A Data-Driven Road Asset Management Framework- Case Study of Odisha

Transitioning from reactive maintenance to performance-based cost-effective decision making using ORAMS & HDM-4

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WORKS DEPARTMENT
GOVERNMENT OF ODISHA

FRAMEWORK SCOPE
22, 866
Lane-Kilometers

12
Administrative Circles

Global Road Infratech Summit & Expo 05-06 FEBRUARY 2026 Hotel The Ashok New Delhi India

The Challenge of Network Management
Why traditional maintenance are no longer sustainable

✸ **Current Pressures**

🚗↑ **Rising Traffic Demand**
Increased volume and heavier axle loads accelerating deterioration.

💰⊘ **Constrained Budgets**
Limited funds require smarter allocation of funds.

🏛 **Legacy Practices**
Reactive, localized decisions lead to inconsistent network performance.

TRADITIONAL APPROACH
- **Reactive fixes**
- **Subjective**
- **High Cost**

⊘

DATA-DRIVEN RAM
- **Unified data**
- **HDM-4 Analysis**
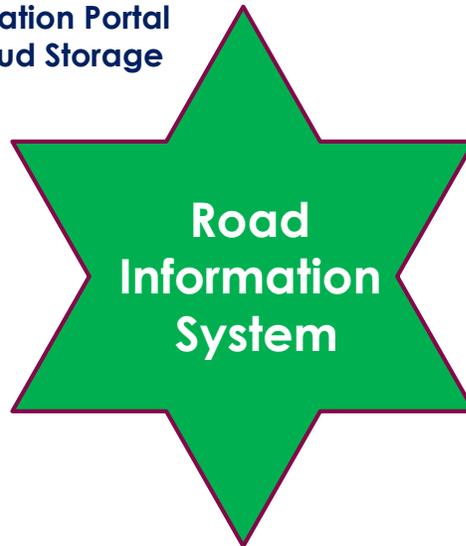- **Optimized Budget**

✓

🔄 **The required Shift**

To ensure economic efficiency and transparency, agencies must shift to a unified data-driven framework based on objective network-level data and structured analytics

Road Asset Management Guidelines (IRC 130-2020)
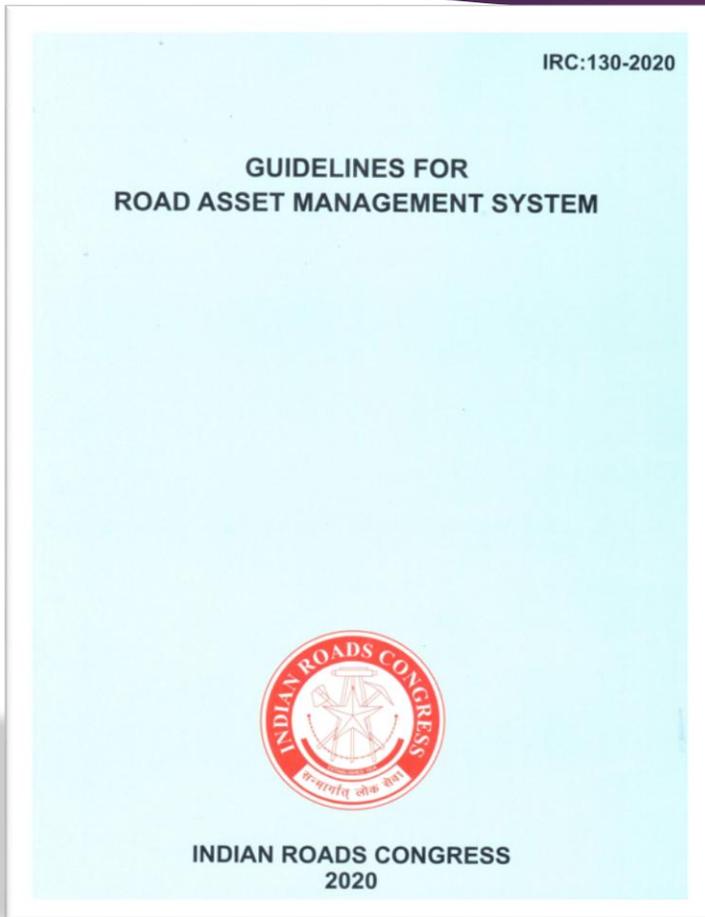
Road Asset Management System (RAMS) at the national level is a strategic framework that guides the maintenance, rehabilitation, and improvement of a country's road network.

