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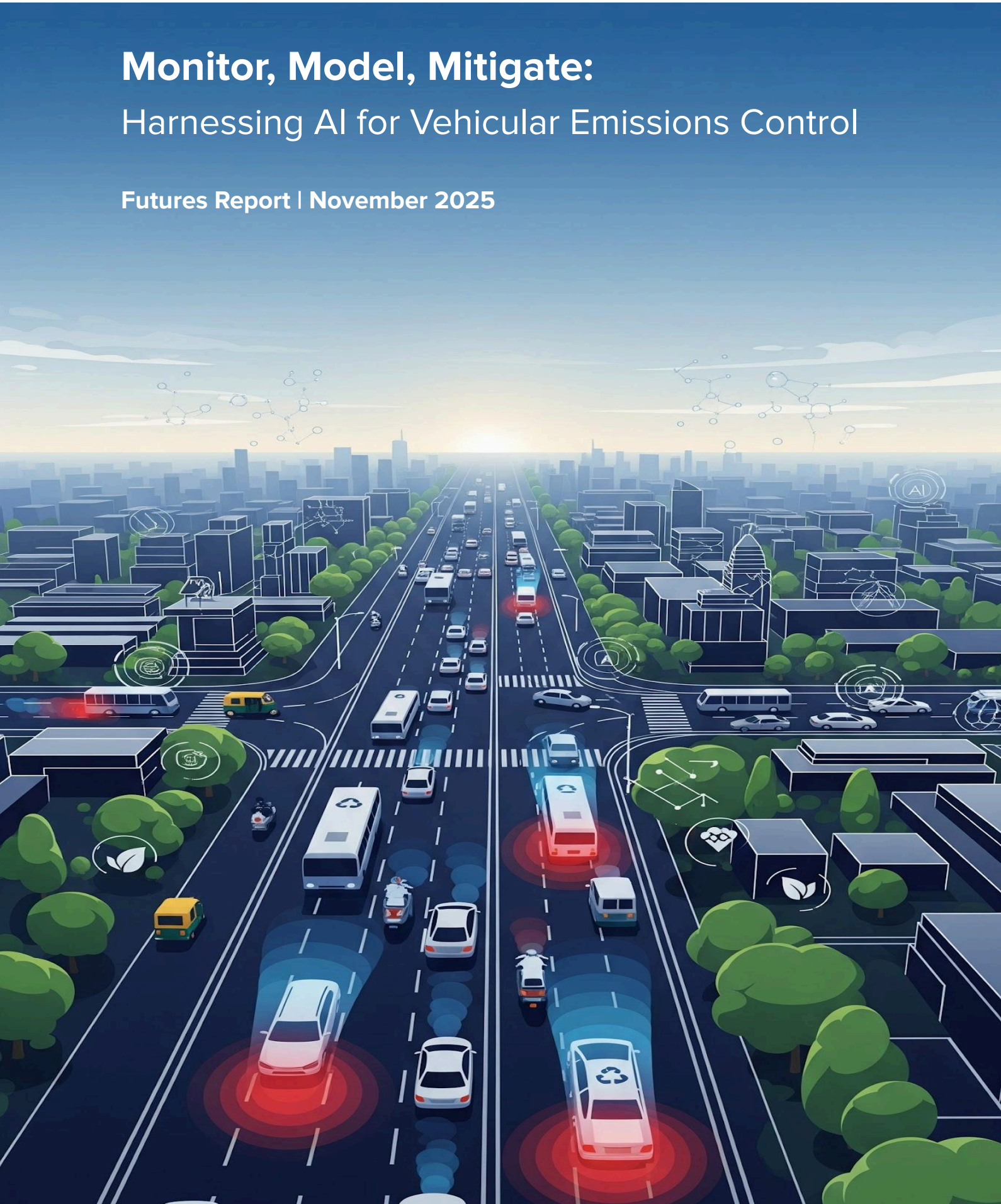
Monitor, Model, Mitigate:

Harnessing AI for Vehicular Emissions Control

Futures Report | November 2025



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November 2025

A Futures Report by

DataCorp Traffic

In Partnership with

ITS India Forum & OMI Foundation Trust

President's Message

Akhilesh Srivastava
President,
ITS India Forum

India is entering an era where intelligence, not just infrastructure, will define environmental governance. ***Monitor, Model, Mitigate: Harnessing AI for Vehicular Emissions Control*** is a timely contribution that illustrates how Artificial Intelligence can transform one of our most pressing urban challenges, i.e. air pollution, into an opportunity for innovation and systemic reform.

Vehicular emissions remain a dominant source of Delhi's deteriorating air quality. This report demonstrates how **AI-powered thermal and infrared monitoring, integrated with VAHAN and PUC databases**, can **detect high-emission vehicles in real time**, **predict pollution hotspots**, and **trigger targeted enforcement**. The findings from the **Kherki Daula Toll Plaza pilot** are particularly noteworthy, showing over 90% alignment between AI-predicted and actual emission readings, confirming the potential of non-intrusive, real-time monitoring to strengthen compliance and accountability.

Equally important are the report's forward-looking recommendations: the creation of **AI-enabled Low Emission Zones (LEZs)**, a **National Clean Air Intelligence Network**, and the **integration of predictive analytics into fleet modernization** and **regulatory frameworks**. Together, these interventions can shift India from reactive pollution control to predictive, evidence-based governance.

The **ITS India Forum** is proud to have co-authored this pioneering work with **DataCorp** and **OMI Foundation**. It exemplifies the kind of collaboration India now needs - where technology, policy, and data converge to serve public purpose. The insights here reaffirm a central truth: intelligent systems can save lives, improve health, and restore our cities' air quality.

As India advances toward its goals of sustainable, AI-driven urban development, this report offers both a roadmap and a call to action. We hope it inspires policymakers, technologists, and citizens alike to imagine and build a future where **every breath in our cities is clean, safe, and intelligently protected**.

Foreword

Dr R.S.Sharma IAS (Retd.)
Former Chairman,
TRAI
Govt. of India

Air pollution and climate change represent intertwined challenges that require coordinated, technology-enabled, and evidence-based responses. As urban centres continue to expand and mobility demands rise, the urgency to deploy reliable, scalable, and citizen-centric solutions grounded in data integrity and real-time intelligence has never been greater.

The transport sector is central to this effort. Vehicular emissions form a substantial component of urban pollution, and traditional approaches to monitoring and compliance are increasingly inadequate in addressing the scale and speed of today's environmental imperatives. Harnessing Artificial Intelligence alongside robust digital public infrastructure offers an opportunity to shift towards proactive, predictive, and transparent emissions management.

This report, ***Monitor. Model. Mitigate: Harnessing AI for Vehicular Emissions Control*****,** underscores the importance of integrating AI with trusted data frameworks, secure communication networks, and interoperable digital platforms. The findings validate how AI-enabled governance can improve monitoring accuracy, streamline enforcement, and enhance public accountability while reducing manual burden and operational inefficiencies.

