ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume X-5/W2-2025
Unleashing the power of Geospatial & Frontier Technologies for a Sustainable Future – GIFTS Summit 2025,
1–3 September 2025, Symbiosis International University, Pune, India

Spatial Data Infrastructure for Sustainable Development: Evaluating PM Gati Shakti as India's Geospatial Framework

Piyush Shah [a], Jenish Patel [b], Janki Adhvaryu [c], Jay Prajapati [d]

[a] Senior GIS Expert and Team lead PM Gati Shakti Gujarat Project, CEPT Research and Development Foundation, CEPT University, Ahmedabad, India
piyushsh18@gmail.com
[b] Project Associate PM Gati Shakti Gujarat Project, CEPT Research and Development Foundation, CEPT University, Ahmedabad, India
jenishvpatel@gmail.com
[c] Project Associate PM Gati Shakti Gujarat Project, CEPT Research and Development Foundation, CEPT University, Ahmedabad, India
21ptphde245@nirmauni.ac.in
[d] Project Associate PM Gati Shakti Gujarat Project, CEPT Research and Development Foundation, CEPT University, Ahmedabad, India
prajapatidjay@gmail.com

Keywords: Spatial Data Infrastructure; PM Gati Shakti; Sustainable Development; Geospatial Framework; GIS; India.

Abstract

Spatial data infrastructures (SDIs) play a crucial role in sustainable development as they integrate diverse geospatial datasets, policies, and technologies to support evidence-based decision-making. This paper evaluates India's PM Gati Shakti National Master Plan as a nascent SDI. Using official documents, literature on SDIs, and case studies, the study examines the platform's design against SDI components—data/metadata, standards, technological architecture, policy, and users. It analyses strengths such as overall data integration, cross-ministerial coordination, and real-time analysis; identifies gaps in open data policies and interoperability, metadata catalogues; and provides measures of improvements in data governance, quality assurance, and state-level logistics integration. The findings of the research suggest that PM Gati Shakti has the potential to become a robust SDI underpinning sustainable and inclusive growth when coupled with open standards, transparent policies, and capacity building.

1. Introduction

Geospatial information is crucial for effective planning, monitoring, and achieving the Sustainable Development Goals (SDGs). At the heart of this is the concept of a Spatial Data Infrastructure (SDI), which can be thought of as a structured system of geospatial data, metadata, users, and tools designed to make working with spatial information easier and more adaptable. An SDI comprises the key elements of institutional arrangements, standards, technologies, and policies that enable people to find, access, combine, and analyse geographic data efficiently. These systems are vital because they help governments and communities make smarter decisions about land use, infrastructure, environmental management, and social services, all of which are essential for sustainable growth. Essentially, an SDI acts as the backbone for collaborative planning and oversight, bringing together diverse geographic datasets and promoting interoperability through standards like the Open Geospatial Consortium's (OGC) Catalogue Service for the Web (CSW).

India's rapid urban growth and increasing infrastructure demands have highlighted the urgent need for coordinated evidence-based planning. In the past, different departments and ministries operated independently, often leading to inefficiencies, delays in approval processes, and duplicated efforts. To address these challenges, the Indian government launched the PM Gati Shakti National Master Plan (PMGS-NMP) in October 2021—a digital platform aimed at integrating multi-modal connectivity and infrastructure planning across various ministries and states. The goal of this initiative is to speed up project execution, reduce logistical costs, and improve last-mile connectivity. This study explores how PM Gati Shakti can serve as a national spatial data infrastructure, supporting India's broader pursuit of sustainable development.

2. Methodology

The research adopts a descriptive and analytical approach. Official government sources (Press Information Bureau, India's National Portal, and PMGatiShakti.gov.in) and secondary literature were the primary sources of information on PM Gati Shakti. Using peer-reviewed literature, the SDI concept was placed in perspective. The design and operations of PM Gati Shakti were evaluated in relation to the SDI's technological architecture, data/metadata, policy/institutional framework, interoperability standards, and user interaction components. By examining case studies of sectoral projects published by government sources, we also evaluated the platform's assistance for sustainable development. Strengths, weaknesses, and suggestions are highlighted in the analysis.