It ensures that road infrastructure is managed efficiently, cost-effectively, and sustainably over its lifecycle.
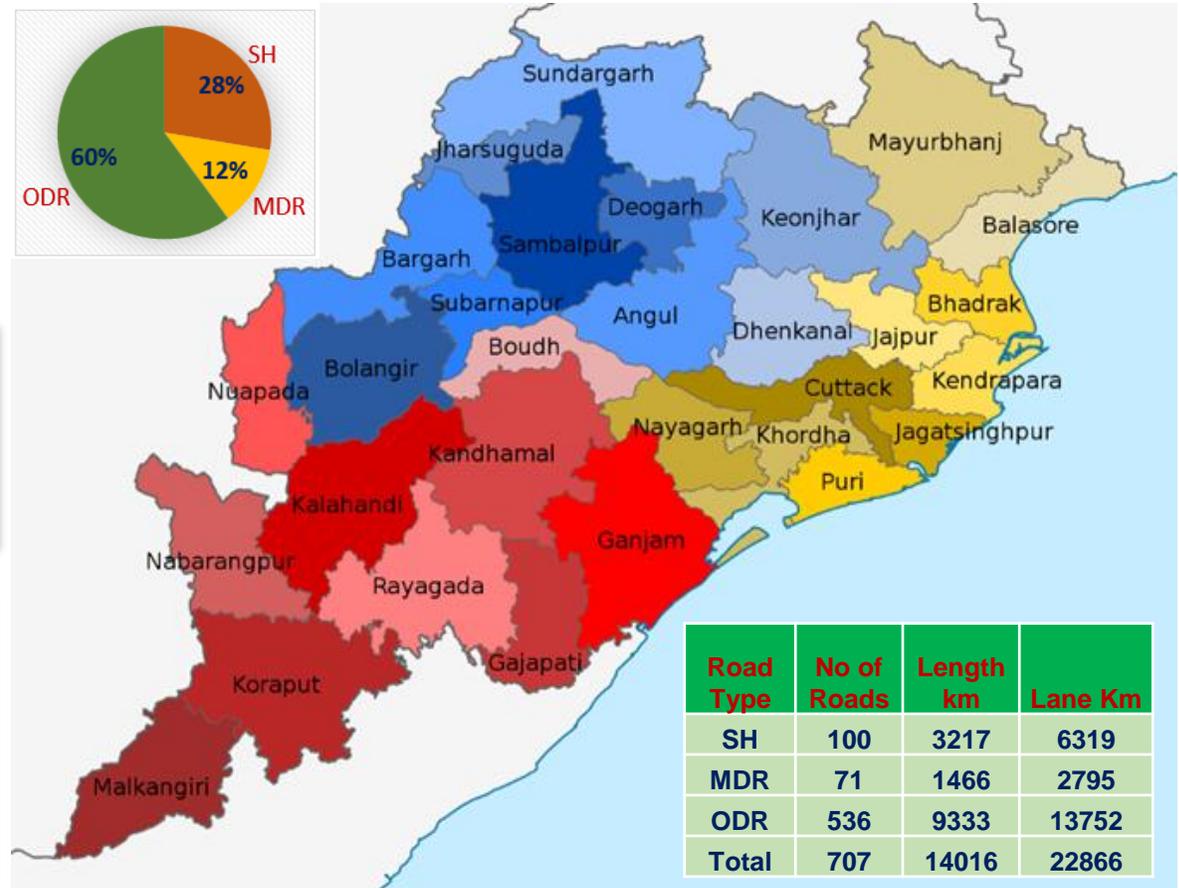
IRC:130-2020

GUIDELINES FOR
ROAD ASSET MANAGEMENT SYSTEM

INDIAN ROADS CONGRESS
2020

Odisha Study

Development of Annual Maintenance Plan (AMP) for 22866 lane kms

- **12 administrative Circles**
  Managed across distinct geographical zones (Coastal plains, river basins, hilly Eastern Ghats, western plateau, flood-prone areas, and urban corridors)

- **Road classification**
  SH (State Highways), MDR (Major District Roads, and ODR (Other District Roads)

- **Varied Conditions**
  Heterogeneous network with diverse traffic levels, terrain types and pavement structures.