A digitally empowered emissions ecosystem characterised by secure data exchange, interoperable registries, and ethical AI protocols can significantly strengthen national climate objectives while advancing citizen welfare. Such models also reinforce the strategic role of telecom and digital infrastructure in enabling smart, resilient, and environmentally responsible urban systems.

The lessons outlined here extend beyond transport management and can inform broader national efforts to build future-ready regulatory frameworks that prioritise transparency, innovation, and public trust. I commend ITS India Forum and OMI Foundation for advancing this important agenda. Their work offers actionable insights for regulators, policymakers, and industry stakeholders committed to fostering a cleaner, smarter, and digitally empowered future for India.

Foreword

Shri Giridhar Aramane, IAS (Retd.)
Former Secretary, Defence and Ministry of Road Transport and Highways.
Govt. of India

India's transport sector stands at a pivotal juncture. Rapid motorisation, expanding road networks, and shifting mobility patterns have unlocked new opportunities for economic growth and connectivity. At the same time, they have reinforced the need to steer this growth in a direction that safeguards public health, enhances road safety, preserves environmental quality, and strengthens governance. Over the past years, the Government has undertaken significant steps to upgrade regulatory mechanisms, elevate vehicle and fuel standards, modernise enforcement, and mainstream sustainable mobility solutions, thereby laying the foundation for a resilient, future-ready transport ecosystem.

Among the critical challenges ahead is the effective reduction of vehicular emissions, particularly in dense urban corridors. Conventional compliance mechanisms, while foundational, are increasingly constrained by scale and complexity. The path forward lies in institutionalising technology-enabled, data-driven, and real-time monitoring and enforcement systems that enable evidence-based policymaking, streamline compliance, and bring greater efficiency and transparency into transport governance.

This report, *Monitor. Model. Mitigate: Harnessing AI for Vehicular Emissions Control*, underscores the role of Artificial Intelligence in strengthening emissions governance. The pilot results demonstrate how AI can accurately identify high-emission vehicles, support enforcement workflows, and reduce manual inefficiencies, offering a scalable model for future adoption.

As India progresses towards integrated, intelligent, and citizen-centric mobility systems, AI-enabled platforms can serve as a valuable complement to digital transport initiatives, data harmonisation efforts, and inter-agency coordination mechanisms. By embracing innovation and institutional collaboration, India can accelerate the transition to cleaner, healthier, and more sustainable mobility.

I commend the team for contributing to this important discourse and presenting actionable insights that support the nation's continuing efforts to build a cleaner, safer, and technology-enabled transport future.

Foreword

Shri Rohit Kumar Singh IAS (Retd.)
Former Secretary, Ministry of Consumer Affairs; and Member, National Consumer Dispute Redressal Commission Govt. of India

Consumer-centricity lies at the core of India's governance vision. As mobility systems evolve and digital interfaces increasingly mediate public services, ensuring that citizens receive safe, clean, reliable, and fair transport services becomes both a public priority and a consumer right. Vehicular emissions directly impact the health, welfare, and everyday experience of citizens, making clean mobility an essential consumer protection imperative as much as an environmental necessity.

Delhi has taken significant strides in advancing a cleaner, more efficient mobility ecosystem through initiatives such as the Electric Vehicle Policy, modernisation of public transport, and strengthened compliance frameworks. The next phase of progress must focus on enabling transparent, technology-based systems that build public trust, enhance service quality, and protect consumer interest without imposing additional burden on commuters or service providers.

This report, ***Monitor. Model. Mitigate: Harnessing AI for Vehicular Emissions Control***, presents a compelling blueprint for how Artificial Intelligence can support timely detection of high-emission vehicles, improve monitoring accuracy, and ensure fair, consistent, and data-driven enforcement. Its findings underscore the role of digital infrastructure, interoperable data platforms, and intelligent decision systems in creating governance mechanisms that are responsive, efficient, and citizen-first.

For Delhi and for India the path ahead lies in combining technological innovation with strong consumer safeguards, ethical data use, and clear accountability frameworks. When aligned with consumer protection principles, AI-enabled systems can strengthen grievance-free public service delivery, foster transparency, and improve the daily lives of millions of road users.

I commend the team for advancing this important work. I am confident that the insights in this report will encourage greater collaboration across departments and help accelerate the development of a cleaner, healthier, and more consumer-centric mobility ecosystem for our citizens.

Foreword

Ambassador (Retd.) Gautam Bambawale
Managing Trustee,
OMI Foundation

Harish Abichandani
First Trustee,
OMI Foundation

The air we breathe tells the story of our cities - of how we grow, how we move, and how we care for the spaces we share. For too long, this story has been clouded by smog and silence. Yet in every crisis lies a chance to reimagine, to act differently, and to build better.

Monitor, Model, Mitigate: Harnessing AI for Vehicular Emissions Control is born out of that conviction. It reflects a belief that technology, when guided by purpose, can renew trust in governance and empower citizens with intelligence that serves the common good. Artificial Intelligence is not merely a tool for efficiency; it is an instrument for empathy, foresight, and collective responsibility.

The **promise of AI** lies not just in its computational power, but in its ability to **make governance** more **anticipatory**, **transparent**, and **humane**. As this report shows, intelligent systems can help cities sense risk before it becomes harmful, by detecting patterns invisible to the human eye, coordinating responses across agencies, and strengthening public institutions with real-time knowledge. If deployed thoughtfully, **AI can shift our environmental response** from reactive control **to predictive care**, transforming how India manages its most basic natural asset: the air we share.

This report embodies the **spirit of collaboration between public and private innovation**. It brings together the expertise of technologists, researchers, and policymakers who share a common goal: to make India's cities not only smarter, but also healthier and more humane.

As trustees of the OMI Foundation, we see in this work a glimpse of the **future** we strive for: **where clean air is not a privilege but a promise**, where intelligence is harnessed to protect life, and where every act of design and policy contributes to the well-being of all.

