

# Smart Asset Management for Road Networks

Digital Transformation from Legacy Systems to Intelligent Networks

 6.5 Million km  
Network Scale

 AI-Powered  
Intelligence



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From reactive maintenance to predictive intelligence

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01

# The Transformation Imperative

From reactive maintenance systems to predictive,  
AI-powered intelligence

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*Legacy → Intelligent Networks*

# Legacy System Limitations

Critical gaps in India's 6.5 million km road network management

## Current State Deficiencies

### 1 Infrequent Inspections

Periodic condition surveys conducted only every **2-5 years**, with manual inspection covering merely **5-10%** of the network annually

### 2 Subjective Assessments

PCI evaluations suffer from **±15-point variance** due to human judgment, creating unreliable condition data

### 3 Reactive Maintenance

Emergency repairs cost **3-5× more** than preventive maintenance, with condition assessment lagging 3-6 months behind manifestation

**22%**

Roads in Poor Condition

**PCI <40**

Pavement Condition Index

## Data Silos

Fragmented information across departments prevents integrated decision-making and holistic network management

## Budget Allocation

₹100-1200 Cr annual maintenance budgets driven by political cycles rather than condition-based priorities

# Why Transformation is Urgent

Three converging drivers making intelligent RAMS essential



## Scale Demands Automation

Manual inspection is untenable at **6.5 million km** scale. Automated surveys achieve breakthrough efficiency.

Crack Detection Accuracy **95%**



**500-1K**

km/day automated

**50**

km/day manual



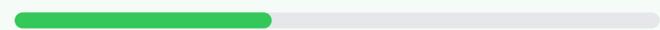
## Technology Maturity

2024-2025 research validates AI/ML readiness with proven accuracy and cost efficiency.

Deterioration Prediction **85%+**



Lifecycle Cost Reduction **35-40%**



## National Proof Points

Digital RAMS is operational, not experimental. Multiple validated implementations across India.



**NHAI AI Cell**

20,000+ km monitored



**Bihar OPRMC**

13,000+ km, 70% cost ↓



**UP Safety Pilot**

90%+ risk accuracy



### Key Insight

Commercial viability achieved: IoT sensors <₹50K/km, drone surveys ₹5-10K/km, cloud platforms enable centralized data

**Operational**

Not Experimental

02

# Intelligent Network Architecture

Five core technology components powering the digital transformation

AI • IoT • Digital Twins

1777  
Today's Alarm Count  
Unhandled

0  
Handled

0  
Faults

Alarm Trends



## Recent Videos



Camera  
2024-12-18  
14:17:33



Camera  
2024-12-18  
14:17:53



Camera  
2024-12-18  
14:16:53



Camera  
2024-12-18  
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2024-12-18  
14:16:53



Camera  
2024-12-18  
14:16:53



Camera  
2024-12-18  
14:16:53

# Five Core Components

Integrated technology ecosystem for intelligent asset management



## Automated Condition Assessment

3D survey vehicles, drones, and dash-cams with deep learning classify distresses and calculate PCI automatically.

**95%**

Crack Detection

**<₹2K**

per km Cost



## Predictive Analytics

ML models predict deterioration 3-6 months ahead using condition, weather, traffic, and maintenance data.

**35-40%**

Cost Reduction

**15→30 yr**

Pavement Life



## IoT Sensor Networks

Real-time temperature, moisture, stress, and drainage data feed central platforms for proactive maintenance.

**<₹50K**

per km Sensors

**Edge+Cloud**

Processing



## Digital Twins

Virtual replicas enable "what-if" scenario testing for design changes, climate extremes, and traffic impacts.

**2050**

Climate Scenarios

**Virtual**

Testing



## Federated Data Platforms

Centralized repositories aggregate condition, accident, design, and maintenance data with iRAD integration.

**Gati Shakti**

Integration

**iRAD**

Linked



## Integrated Ecosystem

All five components work together through APIs and standardized data formats

**500+**

km/month coverage



03

पथ निर्माण विभाग बिहार

# Proven Implementation: Bihar OPRMC

12 years of validated success and measurable  
outcomes

Long Term Output &  
Performance Based Road  
Assets Maintenance Contract  
(OPRMC)

# Bihar OPRMC: 12 Years of Proven Success

Pioneering output-based maintenance with AI/ML integration

## Three-Phase Implementation Journey



2013-2018

Foundation Phase

72 packages, pioneered output-based contracting shifting from input-based to outcome-based model