Road Type	No of Roads	Length km	Lane Km
SH	100	3217	6319
MDR	71	1466	2795
ODR	536	9333	13752
Total	707	14016	22866

Methodology for AMP

Road Type	No of Roads	Length km	Lane Km
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Total	707	14016	22866

Odisha Road Network

Survey using Network Survey Vehicle (NSV) 22866 lane km

Road Inventory and Surface Condition data

Calculation of Pavement Condition Index (PCI) as per IRC: 82-2023 i.e. 0 (failed) to 100 (Excellent) Scale Rating

Falling Weight Deflectometer Survey on Roads Having PCI < 80

FWD Deflection Data

Traffic Data

Axle Load Data

Pavement Crust Details

History Data & Costs

Odisha Road Asset Management System (ORAMS)

Development of Annual Maintenance Plan Using HDM-4

Pavement Condition Index (IRC: 82-2023)

CODE OF PRACTICE FOR MAINTENANCE OF BITUMINOUS ROADS

(Second Revision)

IRC:82-2023

INDIAN ROADS CONGRESS
2023

Representation of PCI Scale

| IRI |
| Pothole |
| Rut Depth |
| Cracking |
| Ravelling |
| Patch Work |

- Excellent — >80-100
- Good
- Satisfactory — >40-80
- Fair
- Poor — 0-40
- Failed

Maintenance Recommendations based on PCI value (0-100 scale)

Condition	Excellent to Good		Satisfactory to Fair		Poor to Fail	
	Excellent	Good	Satisfactory	Fair	Poor	Fail
PCI Rating	>90 to 100	>80 to 90	>60 to 80	>40 to 60	>20 to 40	0 to 20
Recommendations	Routine Maintenance	Preventive Maintenance	Renewal (as per section 9.5)	Minor Rehabilitation (based on Structural evaluation)	Major Rehabilitation/ Structural Overlay	Re-Construction

Modern Data Collection Techniques
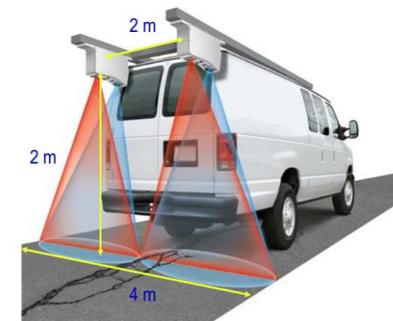

Network Survey Vehicle

UAV / Drone

Falling Weight Deflectometer

Ground Penetrating Radar

Continuous Friction Measurement

Weight-In Motion

Automatic Vehicle Counter cum Classifiers

Modern Data Collection Techniques

Odisha Road Asset Management System (ORAMS)

A unified, GIS-enabled digital platform for network level decision support

ORAMS serves as the single source of truth for the state's road network, integrating disparate datasets into a centralized, geo referenced database accessible via orams.in.

Unified Asset Database
Integrates road inventory, pavement condition, structural strength, bridge data and maintenance history.

GIS Visualization
Spatially consistent visualization of network performance enabling transparent monitoring across circles. .

Decision Support Integration
Formats data inputs for HDM-4 modelling, linking condition data to economic analysis.

SYSTEM ROLE
ORAMS acts as the information Backbone while HDM-4 serves as the Analytical Engine.

Framework for Annual Maintenance Plan

The Annual Maintenance Plan (AMP) is developed using a data-driven RAM approach

1

Integrated Data Collection

All critical road information is collected:
- Road geometry & pavement type
- Pavement crust composition
- Surface condition (NSV surveys)
- Structural strength (FWD tests)
- Traffic volume, axle loads & growth
- GIS-based inventory

All data was stored in a unified database-ORAMS.

2

Performance Modelling & Economic analysis

Using HDM-4:
- Pavement deterioration is predicted
- Future condition under different treatments is estimated
- Life-cycle cost analysis is performed
- Both agency cost and road user cost are considered

➡ Output:
Economic indicators for comparing treatment options

Framework for Annual Maintenance Plan

The Annual Maintenance Plan (AMP) is developed using a data-driven RAM approach.