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INDIA
P.S.
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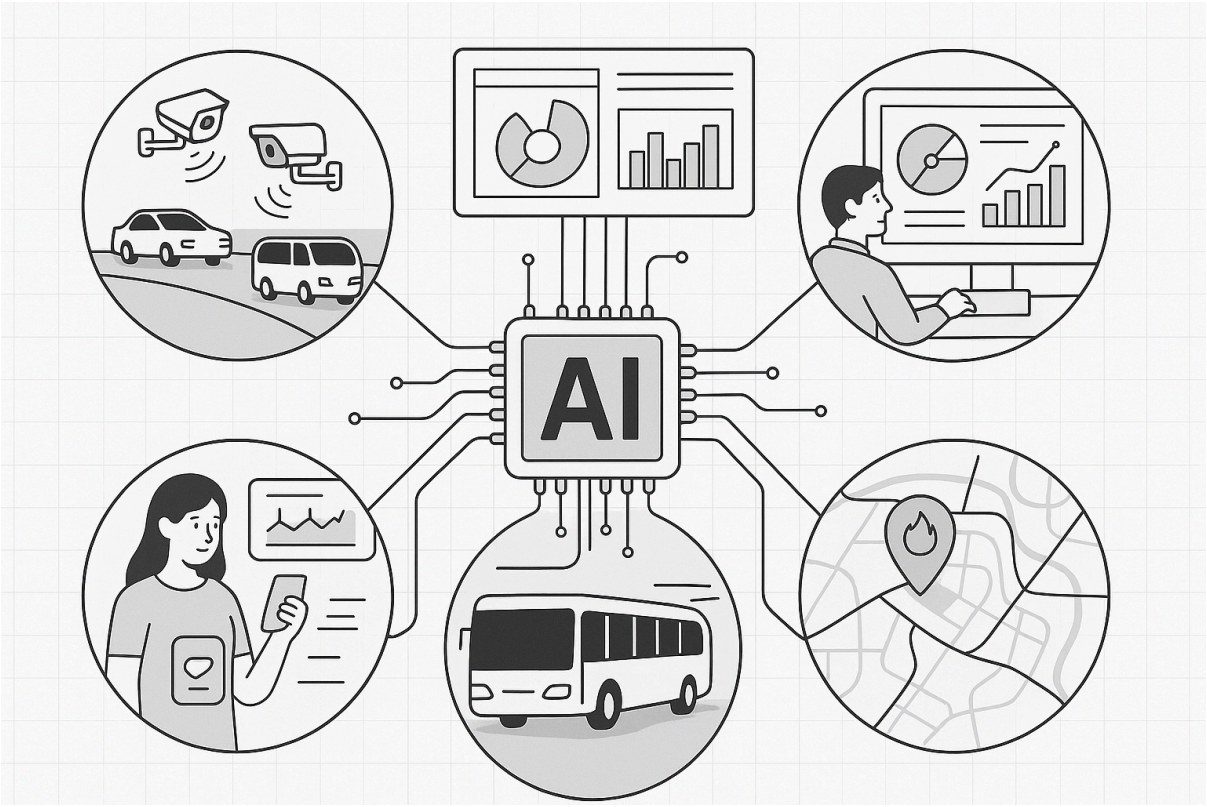
Executive Summary

An AI Response to Pollution Management

Delhi's air pollution crisis is not just an environmental challenge; it is an innovation opportunity waiting to be realized. Despite years of policy action, from the transition to BS-VI fuel standards to the Graded Response Action Plan (GRAP), the capital continues to record $PM_{2.5}$ concentrations five to ten times higher than the World Health Organization's safe limit. With more than 12 million vehicles and rapid urbanization, traditional enforcement mechanisms can no longer match the scale or complexity of emissions.

This Futures Report, ***Monitor. Model. Mitigate: Harnessing AI for Vehicular Emissions Control,*** reimagines **pollution management** through the lens of **Artificial Intelligence (AI), data fusion, and real-time environmental intelligence**. It proposes an integrated **Clean Air Intelligence Framework** - an AI-powered, non-intrusive system designed to **detect, predict, and mitigate vehicular emissions dynamically and autonomously**.

Figure 1: Clean AIr Intelligence Framework: An interconnected system detecting, predicting, and mitigating vehicular emissions through data fusion, real-time analytics, and adaptive intelligence.



Source: AI-generated image; Authors.

Clean Air Intelligence Framework: A Pilot in Delhi

At the core of this framework lies the **convergence of thermal and infrared imaging**, **Automatic Number Plate Recognition (ANPR)**, **edge computing**, and **machine learning analytics**. These technologies work in tandem to **identify high-risk and non-compliant vehicles,** such as older diesel or petrol models, those without valid Pollution Under Control (PUC) certificates, or non-BS-VI vehicles entering restricted zones. By **integrating with VAHAN** and **PUC databases**, the system enables data-driven enforcement that is transparent, scalable, and continuously improving through adaptive learning.

A **pilot** conducted at the **Kherki Daula Toll Plaza** demonstrated the feasibility of this approach. The AI-powered system successfully captured **real-time emission data from both heavy and light vehicles**, classifying them into **Normal, High, and Critical emission bands**. Strong correlation between predicted and actual hydrocarbon readings validated the accuracy of the model. These findings mark a new paradigm in **enforcement** - **proactive, evidence-based, and technology-led** - that can be scaled across India's major urban centers.

A Vision for Predictive Clean Air Governance

By 2030, India's cities can operate on **predictive air intelligence systems** where AI anticipates pollution spikes, triggers real-time mitigation, and empowers citizens with live air-quality insights. Such systems would seamlessly integrate data from satellite imagery, ground sensors, and on-road AI monitors to manage emissions before they escalate into health crises.

Delhi, once synonymous with smog and hazardous air, can evolve into a **global innovation hub for clean air governance**. This transformation demands collaboration among policymakers, technologists, and citizens, aligning AI innovation with regulatory foresight and civic participation.

In this new era of **AI-enabled environmental governance**, Delhi has a defining opportunity: to move from reactive control to predictive prevention; from fragmented monitoring to an integrated intelligence network. With the right strategy and institutional commitment, the capital can reclaim its skies, **demonstrating how AI, data, and design can converge to safeguard the right to breathe**.

1. Introduction: Reimagining Delhi's Air, From Crisis to Intelligent Action

Delhi's air story is not just one of crisis - it is one of **extraordinary opportunity**. The capital stands today at the intersection of two defining forces: the urgency of environmental survival and the promise of technological renaissance. How India responds to Delhi's air pollution challenge will define not only the future of its cities but the credibility of its growth model and its global climate leadership.

For decades, Delhi's skies have mirrored the price of rapid urbanization. Fine particulate levels ($PM_{2.5}$) continue to exceed the **World Health Organization's annual safety benchmark should not exceed 15 µg/m^3** by **five to ten times** (Down To Earth, 2023). In 2023, Delhi's annual average stood near **108 µg/m^3** - among the highest in the world (IQAir, 2024). During winter, when cool air traps emissions from vehicles, industries, and crop burning, the city transforms into a haze that disrupts transport, education, and public health. Air pollution shortens life expectancy by **over eight years** and contributes to **1.5 million deaths annually across India (Stearnbourne, 2024)**.

Yet beneath these statistics lies a deeper narrative - one of adaptation, experimentation, and potential breakthrough. Over the past five years, India and Delhi have introduced ambitious measures to reverse the tide: the **Graded Response Action Plan (GRAP)**, **BS-VI fuel transition**, **closure of coal-based power plants**, and **expanded urban greening and public transport networks**. These interventions have **stabilized particulate levels** and signaled a shift from passive control to active governance. In 2023, Delhi recorded its **lowest PM_{10} levels in six years**, a testament to sustained policy effort and growing public awareness.