3. Spatial Data Infrastructure Concepts and Their Importance

A Spatial Data Infrastructure (SDI) acts as a vital system for sharing, updating, and finding geospatial information. It brings together several key components that work together to enable informed decision-making for sustainable development.

The Key elements include:

- **Data and Metadata:** This involves gathering comprehensive spatial datasets such as topographic maps, socio-economic information, and environmental data, and

accompanying metadata that describe the content, accuracy, and temporal and spatial coverage. Metadata catalogues are essential tools for locating and understanding data.
- **Standards and Interoperability**: Adopting international standards like ISO 19115, OGC CSW, WMS, and WFS ensures that different datasets and online services can work seamlessly together, making data integration easier.
- **Technological Infrastructure:** The backbone of an SDI is a distributed setup of servers, databases, processing tools, and web-based platforms that deliver data and analytical services to users.
- **Institutional and Policy Framework:** Clear governance structures, laws, and agreements promote data sharing, safeguard privacy, and ensure coordination among various stakeholders.
- **Users and Capacity Building:** Engaging government agencies, private companies, academia, and citizens—along with training programs—helps build skills and increase understanding of geospatial technologies.

By integrating these parts, an SDI enables evidence-based decisions in areas like environmental monitoring, infrastructure development, disaster management, and tracking progress toward SDG indicators.

4. Overview of PM Gati Shakti National Master Plan

4.1 Genesis and Objectives

On October 13, 2021, the PM Gati Shakti National Master Plan was introduced to give economic zones multimodal connectivity infrastructure. On October 21, 2021, the Cabinet Committee on Economic Affairs gave its approval for implementation. To manage infrastructure connectivity projects, the strategy aims to combine 16 Ministries, including Roadways and Railways. To improve last-mile connectivity and cut down on travel time, it seeks to facilitate the smooth movement of people, commodities, and services between modes.

4.2 Digital Platform and Data Layers

The National Master Plan (NMP) is a comprehensive digital tool developed by BISAG-N (Bhaskaracharya National Institute for Space Applications and Geo-informatics) using an open-source GIS platform. It leverages a vast geospatial database stored in the Government of India's cloud system, MEGHRAJ, to dynamically map infrastructure projects and provide real-time updates. The NMP incorporates over 1,600 data layers and involves the participation of 36 States and Union Territories, along with 44 Central Ministries. Standard Operating Procedures (SOPs) for data updates have been finalized for fifteen social-sector ministries and eight infrastructure ministries to ensure data accuracy and consistency. Key infrastructure projects like Bharatmala, Sagarmala, inland waterways, dry ports, and UDAN are visualized on the platform, making it a powerful tool for planning, monitoring, and decision-making.

4.3 Pillars and Features

PM Gati Shakti rests on six pillars:
- **Comprehensiveness** – Integrates all existing and planned infrastructure initiatives into a central portal, enabling each ministry to have visibility of others' activities.
- **Prioritisation** – Enables departments to prioritise projects through cross-sectoral interactions.
- **Optimisation** – Assists ministries in planning modification or expansion of projects after identifying critical gaps; helps select optimal routes for goods based on time and cost.
- **Synchronisation** – Provides coordination across departments and layers of government, addressing delays due to ministries working in silos.
- **Analytical** – Offers GIS-based spatial planning and analytical tools with 1600+ data layers, giving executing agencies better visibility.
- **Dynamic**– Allows ministries to visualise, review, and monitor cross-sectoral projects; satellite imagery updates on-ground progress periodically, and enables interventions for updating the master plan.

A monitoring group under the Department for Promotion of Industry and Internal Trade (DPIIT) oversees project progress, ensures resolution of key issues, and reports to the Prime Minister's Office.

4.4 Seven Engines of Growth

The Master Plan's seven engines—roads, ports, waterways, airports, mass transit, railroads, and logistics infrastructure—all work together to promote sustainable development and economic progress. The engines are supported by clean energy and "Sabka Prayas," which are joint initiatives of the federal, state, and commercial sectors. With an emphasis on multimodal connectivity and logistics efficiency, the plan's scope includes both state-developed and National Infrastructure Pipeline infrastructure projects.