9,064 km

₹2,579 Cr



2019-2026

Expansion Phase

72 packages, AI/ML integration begins with command center establishment

13,064 km

₹6,655 Cr



2026-2033

Full Coverage

Full state highway and major district road network coverage

19,197 km

Complete SH/MDR

## AI/ML Integration Milestones

July 2022

Command & Control Centre established monitoring 10,400 km via ICT platform

July 2024

AI/ML dash-cam deployed on 1,000 km achieving breakthrough metrics

## Measurable Outcomes

Emergency Repairs Reduction

Preventive maintenance effectiveness

60%

Lifecycle Cost Reduction

Through predictive optimization

35-40%

Inspection Cost Reduction

AI/ML automation impact

70%

NPV Savings per 200 km

Net present value over project life

₹5-7 Cr

## Economic Impact

Road Density

3,086 km/1,000 km<sup>2</sup>

GSDP Growth contributor

2015-16 to 2022-23

10.43% CAGR



# MULTI-TIER NETWORK OPERATIONAL READINESS

# Pan-India Validation: Multi-Tier Network

Intelligent asset management is operational across India's road hierarchy



## NHAI National Highways

AI Cell Operational Since August 2025

**20,000+**

km Monitored

**160K**

km Expansion Target

- ✓ Real-time quality control
- ✓ Predictive maintenance
- ✓ Design optimization

Status: **Operational & Scaling**



## Urban Networks

Pune, PCMC GIS-Based RAMS

**1,000+**

km Deployed

- ✓ GIS-based inventory
- ✓ Automated condition surveys
- ✓ Citizen-reported defects

Web platforms enable **preventive planning**



## State Networks

UP, Karnataka Leading Implementation



Uttar Pradesh

**90%+ Accuracy**

High-risk segment identification through predictive safety analytics



Karnataka

**AI Surveillance + Command**

Central command integration with continuous monitoring



## Rural Networks

PMGSY eMARG Platform

**5.6L+**

km Covered

- ✓ eMARG e-Governance
- ✓ Performance based
- ✓ Post-construction maintenance

Odisha leading **PCI prioritization**

05

# Institutional Framework

Governance structure for national rollout



# Institutional Framework for National Rollout

Clear roles for Central and State governments with phased implementation



## Central Government Roles

- 1 National Standards**  
Unified IRC-based PCI methodology, defect classification, PBMS/BBMS software requirements
- 2 Gati Shakti /eDisha Platform**  
Centralize condition, accident, maintenance data. Link to iRAD for cause-linked interventions
- 3 Capacity Building**  
Partner with IITs for AI/ML curriculum. Train 5,000 state PWD engineers
- 4 Technology Vetting**  
Bulk licensing agreements reducing per-state costs by 40-50%
- 5 MDB Financing**  
Facilitate World Bank, ADB lending linked to sustainability metrics



## State Implementation Phases

- Phase 1: Pilot** ₹2-3 Cr  
Year 1-2  
200-300 km high-traffic highways. Validate workflows, train teams.
- Phase 2: Scale** ₹8-12 Cr annually  
Year 2-4  
1,500-2,000 km secondary roads. Gati Shakti integration, IoT deployment.
- Phase 3: Full Coverage** ₹15-25 Cr annually  
Year 4-7  
Full state coverage with bridge management. Real-time SLA dashboards.

## Safety & Environmental Integration

### iRAD Integration

30-35% accident reduction  
5,000-7,000 lives saved/year

### Sustainability

25-30% CO2 reduction  
2-3 million tons annually

# Measurable Outcomes & Roadmap

QUANTIFIED BENEFITS



5-YEAR IMPLEMENTATION PLAN

QUANTIFIED BENEFITS



Quantified benefits and 5-year implementation plan

# Measurable Outcomes & 5-Year Roadmap

Quantified benefits for 6.5 million km national network

## Quantified Benefits (5-Year Target)

	<b>Pavement Life Extension</b> ₹1,600-2,200 Cr lifecycle deferral	<b>15→30 yr</b>
	<b>Maintenance Cost Reduction</b> ₹350-500 Cr annual savings	<b>30-35 %</b>
	<b>User Cost Reduction (VOC)</b> ₹325-650 thousand Cr annually	<b>12-15%</b>
	<b>Accident Reduction</b> 5,000-7,000 lives saved/year	<b>30-35%</b>
	<b>CO2 Emissions Reduction</b> 2-3 million tons reduction	<b>25-30%</b>

## Implementation Roadmap

<b>1</b>	<b>Year 1 (2026)</b> Foundation Establish Central Guidelines, 10 state pilots (200-300 km each) Central Support:	<b>₹50-75 Cr</b>
<b>2</b>	<b>Year 2-3 (2027-28)</b> Expansion 15-20 states, 1,500-2,000 km each. eDisha + Gati Shakti + iRAD integration Annual Savings:	<b>₹200-300 Cr</b>
<b>3</b>	<b>Year 4-5 (2029-31)</b> National Coverage Entire country, complete NH/SH/MDR networks, bridge management Lifecycle Savings:	<b>₹1,600-2,200 Cr/yr</b>

## Investment & Returns

Total Investment	<b>₹20-26 L Cr</b>
7-Year Benefits	<b>₹80-100 Cr</b>
Benefit-Cost Ratio	<b>2.7-4.0</b>

# The Path Forward

India's road asset management transformation is **no longer optional**

We have the **capability, technology, and framework** to scale intelligent asset management across 6.5 million km.

The question is not whether to transform, but how quickly we can deploy.