But incremental improvement is not enough. The next frontier lies not in monitoring pollution after it occurs - but in **predicting and preventing it**. The convergence of **Artificial Intelligence (AI), satellite analytics, and real-time data systems** now offers India a transformative edge: the ability to forecast pollution episodes before they emerge, pinpoint emission hotspots with precision, and trigger automated, evidence-based responses.

Delhi's air crisis, therefore, is not merely a challenge to be endured; it can become a **national testbed for innovation**. It offers India the opportunity to pioneer a new governance paradigm - one that fuses environmental science with digital intelligence and citizen participation. The success of such a transformation would ripple far beyond Delhi, shaping the future of India's smart cities, public health systems, and climate action frameworks.

This report begins from a bold, defining question - one that reimagines governance itself:

Can AI transform Delhi's air quality management into a predictive, preventive, and participatory system - one that safeguards health, drives innovation, and sets a global benchmark for clean urban futures?

2. Why AI: From Data Fragmentation to Predictive Foresight

India today generates an enormous volume of environmental data from air quality monitors, IoT sensors, and satellite imagery to citizen-led reports. Yet, this data remains scattered across agencies and systems, creating silos that limit its utility. The challenge is not the lack of information, but the absence of integrated intelligence.

Artificial Intelligence (AI) offers the bridge from fragmented data to predictive foresight (Bibri, 2025). By unifying and analyzing streams from meteorological models, industrial operations, traffic networks, and emission inventories, AI can reveal real-time patterns, identify hotspots, and forecast pollution surges before they occur.

Beyond prediction, AI enables **non-intrusive, real-time monitoring and automated enforcement** systems that can detect violations, estimate emission loads, and recommend corrective measures without disrupting urban activity. Such intelligent systems can dynamically adjust traffic signals to ease congestion, regulate industrial output during high-risk periods, or flag non-compliant construction and waste-burning activities reducing emissions at their source.

This approach transforms governance from reactive control to proactive management. Global cities like Beijing and London have already demonstrated the power of AI-driven environmental intelligence (IndiaAI & Parse, 2024). India now has the technological and institutional capacity to develop its own model, one that aligns with the **Digital Public Infrastructure** vision and leverages national initiatives like **IndiaAI Mission**, **National Data Governance Framework Policy**, and **Digital India 2.0**.

Delhi, as the nation's capital and innovation hub, can pioneer this transformation. By deploying AI not just to observe but to act through predictive analytics, autonomous alerts, and data-informed interventions, the city can shift towards a cleaner, smarter, and more resilient urban future.

The goal is clear: **to turn Delhi from a centre of air quality concern into a global exemplar of AI-powered environmental innovation where clean air, growth, and technology advance together.**

3. The Framework: Building an Integrated AI System for Clean Air

3.1. Integrated Clean Air Intelligence System

If Delhi is to lead the global transition toward AI-enabled environmental governance, it must evolve from fragmented monitoring to **an integrated Clean Air Intelligence System** - one that connects data, decisions, and citizens in a single responsive network.

To address vehicular emissions, a major contributor to Delhi's air pollution, **AI-powered, non-intrusive real-time monitoring and enforcement systems can aid in reducing emissions** (Khanam et al., 2024). This framework targets high-risk and non-compliant vehicles, combining advanced AI analytics, data integration with government databases, and policy-based enforcement zones across Delhi.

Table 1: Technology Options & Specifications for an Integrated AI System for Clean Air

Technology	Purpose
Thermal Imaging Cameras	Detect abnormal exhaust temperatures, visualize soot and hydrocarbon emissions in diesel engines
ANPR Cameras	Automatic Number Plate Recognition for vehicle identification and tracking
VAHAN & PUC Integration	Real-time access to vehicle registration and pollution compliance records
EDGE Computing	On-site processing for rapid AI inference and low-latency alerts
Mobile Enforcement Tools	Alerts and actionable information delivered to enforcement personnel in the field
Monitoring & Analytics Platform	Centralized dashboard for visualization, reporting, and compliance analytics

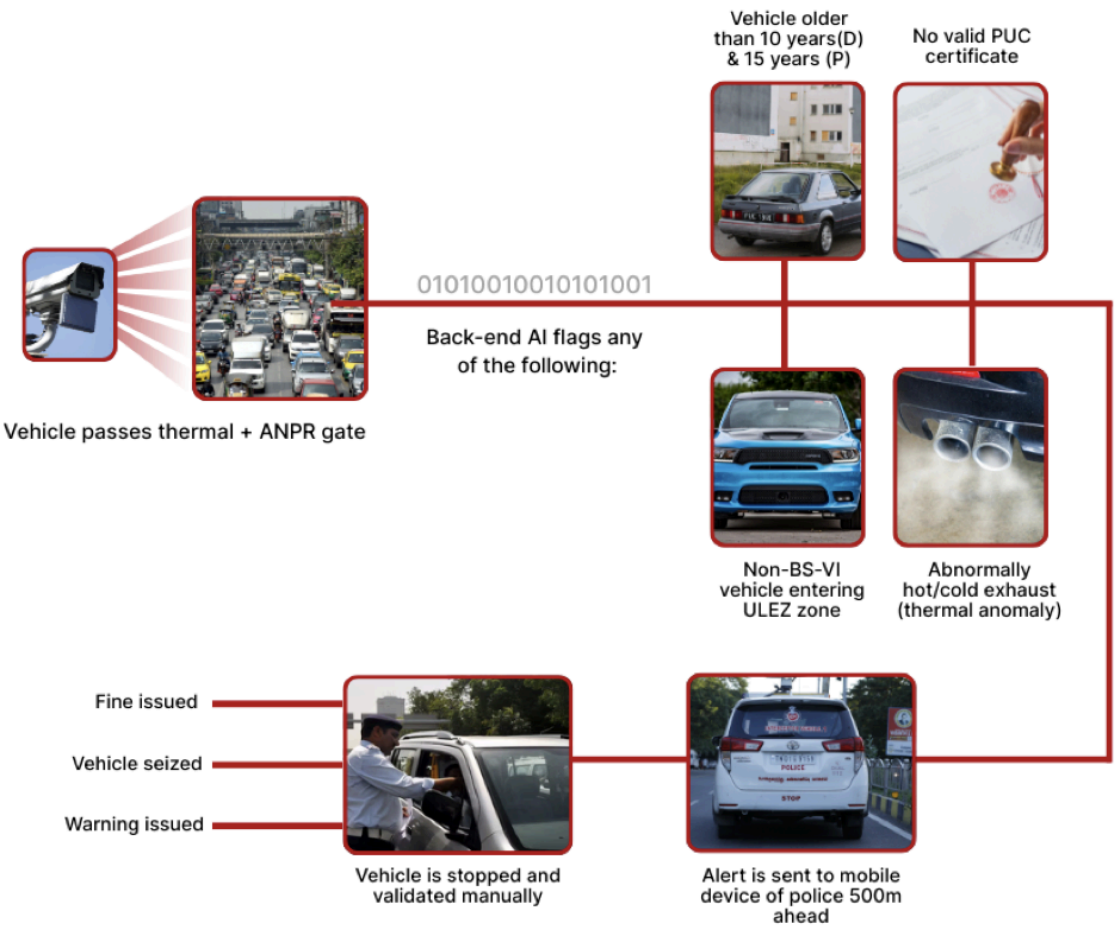
Thermal and infrared (IR) cameras are essential for detecting soot and hydrocarbons (HC) in diesel exhaust because these pollutants absorb and emit radiation at specific wavelengths (Yue & Reitz, 2019). HC molecules exhibit characteristic absorption in the mid-infrared range (3.3–3.9 μm) due to C-H bond vibrations, allowing specialized filters to visualize HC-rich regions in the exhaust plume. Soot particles, or black carbon, emit thermal radiation across broad wavelengths, producing a detectable heat signature. During engine acceleration, higher exhaust temperatures and increased particulate concentration amplify this thermal signal, making emissions more visible. By capturing these infrared signatures, thermal cameras provide a non-intrusive, precise, and real-time method to monitor and quantify vehicular emissions.