5. Evaluation of PM Gati Shakti as a Spatial Data Infrastructure

5.1 Data Integration and Metadata

The effort to gather and integrate 1,614 data layers from various states and central ministries highlights a comprehensive approach to data collection. This extensive dataset covers a wide range of infrastructure plans, including ports, canals, highways, railroads, and airports, ensuring a broad and detailed view of the country's development initiatives.

Metadata and catalogue services are vital components of a robust Spatial Data Infrastructure (SDI). Currently, multiple ministries can upload geospatial data following established SOPs through the PM Gati Shakti portal. However, there is limited publicly available documentation on the catalogue services and metadata standards in use. To fully align with SDI best practices, the portal should incorporate OGC-compliant catalogue services, such as CSW (Catalogue Service for the Web). This would enable external stakeholders—researchers, planners, and developers—to discover, access, and reuse geospatial content more effectively, fostering greater collaboration and transparency.

5.2 Technological Architecture and Interoperability

The platform developed by BISAG-N is built using open-source GIS technologies and hosted on the Government's cloud infrastructure, which provides both scalability and security. With access to over 1,600 geospatial layers and a suite of analytical tools, it supports complex tasks like route planning and identifying infrastructure gaps. Its real-time satellite imagery updates and interactive dashboards exemplify SDI

principles, offering up-to-date information and an intuitive user experience.
Interoperability across different government ministries has been facilitated through shared standard operating procedures (SOPs) and a unified portal. However, to maximize collaboration beyond government, especially with private sector players and academic institutions, external interoperability needs further assessment. Implementing open standards such as WMS (Web Map Service), WFS (Web Feature Service), and CSW (Catalogue Service for the Web) would significantly improve the platform's ability to share and integrate geospatial services with third-party applications, fostering broader access and innovative uses of the data.

5.3 Institutional and Policy Framework

PM Gati Shakti brings together 36 states and Union Territories along with 44 central ministries, creating a framework that institutionalizes coordination across different levels of government. The system is supported by standard operating procedures (SOPs) and dedicated monitoring groups, which promote regular data updates and ensure the quality of information. The governance model emphasizes cooperative federalism and a whole-of-government approach, reflecting a commitment to integrated planning.

However, key components of a robust SDI, such as policies on data exchange, privacy, and access, are not yet publicly accessible. Establishing transparent regulations that balance open data principles with the need to protect sensitive information is vital for building a sustainable and trustworthy SDI. Additionally, the upcoming District Master Plan portal, currently in beta with 28 pilot districts, demonstrates a strategic move towards vertical integration, aiming to extend district-level planning and data sharing, further strengthening the infrastructure for decentralized, localized development planning.

5.4 User Engagement and Capacity Building

Active user engagement and capacity-building are essential for the success of any SDI, and the PM Gati Shakti platform demonstrates this through widespread adoption across various sectors. District authorities receive training and participate in capacity-building sessions, which help them effectively utilize the platform for planning and decision-making.

Numerous ministries are leveraging the platform to accomplish significant infrastructure and development projects. For example, the Ministry of Road Transport and Highways has used it to plan nearly 8,900 km of roads, while the Ministry of Railways has mapped over 27,000 km of rail lines and accelerated the Final Location Surveys. The Ministry of Petroleum and Natural Gas employed electronic Detail Route Survey (eDRS) technology, reducing survey reporting time from several months to just one day—a remarkable increase in efficiency.

Beyond transportation, the platform supports a wide array of applications such as mapping health facilities, identifying school locations, planning coastal corridors, devising disaster management strategies, and designing renewable energy corridors. These diverse use cases illustrate how government agencies and ministries are actively utilizing the platform to improve productivity, optimize resource allocation, and enable data-driven approaches to development and disaster preparedness.

5.5 Alignment with Sustainable Development Goals

PM Gati Shakti's integrated approach to infrastructure planning and monitoring plays a vital role in advancing multiple Sustainable Development Goals (SDGs).

