RMF
Roads Maintenance Forum

From Data to Action

(Not data-to-archive)

Smarter Data Solutions for Smarter Road Maintenance

Shaun Moodley
ARRB Systems

24 JUNE 2026

Introduction

- Road Data
- Better Condition Insight
- Predict Deterioration
- Better Maintenance Timing
- Protected Pavement Life Cycle
- Safer Roads + Lower Life-Cycle Cost

The Real Cost of Waiting

Weak data means…

- deterioration is underestimated
- maintenance is delayed
- life-cycle cost escalates
- road safety risk grows.

How Pavement & Road Safety Data Drive Maintenance Decisions

Combining asset condition and safety risk into practical road maintenance strategies

Pavement condition data

IRI, rutting, cracking, deflection, texture, imagery

Road safety data

Markings, delineation, roadside hazards, shoulders, crossings, speed environment

Integrated evidence base

Asset + safety + location

Decision filters

Structural risk
Surface distress
Safety risk
Freight exposure
Service criticality

Maintenance decisions

Crack seal, patch, resurface, strengthen / rehabilitate

Safety maintenance

Re-mark, RRPMs, chevrons, shoulders & barriers

Corridor packaging

Route work orders, quantities, traffic accommodation & annual programmes

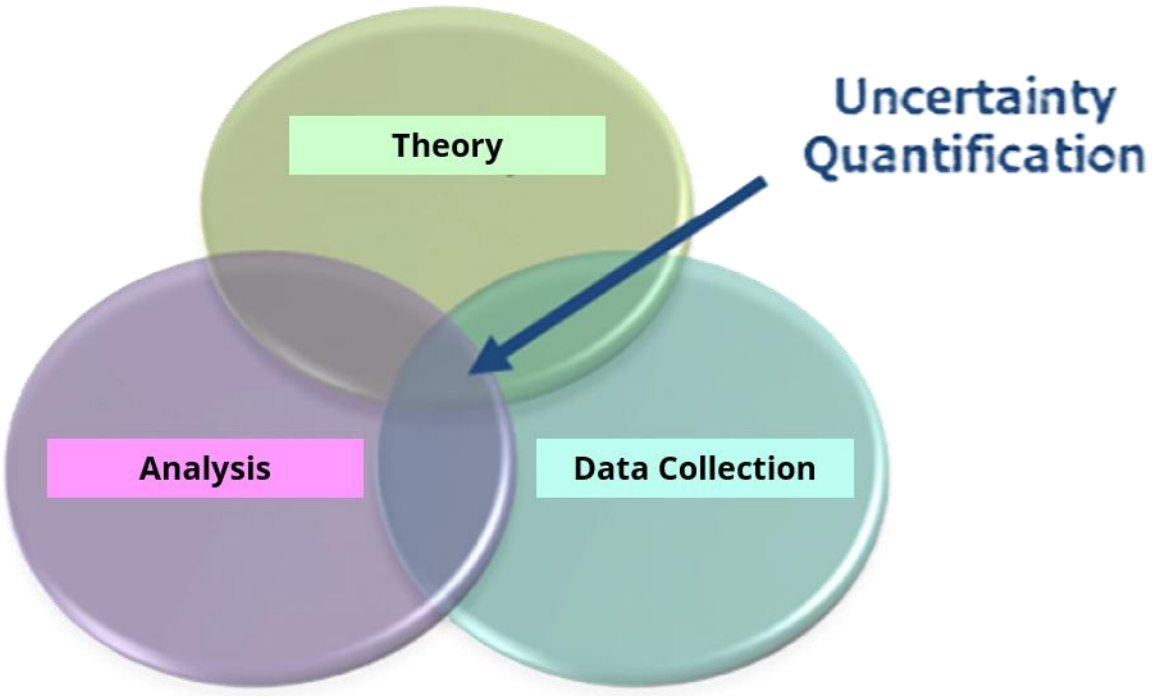
Strategy outcomes

Lower whole-life cost
Safer roads
Targeted budgets
More credible maintenance plans

If the datasets remain separate or too sparse → weak zones get hidden → intervention timing weakens → treatment escalates → cost and safety risk rise.

Reducing Uncertainty

Continuous data reduce uncertainty, improve confidence in deterioration analysis, and help road authorities intervene earlier, more accurately, and more cost-effectively.



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PAVEMENT MANAGEMENT INTELLIGENCE

Intelligent Pavement Assessment Vehicle (iPAVE)

NSV – Hawkeye 2000

Intelligent Safety Assessment Vehicle (iSAVE)

Better Data = Better Decisions

- Unlike sparse or ***point-based*** surveys, **iPAVe** provides ***continuous traffic-speed pavement data*** that reveal localised weaknesses and improve the reliability of deterioration analysis.

- This gives road authorities better information, better timing, and better maintenance decisions—reducing cost escalation and preserving the network for longer.