3.2. Vehicle Monitoring & Enforcement Flow

The enforcement process begins when a vehicle passes through a **thermal and ANPR monitoring gate**, where cameras capture both license plate details and the thermal signature of the exhaust. This data is analyzed in real time by a **back-end AI system**, which flags vehicles based on compliance criteria: diesel vehicles older than 10 years or petrol vehicles older than 15 years, missing or invalid PUC certificates, non-BS-VI vehicles entering designated **Ultra-Low Emission Zones (ULEZ)**, or abnormal exhaust temperatures indicating a thermal anomaly.

When a vehicle is flagged, an **alert is immediately sent to the mobile device of enforcement personnel 500 meters ahead**, enabling timely intervention. The vehicle is then stopped for **manual validation**, after which appropriate action is taken - issuing a fine, seizing the vehicle, or providing a warning. This process ensures **real-time, precise, and non-intrusive enforcement**, combining advanced AI, sensor data, and field operations to maximize compliance and minimize traffic disruption.

Figure 1: Enforcement Workflow to Detect Vehicular Pollution Using AI



Source: Authors

Table 2: Expected Outcomes and Impact of AI for Vehicular Emissions Control

Impact Area	Expected Outcome
Pollution Reduction	Targeted enforcement of high-emission vehicles reduces $PM_{2.5}$ and black carbon in urban hotspots.
Policy Effectiveness	Data-driven insights guide ULEZ zoning, fleet modernization, and real-time regulatory interventions.
Operational Efficiency	AI-enabled alerts allow enforcement to act proactively, reducing resource use and avoiding unnecessary stops.
Citizen Health & Awareness	Cleaner air and public transparency encourage responsible vehicle ownership and behavior change.
Scalability	Framework can be extended to other cities for national-level vehicular pollution management.

Table 3: Proposed Criteria for Flagging Vehicles

Criteria	Threshold	Action
Thermal Signature	Hydrocarbon/Soot Emission exceeds threshold	Flag
Age of Vehicle	Diesel >10 years, Petrol >15 years	Flag
PUC Expired	> 7 days overdue	Flag
BS Norm	Below BS-VI in ULEZ	Flag
No Registration	Fake/invalid plate	Flag & hold

By integrating AI, advanced sensing, and backend database connectivity, this framework transforms vehicle pollution control from reactive inspections to predictive, evidence-based enforcement, enabling measurable improvements in air quality while maintaining smooth traffic flow.

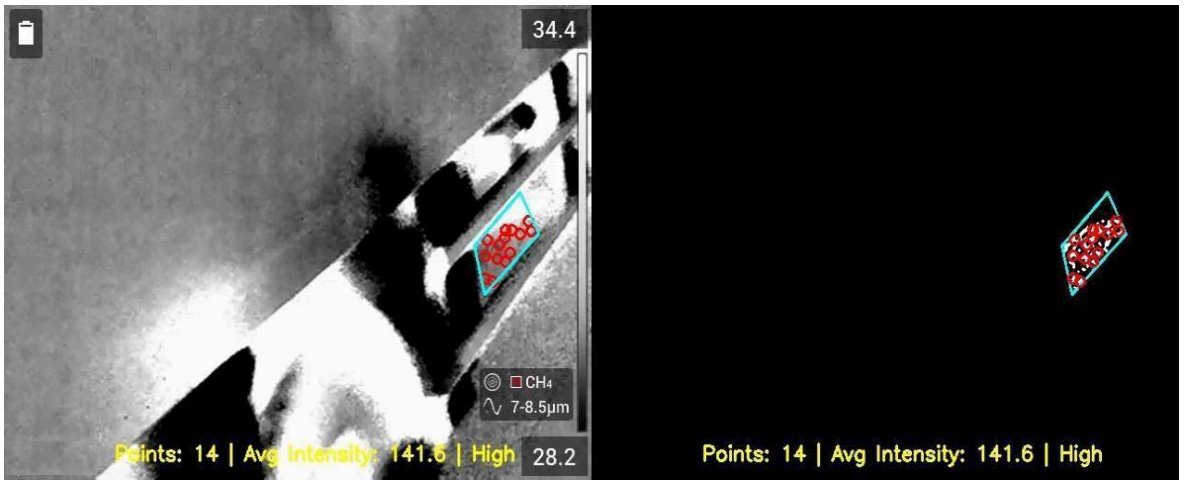
4. Pilot Implementation in Delhi

4.1. Pilot Setup

To evaluate the effectiveness of the AI-powered vehicle monitoring system, a **pilot test was conducted on 25 August 2025 at Kherki Daula Toll Plaza**, a key entry point to Delhi. This location experiences a **heavy mix of commercial and private vehicles**, particularly during peak hours, resulting in **congestion and elevated vehicle idling**, which significantly contributes to local emissions and deteriorates air quality.