3

Prioritization & Budget Optimization

Road sections are ranked using:
- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Benefit–Cost Ratio (BCR)

✓ Treatments are selected

✓ Timing is optimized

✓ Budget is allocated where maximum network benefit is achieved

4

AMP Formulation & Monitoring

The final AMP includes:
- Section-wise treatment type
- Year of intervention
- Estimated cost

After implementation:

Condition & traffic are re-surveyed

Data are updated in RAM system

Results feed back into next planning cycle

State-Level Maintenance Budget Distribution
Optimized allocation across 22,866 lane km (Unconstrained Budget)

Investment Breakdown

THIN STRUCTURAL OVERLAYS (≤40 MM)
Network-level preservation strategy
73.92%
₹1,095.60 Cr

THICK OVERLAYS (>40-140 MM)
Structural strengthening for high traffic
23.63%
₹350.27 Cr

ROUTINE MAINTENANCE
Essential serviceability & safety
1.25%
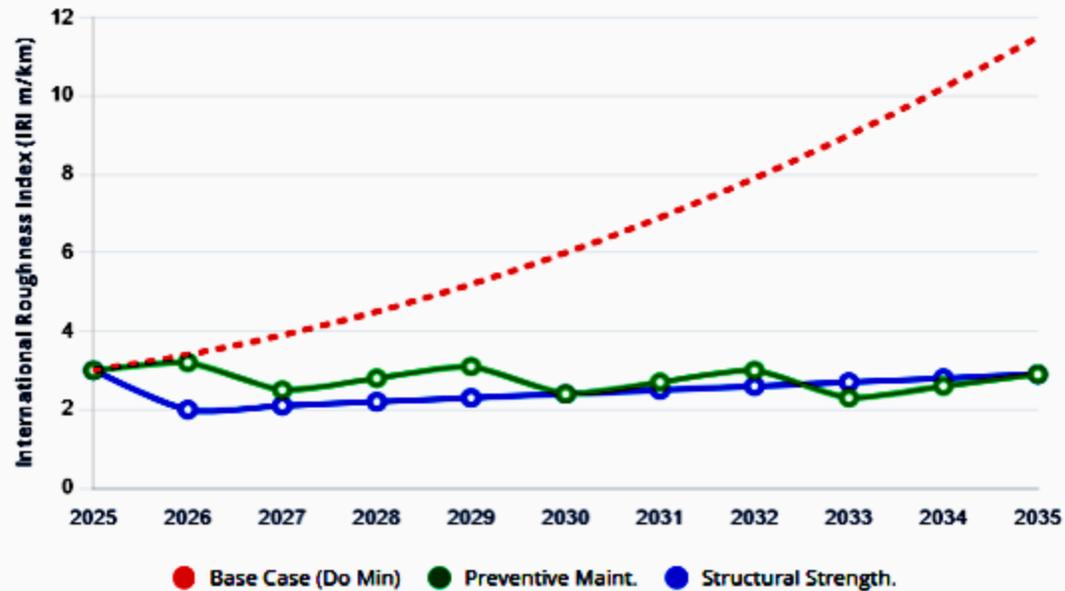₹18.58 Cr

PREVENTIVE MAINTENANCE
Surface renewals & protection
1.19%
₹17.69 Cr

● *Data Source: ORAMS Annual Maintenance Plan Reports, 2025*

Economic Analysis & Strategy Selection
Comparing life-cycle performance of maintenance alternatives on flexible pavements
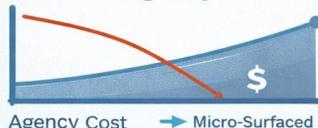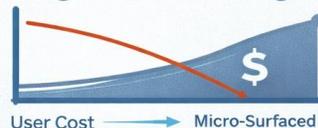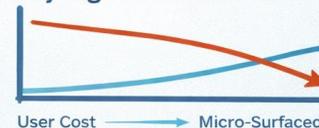
The base case leads to rapid deterioration (IRI>6), Preventive Interventions Keep roughness low (IRI 2.5-3.5), significantly reducing vehicle Operating Costs (VOC)

Economic Analysis & Strategy Selection

Comparing life-cycle performance of maintenance alternatives on flexible pavements

Key Technical Finding

Integrated roughness–economic evaluation using HDM-4 shows:

✓ **Early, timely strengthening = lowest life-cycle cost**

✓ **Delayed heavy rehab = economically inefficient**

✓ **Preventive/performance-based strategy maximizes returns**

Overall Key benefits & Outcomes
Value delivered by the ORAMS data-driven framework

Asset Longevity

+5-10 years
Pavement Life Extension
Achieved through timely preventive interventions like surface renewals

Financial Efficiency

20-30%
Life-Cycle Cost Reduction
Savings in maintenance and rehabilitation costs versus reactive strategies

