (2021, June 11). *Delhi draft Master Plan 2041: A heartening fresh approach to mobility*.
11. EPCA (2019). *Reports to the Supreme Court on Air Pollution in Delhi NCR*. Environmental Pollution Control Authority.
12. GIZ (2020). *Sustainable Urban Transport: Avoid-Shift-Improve (A-S-I)*.
13. GIZ (2020). *Sustainable Urban Transport: International Case Studies*.

14. Government of NCT Delhi (2020). *Delhi Electric Vehicle Policy*.
15. Indian Express. (2019, Feb 20). *Making neighbourhoods walkable a priority in Delhi's Master Plan 2041*. *The Indian Express*.
16. ITDP (2020). *The Role of Sustainable Transport in Achieving the SDGs*.
17. ITDP (2020). *The TOD Standard*. Institute for Transportation and Development Policy.
18. Jain, A., Kumar, A., Balodi, S., & Biyani, P. (2019). *Benchmark dataset for timetable optimization of bus routes in the City of New Delhi*. *arXiv*.
19. Jain, D., & Tiwari, G. (2013). *NMT infrastructure in India: Investment, policy and design*. UNEP – Risø DTU.
20. Kaloni, D., Lee, Y. H., & Dev, S. (2022). *Air quality in the New Delhi metropolis under COVID-19 lockdown*. *arXiv*.
21. **Linstone, H. A., & Turoff, M.** (2002). *The Delphi Method: Techniques and Applications*. Reading, MA: Addison-Wesley.
22. **Miles, M. B., & Huberman, A. M.** (1994). *Qualitative Data Analysis: An Expanded Sourcebook* (2nd ed.). Thousand Oaks, CA: Sage Publications.
23. Ministry of Housing and Urban Affairs (2006). *National Urban Transport Policy*.
24. Ministry of Housing and Urban Affairs. (2006). *National Urban Transport Policy*. Government of India.
25. **MoUD.** (2014). *National Urban Transport Policy*. Ministry of Urban Development, Government of India.
26. Nag, D. (2021, June 10). *Master Plan of Delhi 2041: Greener environment, 24-hour city, vibrant economy!*. *The Financial Express*.
27. NDTV / PTI. (2021, June 09). *From strategic corridors to Ring Rail revamp: Delhi's Master Plan of Delhi 2041*. *NDTV*.
28. New Indian Express. (2021, June 10). *Master Plan of Delhi sets target of 'no private vehicles' in capital by 2041*.
29. ORF. (Date Unknown). *The 'Green' in Delhi's draft Master Plan: Weighed and found wanting*. *ORF*.
30. Prakash, P. (2023, March 09). *Key focus areas of the draft Delhi Master Plan 2041*. *The Hindu*.
31. Rajesh, K., & Kumar, S. R. (2025). *Deep reinforcement learning for urban air quality management: Pollution mitigation booth placement*. *arXiv*.
32. Singh, A., & Sharma, V. (2022). *Urban Transport Governance in Indian Cities: Challenges and Opportunities*. *Journal of Urban Affairs*.
33. SLoCaT (2018). *Transport and Climate Change Global Status Report*. Partnership on Sustainable, Low Carbon Transport.
34. Staff Reporter. (2021, June 9). *Green economy and mobility key aspects of draft 2041 master plan*. *The Hindu*.
35. The ORF Team (Aijaz, R.). (2022, Sep 27). *Transport and environment proposals for Delhi*. *ORF – Expert Speak*.

36. The World Bank / IIT Delhi (Replogle, M., Tiwari, G., Mohan, D.). (1998). *Bicycle Master Plan for Delhi*. Transport Department, TRIPP, IIT Delhi.
37. Times of India. (2025, July 22). *Delhi air foulest among serial offenders*. *Times of India*.
38. Times of India. (2025, July). *Commuters struggle amid poor facilities at this ISBT*.
39. Tiwari, G., & Mohan, D. (1997). *Road safety in India: Issues and concerns*. TEC-PRIPP, IIT Delhi.
40. Tota, K. (1999). *The role of non-motorized transport in sustainable urban transport systems: Vikas Marg case study*. TERI / IIT Delhi.
41. **TRIPP, IIT Delhi**. (n.d.). *Transport Research and Injury Prevention Programme*. Retrieved from <https://tripp.iitd.ac.in/>
42. UITP (2018). *Public Transport: The Smart Green Solution*.
43. UITP (2018). *Sustainable Mobility in Practice*.
44. UN (2015). *Transforming our world: The 2030 Agenda for Sustainable Development*. United Nations.
45. UN Department of Economic and Social Affairs (2015). *Transforming our world: the 2030 Agenda for Sustainable Development*.
46. UN DESA (2016). *The World's Cities in 2016*. United Nations Department of Economic and Social Affairs.
47. UNDP (2020). *Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation*. United Nations Development Programme.
48. UNFCCC (2020). *Climate Action Pathway: Transport*. United Nations Framework Convention on Climate Change.
49. United Nations (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*.
50. UTTIPEC. (2009). *Street Design Guidelines*. UT-TIPEC, Government of Delhi.
51. Viswanath, K. (2018). *Women, violence, and the city*. *City & Security*.
52. Viswanath, K., Whitzman, C., & Andrew, C. (2014). *Partnerships for Women's Safety in the City*. *Environment and Urbanisation*, 26(2).
53. Wiswanath, K. (2007). *Shall we go out? Women's safety in public spaces in Delhi*. *Economic & Political Weekly*.
54. World Bank (2018). *Sustainable Urban Transport Planning*.