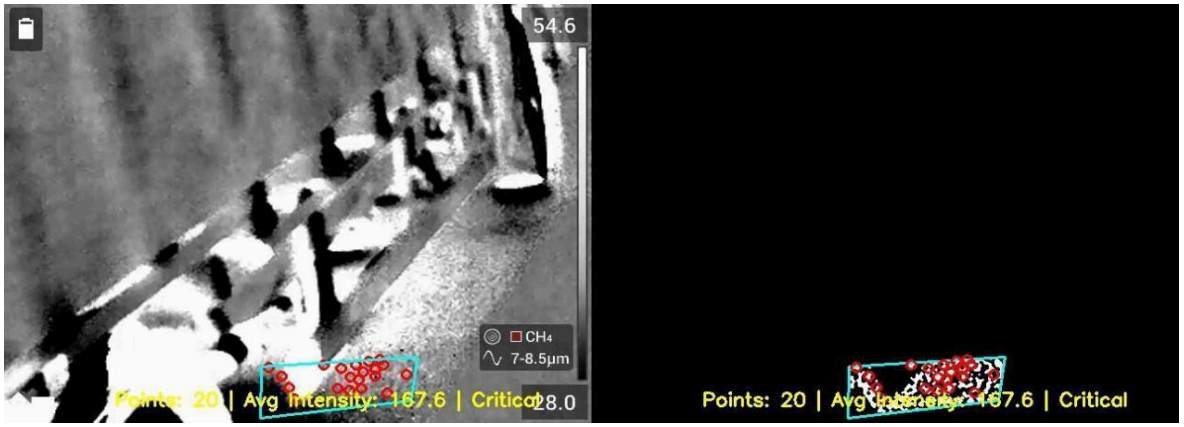
Figure 2: Collage of Images from the AI for Vehicular Emissions Control Pilot in Delhi

Thermal-Infrared Capture of Heavy Vehicle Exhaust (Normal Emission Band):
AI system output showing a heavy vehicle with stable exhaust temperature and soot concentration within normal hydrocarbon emission limits.



Thermal Signature of Heavy Vehicle (Critical Emission Band):
Visualization of a heavy vehicle with high thermal intensity at the exhaust plume, indicating excessive soot and hydrocarbon emissions beyond safe thresholds.

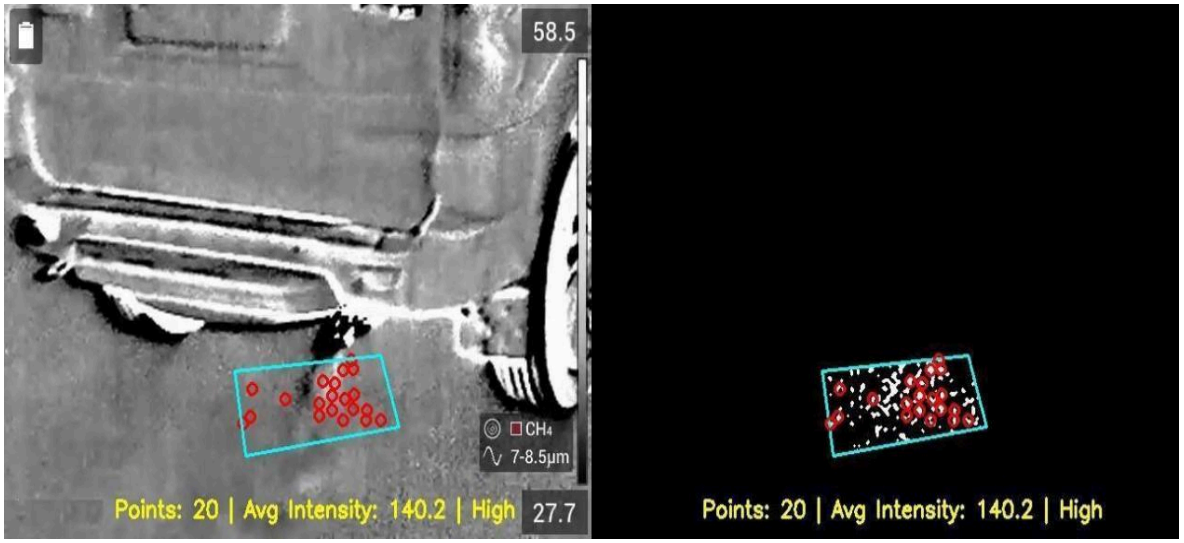
Thermal-Infrared Capture of Heavy Vehicle Exhaust (Normal Emission Band):
Another example of a heavy vehicle classified under the normal emission category, showing consistent thermal dispersion and low hydrocarbon output.



Thermal Signature of Heavy Vehicle (High Emission Band):
AI-based emission visualization of a heavy vehicle with elevated exhaust temperature and visible soot intensity, classified under the high emission band.

Light Vehicle Emission Profile (Normal Classification):

Infrared emission analysis of a light vehicle showing low hydrocarbon concentration, corresponding to normal emission readings in the AI-predicted dataset.



Light Vehicle Emission Profile (High Emission Classification):
AI-generated visualization of a light vehicle with elevated hydrocarbon intensity and visible hot spots on the exhaust region, flagged under high emission category.

4.2. Test Summary

The pilot involved **real-time emissions monitoring** of both heavy and light vehicles, using the integrated thermal/IR and ANPR-based AI system.

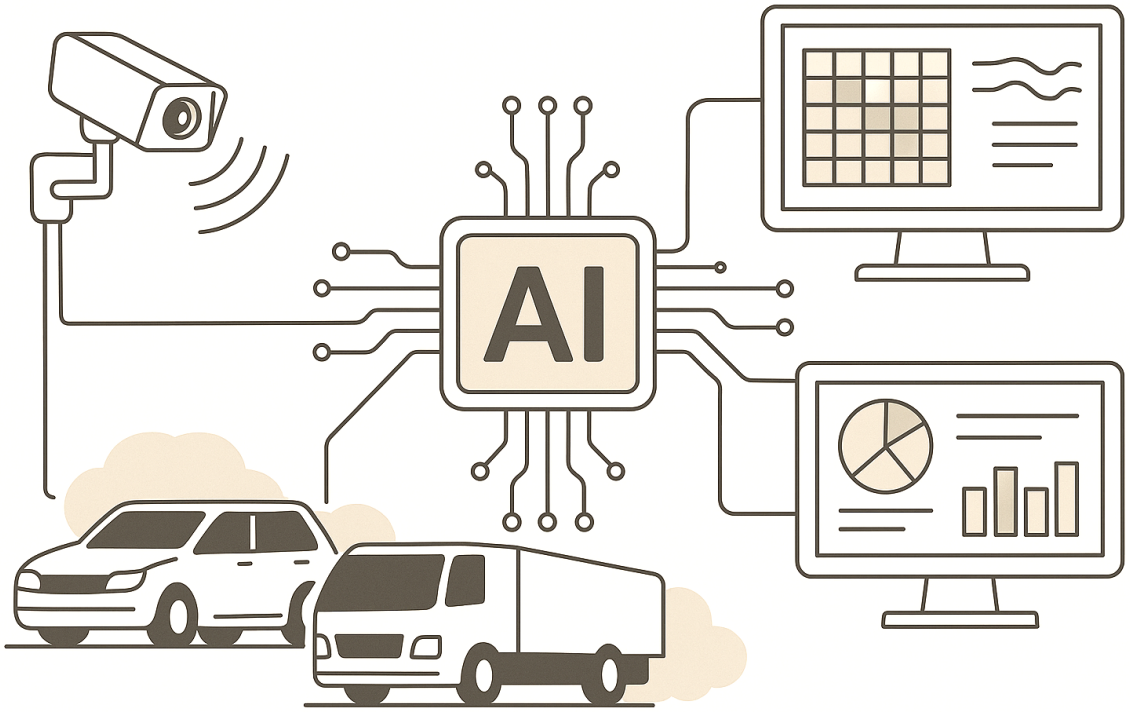
1. **Vehicle Type: Heavy Vehicles (HV)**
    a. Total Vehicles Monitored: 16
    b. Normal: 9
    c. High: 4
    d. Critical: 3
    e. Predicted HC/ Soot ppm Range: 61.7 - 167.6
    f. Key Insights: Several vehicles exceeded safe pollution thresholds; AI predictions closely matched actual emissions.
2. **Vehicle Type: Light Vehicles (LV)**
    a. Total Vehicles Monitored: 29
    b. Normal: 21
    c. High: 4
    d. Critical: 4
    e. Predicted HC/ Soot ppm Range: 23.5 - 190.6
    f. Key Insights: Vehicles in High and Critical categories contribute disproportionately to emissions; targeted monitoring required.