Reduced User Costs
- Lower Fuel Consumption
- Reduced Tyre Wear
- Minimized Travel Delays

Improved Performance
- Better ride quality (IRI) and Safety Standards across network

Better Governance
- Transparent, objective, and defensible Annual Maintenance Plans (AMP) removing subjectivity from allocations

Replicability for Other States

A scalable pathway for sustainable road asset management adoption

Implementation Strategy

01 Digital Foundation
Establish centralized GIS-based asset database (e.g., ORAMS) with strict data standards.
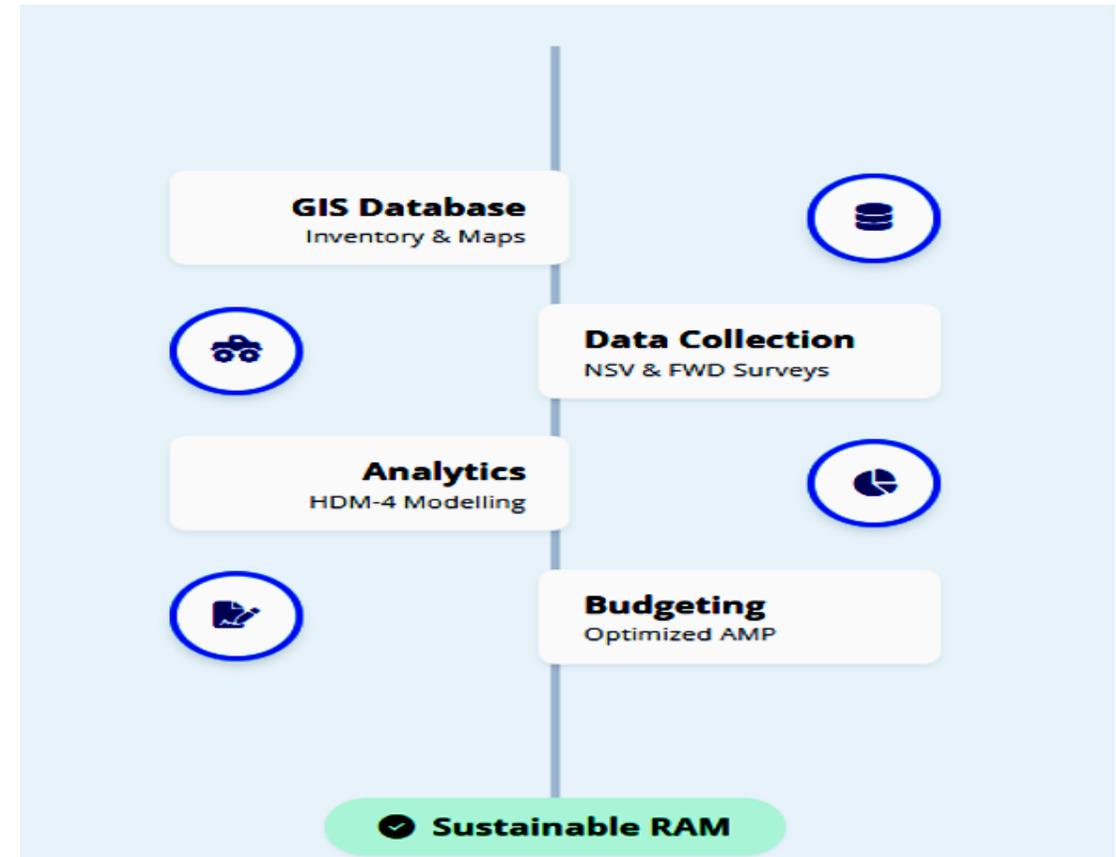
02 Regular Monitoring
Institutionalize network-level NSV, FWD, Traffic, and Axle Load surveys.