- **SDG 9 (Industry, Innovation, and Infrastructure):** The platform enhances planning and oversight of transport and logistics networks, reducing bottlenecks and improving regional and national connectivity, which is fundamental for industrial growth.
- **SDG 7 (Affordable and Clean Energy):** By optimizing the 13 GW renewable energy corridor from Ladakh to Haryana, geospatial planning supports clean energy transmission, minimizes environmental impacts, and promotes sustainable energy access.
- **SDG 11 (Sustainable Cities and Communities):** Tools for designing roads, ports, airports, and the district-level portal facilitate life-enhancing urban and rural development, fostering resilient and sustainable communities.
- **SDG 13 (Climate Action) & SDG 15 (Life on Land):** Disaster management strategies in Goa and forest mapping assist in building resilience against climate impacts and conserving biodiversity.
- **SDG 4 (Quality Education) & SDG 3 (Good Health):** Spatial data-driven identification of locations for schools and healthcare facilities ensures equitable access to essential services across different regions.

By offering a unified, evidence-based geospatial platform, PM Gati Shakti supports cross-sectoral decision-making aligned with sustainable development. However, to truly realize its potential, continual efforts are necessary to promote community participation, ensure transparency, and enforce environmental safeguards. Regular monitoring of these aspects will be crucial to maintain the platform's contribution towards sustainable and inclusive growth.

5.6 Data Governance, Input Protocols, and Quality Assurance

Ensuring the reliability of a Spatial Data Infrastructure (SDI) like the PM-Gati Shakti Gujarat (PM-GSG) portal depends heavily on strong governance frameworks and comprehensive quality assurance measures. In the case of PM-GSG, data-sharing protocols are designed to enable transparent visibility across departments—each can view all data layers but only edit their own—fostering collaboration while maintaining control. The data exchange between the central PM-National Master Plan (NMP) portal and the state portal facilitates seamless information sharing at both levels.

To maintain consistency and interoperability, spatial datasets are uploaded in standardized formats such as KML, KMZ, GeoJSON, or Shapefile. Each upload should include attribute fields and metadata that conform to OGC and ISO 19115 standards. The use of reference layers and standard attribute schemas ensures that data from different agencies aligns both spatially and semantically. Real-time integration is facilitated by Web Map Service (WMS), Web Feature Service (WFS), and Transactional Web Feature Service (WFS-T) connections, enabling live synchronization between central and state-level portals. Looking ahead, the platform can adopt APIs to enable seamless machine-to-machine data exchange. Automated

validation scripts could verify spatial integrity, attribute completeness, and coordinate reference systems before uploads are accepted, thereby reducing human error and improving data fidelity.

On the quality assurance front, independent third-party testing is vital. These evaluations should cover aspects such as cross-browser compatibility, system performance under heavy loads, security robustness, functional correctness, usability, and user interface interactions. They help ensure that portals operate reliably across different devices and environments, validate that user authentication mechanisms protect data security, and confirm that applications can handle anticipated user demand without failure.

Implementing systematic testing and certification processes builds stakeholder trust, reduces technical issues, and minimizes downtime. When combined with sound governance policies and rigorous quality checks, these measures reinforce the SDI's foundation—promoting data integrity, fostering stakeholder participation, and ensuring sustainable, reliable operation of the platform.

Finally, investing in capacity building is crucial. Regular training for government GIS officers, field engineers, and data entry personnel on data validation workflows, metadata entry, and spatial analytics will sustain the SDI over the long term. This ongoing development helps maintain high standards of data governance and ensures a skilled workforce capable of sustaining the system.

5.7 Integration with State Logistic Plans

The vision of PM Gati Shakti to integrate state-level logistics planning with the broader national SDI is ambitious and vital for coordinated development. The evaluation of Gujarat's State Logistics Master Plan webpage offers valuable insights into best practices and areas for improvement to ensure successful expansion and user adoption.

Key lessons include:

- **User Experience Enhancements:** Error pages should be designed to guide users effectively, providing clear instructions or links for next steps instead of displaying generic error messages ("white label" problems). Similarly, registration processes should clearly indicate completion, with helpful messaging to confirm successful registration and ease subsequent interactions.
- **Multi-Scale Data Alignment:** To facilitate detailed supply chain analysis, bottleneck identification, and targeted infrastructure investments, state-specific data layers—such as port capacities, road networks, warehousing facilities, and industrial clusters—must be aligned with the national portal. Consistent data standards and visualization practices are crucial for seamless integration across scales.
- **Design Philosophy:** User-centered design principles and consistent branding across platforms are essential when extending the SDI across different administrative levels. This consistency improves usability, reduces user confusion, and encourages adoption by making the experience intuitive across all states.