4.3. Key Insights & Next Steps

1. The pilot demonstrates that the AI system can effectively classify vehicles by emission risk, providing actionable insights for enforcement.
2. Areas with heavy congestion, like toll plazas, are critical hotspots where targeted monitoring can have immediate air quality benefits.
3. A larger-scale pilot is recommended to test diverse traffic scenarios, refine AI model calibration, and further enhance predictive accuracy.

The Kherki Daula pilot validates the feasibility of deploying **AI-enabled vehicle monitoring in high-traffic, real-world conditions**. Early results indicate strong alignment between predicted and measured emissions, confirming the system's potential as a **scalable, non-intrusive tool for improving urban air quality**.

Figure 3: AI-Driven Vehicular Emissions Monitoring: A technical representation of real-time data flow between on-road sensors, AI analytics, and centralized control systems for predictive air-quality management.



Source: AI-generated image; Authors.

5. Recommendations

The AI-powered vehicle monitoring pilot at Kherki Daula Toll Plaza highlights the potential of predictive, non-intrusive enforcement for reducing vehicular emissions. To scale impact across Delhi, the following recommendations are proposed:

5.1. Policy and Regulatory Measures

1. **AI-Guided Expansion of Low Emission Zones:** Use AI-driven traffic and emission analytics to identify pollution hotspots and dynamically expand Ultra-Low Emission Zones (ULEZ) to high-impact corridors and industrial clusters. Continuous data modeling can help optimize zone boundaries based on real-time air quality and vehicular patterns.
2. **Intelligent Fleet Modernization Incentives:** Deploy AI systems to track fleet composition, vehicle age, and emission performance to target high-polluting segments. Leverage predictive analytics to design data-backed incentive schemes for transitioning to BS-VI or electric vehicles, scrappage prioritization, and compliance monitoring.
3. **Integration with Smart Enforcement Frameworks:** Embed AI-based emission alerts and violation detections into traffic enforcement protocols. Automated flagging, real-time data sharing, and AI-assisted decision support should guide timely actions such as vehicle inspections, penalties, or route diversions to reduce high-emission events.

5.2. Technology Deployment

1. **Scale AI Monitoring Network:** Install additional thermal/IR + ANPR monitoring points at strategic toll plazas, intersections, and industrial approaches to capture high-risk vehicles in real time.
2. **Real-Time Analytics & Dashboard:** Deploy a centralized platform integrating VAHAN, PUC databases, and edge-computed AI predictions for predictive enforcement and hotspot mapping.
3. **Continuous Model Calibration:** Use periodic field validation and emissions data to fine-tune AI logic, ensuring predictive accuracy across diverse traffic conditions.

5.3. Operational Measures

1. **Targeted Field Enforcement:** Leverage AI-generated alerts to enable proactive stops, minimizing disruption while addressing high-emission vehicles.
2. **Data-Driven Decision Support:** Use analytics to guide policy decisions such as congestion management, fleet age regulations, and emission-based fines.
3. **Community Engagement:** Encourage citizen awareness through dashboards and apps that communicate high-emission zones and promote responsible vehicle practices.

Conclusion

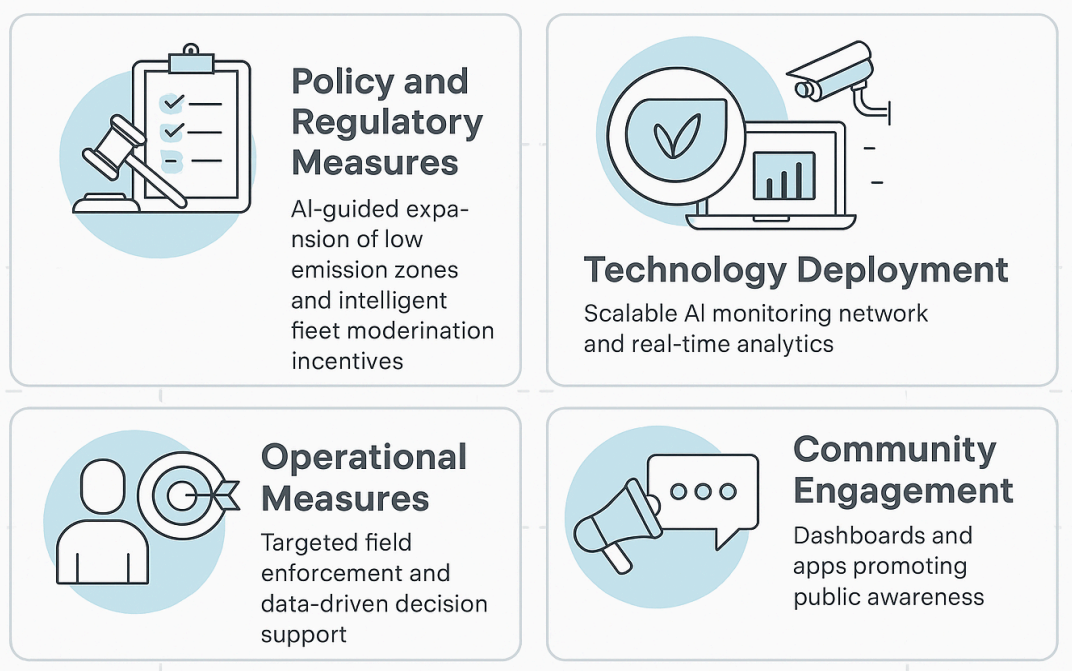
Delhi's air pollution crisis is both a profound challenge and a transformative opportunity. The persistent smog, hazardous $PM_{2.5}$ levels, and staggering public health impacts underscore the urgent need for **systemic change**. Yet within this crisis lies a unique chance for India to **demonstrate global leadership in intelligent urban governance**, leveraging cutting-edge technology, data-driven policy, and active citizen participation.