Intelligent Pavement Assessment Vehicle (iPAVE)

Intelligent Pavement Assessment Vehicle (iPAVe)

Comprehensive Pavement Assessment TM

+ 3D Roughness
Full Lane

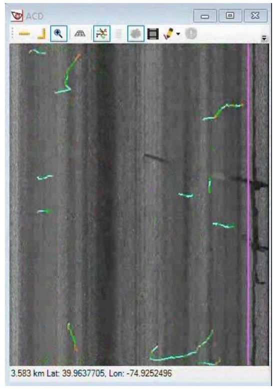
+ GNNS DGPS geospatial location

+ Geometry
Cross fall, Grade, Horizontal and Vertical curvature

+ 3D Rutting
Full Lane

+ 3D Cracking
Full Lane

+ 3D Surface Defects
Full Lane



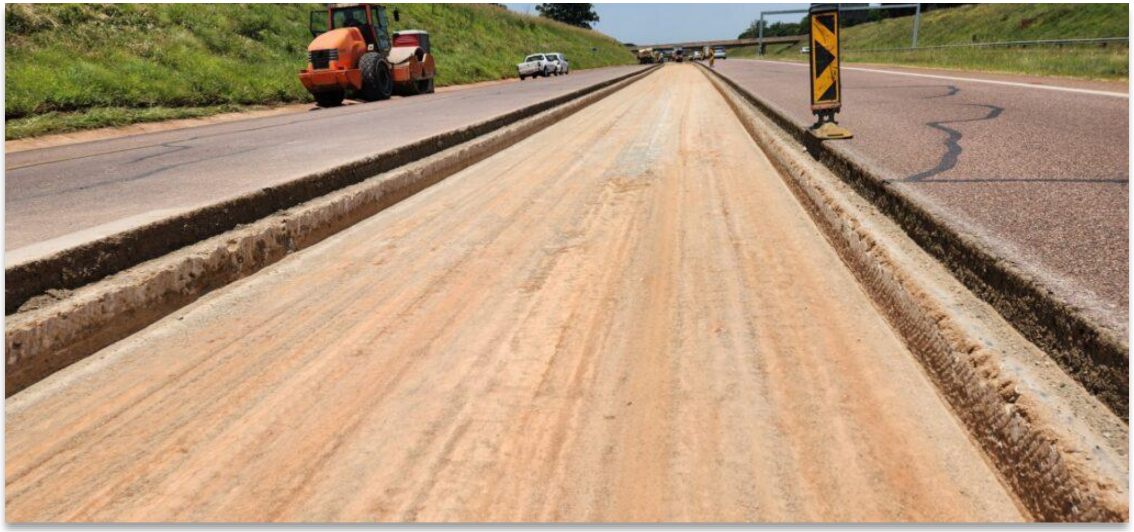
Continuous Deflection Measurement
Pavement velocity
Full Deflection Bowl
Applied Load
Surface & Air Temperature

Roughness
Left and Right wheel paths

+ Texture
Centre and Both wheel paths

+ Digital imaging system

Maintenance Timing, LCA & Asset Management



Study Area & Data

Study Area

- Historic multi-year iPAVe datasets from 10 provincial road sections on the KwaZulu-Natal road network.
- Survey history covered 2020–2023 with georeferenced measurements aligned to kilometre positions.

Data Source

- Continuous pavement condition data collected with iPAVe, integrating structural and surface performance measurements.
- The study focused on data histories that were consistent enough to compare year-on-year deterioration.

Indicators Analysed

- **IRI** → functional condition
- **Rut depth** → surface deformation
- **Ymax** → structural capacity / pavement response

A Road Does Not Fail Evenly

Coefficient of Variation (CV)

- IRI = 0,377
- Rutting = 0,440
- Ymax = 0,477

Conclusion

- Condition is not uniform along a route.
- Some parts are much weaker or more distressed than others.

Median vs P90

- IRI = 1,59
- Rutting = 1,69
- Ymax = 1,78

Conclusion

- Evidence of localised deterioration / weak spots.

Take Away

If you average a whole road section together, the road can look “acceptable,” even though some short stretches are already weak enough to need maintenance.

Sparse Sampling Affects Deterioration Estimates

Continuous data are reduced to 200 m intervals, to imitate a more traditional sparse survey approach.

Slope Error

- IRI = 18.45%
- Rutting = 6.19%
- Ymax = 8.93%

Conclusion

- When the data are made sparse, the **estimated rate of deterioration** becomes less reliable, especially for IRI.

Take Away

- With limited (sparse) data, the road may appear to deteriorate faster or slower than it does.
- This is important because maintenance planning depends heavily on how fast you believe the road is deteriorating.

Maintenance Timing Shift

Compare the time to a 20% decrease in condition using continuous and sparse data.

Median Timing Diff.

- IRI = +0,15 years
- Rutting = +0,03 years
- Ymax = - 0,17 years

Upper-end Variability of P90 timing deviations

- IRI = ± 9,5 years
- Rutting = ± 0,9 years
- Ymax = ± 4,3 years

Conclusion

- For some road sections, especially where deterioration is slow, sparse data can produce very large differences in predicted maintenance timing.
- Sparse data might tell you to intervene years too early or years too late.
- Significant because maintenance timing is one of the most important decisions in road management.