Overall, these lessons highlight that a focus on clarity, branding, and data alignment not only enhances user engagement but also strengthens the coherence of the entire SDI ecosystem. Such practices are fundamental for enabling effective multi-level logistics coordination, reducing bottlenecks, and fostering tailored infrastructure investments that meet local needs within the national framework.

6. Discussion

6.1 Strengths

Comprehensive Data Integration: The integration of 1,614 data layers covering infrastructure schemes across ministries and states demonstrates the platform's breadth. The presence of 1600+ geospatial layers and analytic tools provides a rich context for planning and monitoring.

Institutional Coordination: Bringing 44 ministries and 36 states/UTs into a common framework reduces duplication and facilitates harmonised project execution. SOPs for data updates institutionalise data stewardship.

Technological Innovation: Use of open-source GIS, dynamic mapping, real-time satellite imagery, and cloud hosting aligns with modern SDI architectures. Monitoring dashboards and analytics support evidence-based decision-making.

- **Sectoral Impact:** Documented improvements—such as faster route surveys, accelerated rail surveys, optimised renewable energy corridors, and disaster management planning—highlight real-world benefits.
- **Scalability:** The upcoming District Master Plan portal broadens the SDI to local governance, enabling bottom-up planning.

6.2 Challenges and Gaps

Metadata and Catalogue Services: Public documentation of metadata standards, catalogue services, and data quality protocols is lacking. An SDI should provide discoverable metadata and adopt OGC catalogue standards (CSW) to enable third-party search and reuse.

- **Open Data and Accessibility:** The platform appears primarily for government users. For broader sustainable development benefits, certain datasets (e.g., aggregated infrastructure layers) could be made openly accessible with appropriate licensing, fostering research, innovation, and public participation.
- **Interoperability with External Systems:** Integration with the private sector, academia, and civil society systems is not explicitly described. Adoption of open standards (WMS, WFS, WMTS, WPS) would allow data and services to be consumed by multiple clients, enhancing interoperability.
- **Policy and Legal Framework:** Transparent policies on data sharing, privacy, security, and liability are essential. Without clear legal frameworks, ministries may hesitate to share sensitive data, and citizens may be concerned about data use.
- **Capacity and Digital Divide:** While training programmes exist, varying capacities across states and districts could affect uniform adoption. Continued investment in capacity building is needed to ensure that local governments can effectively use geospatial tools.

6.3 Comparison with International SDIs

Many leading countries have established comprehensive frameworks emphasizing open standards, legal clarity, and transparent access to metadata catalogues. For example, the

United States' National Spatial Data Infrastructure (NSDI) and Europe's INSPIRE Directive serve as benchmarks for fostering interoperability, data sharing, and international collaboration in geospatial data management.

Currently, PM Gati Shakti aligns with these goals of integration and interoperability but does not explicitly adhere to these international standards. By adopting open standards such as OGC standards (e.g., WMS, WFS, CSW), ISO geospatial data standards, and metadata schemas like ISO 19115, India can significantly reinforce its position within the global geospatial community.

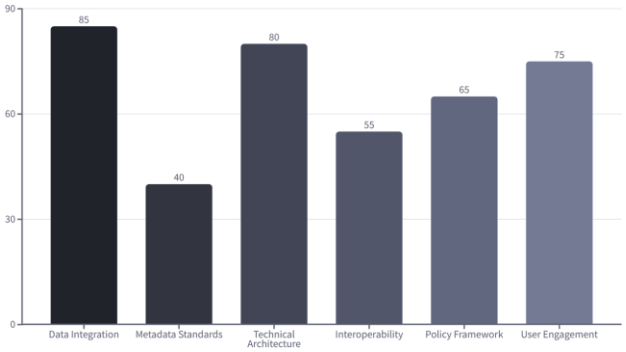

Figure 1. PM Gati Shakti Evaluation as a Spatial Data Infrastructure

Aligning with international standards would:

- **Enhance Data Sharing:** Facilitate seamless cross-border data exchange, enabling India to collaborate more effectively with neighbouring countries and global partners.
- **Improve Data Quality & Interoperability:** Ensure that data from different sources can be easily combined, analysed, and visualized without compatibility issues.
- **Strengthen Credibility & Transparency:** Demonstrate commitment to international best practices, encouraging trust among stakeholders, including foreign governments, international organizations, and the private sector.
- **Support Innovation & Research:** Enable integration with global geospatial tools and platforms, fostering innovation and supporting multinational projects.