The Kherki Daula pilot demonstrates that **AI-driven, non-intrusive vehicle monitoring** can transform urban air quality management. By combining **thermal/IR sensing, ANPR technology, AI analytics, and real-time enforcement**, authorities can **predict, detect, and act on high-emission vehicles with precision**, reducing particulate pollution and hydrocarbon emissions in critical urban hotspots.

This pilot represents more than a test; it is a **blueprint for scalable, city-wide deployment**. By expanding monitoring infrastructure, integrating predictive analytics into policy enforcement, and coupling it with citizen engagement, Delhi can transition from reactive interventions to a **proactive, evidence-driven air quality governance model**.

Vision: By 2030, Delhi and other Indian urban centers can operate under **predictive air intelligence systems**, where technology, governance, and public participation converge. Vehicles, fleets, and infrastructure will be continuously monitored, emissions mitigated in real time, and citizen health safeguarded. **Delhi** can thus **emerge as a global benchmark for intelligent, sustainable, and resilient urban air quality management**, showcasing how AI can turn a city in crisis into a **model of opportunity, innovation, and environmental leadership**.

Figure 4: A framework for scaling AI-powered emissions management



Source: AI-generated Image; Authors

References

Bibri, S. E. (2025, July). Artificial intelligence of things for sustainable smart city brain and digital twin systems: Pioneering Environmental synergies between real-time management and predictive planning. https://www.sciencedirect.com/science/article/pii/S2666498425000699

Directorate of Environment. (2025). Ambient Air Quality. https://environment.delhi.gov.in/environment/ambient-air-quality

Down To Earth. (2023, November 6). Delhiites breathe in PM2.5 almost 30 times WHO safe limits. https://www.downtoearth.org.in/pollution/delhiites-breathe-in-pm2-5-almost-30-times-who-safe-limits-92653

Fastelli, M. (2021, May). NIR-MID Reflectance and Emissivity Study at Different Temperatures of Sodium Carbonate Minerals: Spectra Characterization and Implication for Remote Sensing Identification. MDPI. https://www.mdpi.com/2075-163X/11/8/845

IndiaAI & Parse, P. A. (2024, May 7). Green Intelligence: AI-Driven Innovations for Global Environmental Solutions. IndiaAi. https://indiaai.gov.in/article/green-intelligence-ai-driven-innovations-for-global-environmental-solutions

IQAir. (2024). World's Most Polluted Countries in 2024 - PM2.5 Ranking. IQAir. https://www.iqair.com/in-en/world-most-polluted-cities

Khanam, M., Uddin, K., & Kazi, J. U. (2024, February). Artificial intelligence and IoT driven technologies for environmental pollution monitoring and management. Frontiers. https://www.frontiersin.org/journals/environmental-science/articles/10.3389/fenvs.2024.1336088/full

PIB. (2023, December 31). 2023 - Air Quality Perspective in Delhi. Press Release: Press Information Bureau. https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1991970

Stearnbourne, C. (2024, December 12). Air pollution in India linked to millions of deaths. Harvard T.H. Chan School of Public Health. https://hsph.harvard.edu/environmental-health/news/air-pollution-in-india-linked-to-millions-of-deaths/

Yue, Z., & Reitz, R. D. (2019, February 1). Numerical investigation of radiative heat transfer in internal combustion engines. https://www.sciencedirect.com/science/article/abs/pii/S0306261918316660

Credits

About DataCorp Traffic

DataCorp Traffic is a Technology-driven Transportation Data Collection, Analytics & Advisory Company with a focus on developing Sustainable Mobility Solutions. The company has a team of the brightest young professionals spanning Information Technology Architects, AI Programmers, Data Analysts, ITS Experts, Transport planners, Transport Modellers, Traffic Engineers, Urban Planners, GIS Experts, BIM Operators, and Site Technicians. The company is headquartered in Bengaluru, India, with branch offices spread across India, United Kingdom, Europe, and Africa.

About ITS India Forum

The **ITS India Forum** is a leading not-for-profit think tank dedicated to advancing Intelligent Transportation Systems (ITS) in India. ITS India Forum promotes safety, affordability, and inclusivity in transportation in alignment with the Viksit Bharat Vision 2047. The Forum serves as a collaborative platform for industry professionals, government agencies, and academic institutions working together to shape the future of transportation in the country.

About OMI Foundation Trust

OMI Foundation Trust is a new-age policy research and social innovation think tank operating at the intersection of mobility innovation, governance, and public good. Mobility is a cornerstone of inclusive growth providing the necessary medium and opportunities for every citizen to unlock their true potential. OMI Foundation endeavours to play a small but impactful role in ushering meaningful change as cities move towards sustainable, resilient, and equitable mobility systems, which meet the needs of not just today or tomorrow, but the day after.

OMI Foundation houses four interconnected centres that conduct cutting-edge evidence-based policy research on all things mobility:

1) The Centre for Technology Transitions is dedicated to transforming India's innovation ecosystem through a systems approach. It aims to position India as a global leader in ethical, inclusive, and sustainable technological innovation.

2) The Centre for Future Mobility supports the leapfrog of cities to a sustainable future anchored in the paradigms of active, shared, connected, clean, and AI-powered mobility.

3) The Centre for Clean Mobility catalyses the adoption of electric vehicles, future fuels, and renewable energy within the mobility ecosystem as a key climate strategy of cities.

4) The Centre for Inclusive Mobility promotes safe, accessible, reliable, and affordable mobility for all. It paves the road for the future of work and platform economy to fulfil the modern promise of labour.

About Futures Report

A “Futures Report” is a forward-looking, analytical report that explores emerging trends, transformative technologies, and future mobility scenarios through a combination of data-driven insights, strategic foresight, and policy analysis. Unlike traditional policy briefs or issue papers, the Futures Report anticipates and shapes future mobility developments, helping stakeholders prepare for and navigate upcoming disruptions.

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Ms. Karthikeyan is a dynamic entrepreneur and strong administrator, she combines strategic vision with a bold, can-do attitude. Under her leadership, the company has expanded across five continents with over 1,000 employees and multiple business verticals. She holds a Bachelor of Engineering from VTU, India, and is Six Sigma Green Belt certified. A continuous learner, she has attended PTRC’s *Principles of Transport Planning* in London and actively engages in global transportation forums to stay ahead of industry trends.

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