03 Analytical Framework
Configure and calibrate HDM-4 models with local costs and deterioration parameters.

04 Policy Integration
Link economic prioritization (NPV, BCR) directly to annual budgeting processes.

GIS Database
Inventory & Maps

Data Collection
NSV & FWD Surveys

Analytics
HDM-4 Modelling

Budgeting
Optimized AMP

✓ **Sustainable RAM**

Vision for the Future RAMS

- **Establish an intelligent, technology-driven road asset management ecosystem.**

- **Leverage AI, IoT, and cloud computing for predictive and real-time decision-making.**

- **Ensure nationwide standardization and seamless data integration.**

- **Strengthen cybersecurity and ensure data-driven governance.**
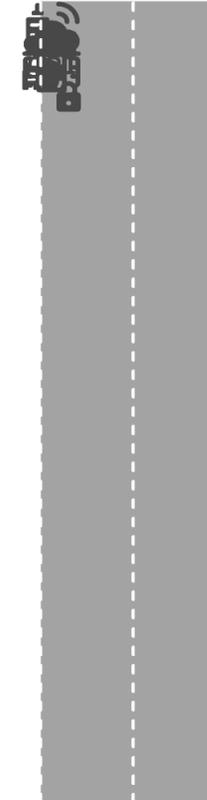
Road Asset Management Ecosystem Development

Establish Ecosystem
Initiate the creation of a technology-driven management system

Leverage AI and IoT
Utilize advanced technologies for decision-making

**Ensure Standardization**
Standardize processes and systems nationwide

Strengthen Cybersecurity
Enhance security measures for data protection

Thankyou

REFERENCES

❖ **IRC:130-2020 – Guidelines for Road Asset Management System**

❖ **IRC:82-2023 – Code of Practice for Maintenance of Bituminous Road Surfaces**

❖ **IRC:115-2014 – Guidelines for Structural Evaluation Using FWD**

❖ **IRC SP:16-2019 – Guidelines on Measuring Road Roughness**

❖ **Highway Development and Management Tool (HDM-4) Manuals**

❖ **Odisha Road Network-Annual Maintenance Plan Reports, 2025, CSIR-CRRI, New Delhi.**

❖ **MoRTH Specifications for Road and Bridge Works, 5th Edition, 2013**
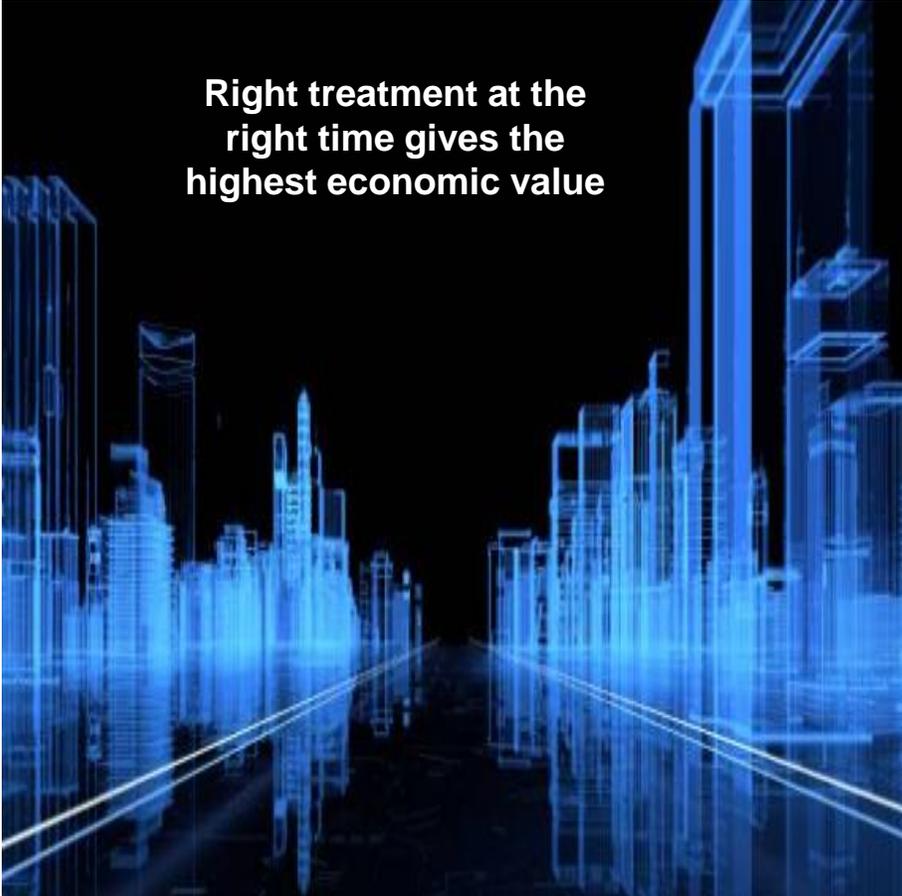
Right treatment at the right time gives the highest economic value