In summary, embracing these standards would not only elevate India's SDI to align with global best practices but also open new avenues for international cooperation, scientific research, and technological advancement in geospatial data management.

7. Conclusions and Recommendations

PM Gati Shakti represents a significant step toward establishing a national spatial data infrastructure in India. It integrates infrastructure data across ministries and states, provides analytic tools with over 200 geospatial layers, and has already demonstrated benefits such as faster surveys and optimised project planning. By aligning infrastructure development with sustainable development goals, the platform has the potential to drive inclusive and sustainable economic growth.

However, to fully realise the vision of a comprehensive SDI, the following recommendations are proposed:

- **Implement OGC-compliant Metadata Catalogues:** Adopt CSW and related standards to make metadata discoverable and accessible to stakeholders outside government.
- **Publish Open Data Policies:** Define clear policies for data sharing, privacy, and licensing. Release non-sensitive datasets openly to stimulate innovation and research.
- **Enhance Interoperability:** Provide services through open standards (WMS, WFS, WPS) to enable integration with other geospatial platforms and applications.
- **Strengthen Capacity Building:** Continue and expand training programmes for state and district officials. Develop user manuals, tutorials, and e-learning modules.
- **Engage Stakeholders:** Involve academia, the private sector, and civil society in platform governance and data contribution. Establish feedback mechanisms to improve data quality and functionality.
- **Monitor Sustainable Development Outcomes:** Integrate indicators that measure how infrastructure projects contribute to SDGs (e.g., reductions in travel time, emissions, improvements in access to services) and publish regular reports.

In the future, the PM Gati Shakti platform is envisioned to be open for private enterprises, corporate users, researchers, NGOs, and academician, enabling them to plan their infrastructure projects while referencing existing government assets. This inclusive accessibility will foster collaborative planning, promote innovation, and enhance transparency. The adoption of standardized SDI frameworks and interoperable data protocols will ensure that information is published and disseminated efficiently and securely supporting a truly participatory and data-driven development ecosystem.

However, realizing its full potential as a national geospatial backbone requires sustained focus on inclusivity, openness, and innovation. The following expanded recommendations outline a pathway for strengthening PM Gati Shakti's role in India's sustainable development journey:

- **Strengthen Data Governance and Open Standards**
    - Institutionalize data governance frameworks defining ownership, stewardship, and accountability for each data layer.
    - Mandate interoperability by adhering to open standards such as OGC (WMS, WFS, WPS, CSW) and ISO (19115, 19157) to ensure high data quality and robust metadata.
    - Create a National Metadata Catalogue that researchers, state departments, and the public can access for discovery and reuse
- **Promote Transparency and Open Data Policies**
    - Implement tiered access policies: (a) fully open datasets, (b) data available for government use with restrictions, and (c) sensitive data under confidentiality.
    - Establish clear data licensing and privacy guidelines, drawing on frameworks like the India Data Accessibility & Use Policy (2022).
    - Encourage the publication of non-sensitive, aggregated infrastructure data to spur innovation, research, and entrepreneurship.
- **Foster Private Sector Participation**

  Private technology firms, and analytics startups can play a pivotal role in extending the platform's analytical and service capabilities.
    - Create Public–Private Innovation Sandboxes that allow companies to test geospatial tools using non-sensitive datasets.

  - Invite private partners for AI/ML-based analytics, such as predictive logistics modeling or urban traffic optimization.
  - Introduce open APIs and developer guidelines to enable integration of private applications with the Gati Shakti SDI ecosystem.
- **Empower Researchers and Academia**
  Academic institutions can act as catalysts in data innovation, capacity building, and policy evaluation.
  - Provide academic access nodes to universities and research institutes for conducting independent assessments and case studies.
  - Encourage joint R&D programs with IITs, NIUA, ISRO, and BISAG-N to develop new spatial models for sustainability, climate resilience, and disaster risk reduction.
  - Develop a research fellowship program focused on applied geospatial analytics using PM Gati Shakti datasets to promote student-led innovation.
- **Engage NGOs and Civil Society**
  Civil society organizations and NGOs can contribute valuable community-level data and ensure inclusive planning
  - Establish a community mapping initiative to integrate local observations, particularly for social infrastructure, environmental monitoring, and disaster-prone regions.
  - Encourage NGOs to use the platform for monitoring SDG-linked indicators such as access to healthcare, education, or clean water.
  - Build participatory dashboards for tracking grassroots development outcomes, reinforcing transparency and citizen trust.
- **Build Capacity for Students and Young Professionals**
  - Introduce PM Gati Shakti Student Innovation Challenges in collaboration with BISAG-N and universities to engage youth in solving real-world spatial problems.
  - Develop e-learning modules, certification programs, and internships that teach geospatial data management, open standards, and SDI design principles.
  - Promote open-source collaboration by encouraging contributions to public geospatial repositories aligned with PM Gati Shakti.
- **Monitor and Report Sustainable Development Outcomes**
  - Integrate SDG-linked performance indicators into the platform to measure infrastructure outcomes in terms of reduced travel time, improved accessibility, and emissions reduction.
  - Publish annual State of Geospatial Infrastructure Reports, evaluating contributions of the SDI to economic, social, and environmental dimensions of development.

PM Gati Shakti stands as a cornerstone of India's transition toward evidence-based, sustainable infrastructure governance. By integrating open data principles, private innovation, academic research, and community participation, it can evolve from a government platform into a national geospatial ecosystem.

A mature SDI built on collaboration, interoperability, and inclusivity will not only strengthen India's internal planning mechanisms but also align the country with global geospatial standards—positioning India as a leader in spatial governance for sustainable development.

By addressing these areas, PM Gati Shakti can evolve into a full-fledged national spatial data infrastructure that not only accelerates infrastructure development but also underpins sustainable and inclusive growth across India. In addition, adopting the data governance protocols and quality assurance frameworks described in Section 5.6 will strengthen data integrity and reliability, while user-centric design and consistent branding—highlighted in the State Logistics Master Plan review—will enhance usability. Collectively, these measures will help PM Gati Shakti realise its vision of a comprehensive, interoperable, and sustainable geospatial framework for India.

Acknowledgements

The author(s) acknowledge the Government of India's Department for Promotion of Industry and Internal Trade (DPIIT), Press Information Bureau, and the National Portal of India for providing publicly available information used in this study. Additional thanks to the scientific community for advancing the concepts of spatial data infrastructure.

References

Corti, P., Kralidis, A.T., & Lewis, B. (2018). Enhancing discovery in spatial data infrastructures using a search engine.

PeerJ Computer Science, 4, e152. https://doi.org/10.7717/peerj-cs.152. (Definition of SDI and discussion of CSW standards used throughout).

Department for Promotion of Industry and Internal Trade (DPIIT). (2024). PM Gati Shakti: Transforming India's Infrastructure and Connectivity. Press Information Bureau (12 October 2024). Available at https://static.pib.gov.in. (Provides details on the digital platform, data layers, ministry participation, and achievements).

India.gov.in. (2024). PM Gati Shakti – National Master Plan for Multi-modal Connectivity. National Portal of India. Retrieved April 5, 2024. (Describes the pillars of PM Gati Shakti and highlights the analytical and dynamic features with 200+ geospatial layers).

Lukmaan IAS. (2024). PM Gati Shakti – National Master Plan for Multi-modal Connectivity. Blog article (accessed 30 July 2025). (Explains the six pillars of PM Gati Shakti and monitoring arrangements).

PMGatiShakti.gov.in. (2025). About PM Gati Shakti. Government of India. (Provides the origin, objectives, and engines of PM Gati Shakti and describes the digital master planning platform developed by BISAG-N).

Ministry of Electronics & Information Technology. (2022, February). Draft India Data Accessibility & Use Policy 2022 [Policy document]. Government of India. Retrieved from https://www.meity.gov.in/content/draft-india-data-accessibility-and-use-policy-2022.

Government of India, Ministry of Science & Technology. (2022, December 28). National Geospatial Policy, 2022 [Policy document]. Government of India. Retrieved from https://www.dst.gov.in/geospatial.