Lessons Learnt

IRI showed the highest sensitivity to sparse sampling.

When **Δ** IRI is slow, small errors in the **Δ** deterioration slope can result in large errors in predicted maintenance trigger timing.

When deterioration is nearly flat the timing estimate becomes mathematically unstable.

If the road is deteriorating only a little each year, and your data are not detailed enough, a small misreading of the trend can shift the predicted intervention year by a long time.

- Continuous data show the real condition picture more clearly, especially the weak spots and the real deterioration trend.
- Sparse data may hide those weak spots and distort the timing of maintenance.

If the timing is wrong, the selected treatment may also be wrong — and that usually means higher cost and poorer life-cycle outcomes.

Why This Matters Now

THE CASE FOR ACTION

South Africa's Roads Are Under Simultaneous Structural And Safety Pressure

750 000 km
Total national road network

R197 bn
Estimated road infrastructure backlog

10 154
Deaths on SA roads in 2024 (as of 1 Dec 2024)

83%
Share of Jan–Sep 2024 freight payload moved by road

- Many authorities still struggle to turn survey outputs into funded maintenance operations.
- Heavy freight accelerates rutting, edge-breaks, crack opening and structural fatigue on strategic routes.
- Routine maintenance is often the cheapest chance to preserve both pavement life and human life.

Thought-provoking lens

If the network is deteriorating rapidly, the question is no longer "**Do we have data**?"

It is: "**Can we turn every 100 m of data into the next most sensible maintenance action**?"

Urgency + freight pressure + safety risk = a maintenance intelligence problem

The Real Problem: The Data-to-Action Gap

Authorities often buy surveys, but do not buy the maintenance decisions that should follow

Data collected
Cracks, rutting, roughness, deflection, geometry, imagery, road safety attributes

Analysis produced
Spreadsheets, dashboards, km-condition summaries, star ratings

Action stalls
No crack sealing package, no line-marking programme, no annual re-marking plan, no route work bank

Consequence
Deferred routine maintenance, higher rehab costs, faster deterioration, avoidable crashes

THE GAP

Operational Consequence

Crack maps do not become crack-seal gangs and route sheets.

Road-marking deficiencies do not become re-marking schedules, RRPM replacement lists or bend delineation packages.

Defects are known, but work orders, quantities, traffic accommodation plans and annual maintenance packages are not generated fast enough.

The opportunity is not more data collection; it is better maintenance conversion

ARRB's Maintenance-Intelligence Stack

The same datasets can support PMS, maintenance operations, asset management and safer roads

SOLUTIONS

iPAVe / Hawkeye Pavement Intelligence
Continuous deflection, roughness, rutting, cracking, texture, geometry and synchronised imagery

Asset & Visual Inventory
Signs, delineation, shoulders, drainage, edge-breaks and location-referenced defects

Maintenance Analytics
Segment prioritisation, annual work-bank generation, budget scenarios, quantity take-off and QA

One corridor

One pass

One evidence base

Road Safety Intelligence
Road markings, edge delineation, chevrons, roadside severity and safety investment logic

Maintenance Operations Conversion
From route-level "what is wrong?" to supervisor-level "what do we do this month?"

Safety + Preservation In One Programme
Patch, seal, mark, delineate, clear drains and restore shoulders in a single package

Same surveys, multiple decisions: structural, functional, operational and safety

Why iPAVe Matters For Maintenance Operations

Traffic-speed, network-scale structural and surface intelligence

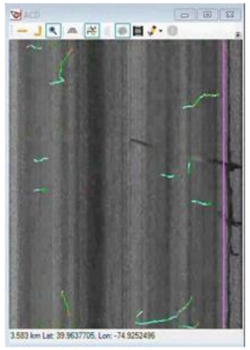
IMAGE-ENHANCED

+ 3D Roughness
Full Lane

+ 3D Rutting
Full Lane

+ 3D Cracking
Full Lane

+ 3D Surface Defects
Full Lane



+ GNNS DGPS geospatial location

+ Geometry
Cross fall, Grade, Horizontal and Vertical curvature

Continuous Deflection Measurement
Pavement velocity
Full Deflection Bowl
Applied Load
Surface & Air Temperature

Roughness
Left and Right wheel paths

+ Texture
Centre and Both wheel paths

+ Digital imaging system

Comprehensive Pavement Assessment

What changes?

Not just "**How rough is the road**?" but also "**Is the structure still carrying the load**?"

Operations language

This supports decisions such as crack seal, route patch, wheel-path repair, mill-and-replace, reseal, overlay or rehabilitation.

Implication

Do not overlay where the corridor needs strengthening. Do not wait for local failures to become corridor failures.

From Inspection Vehicle To Maintenance Work Order

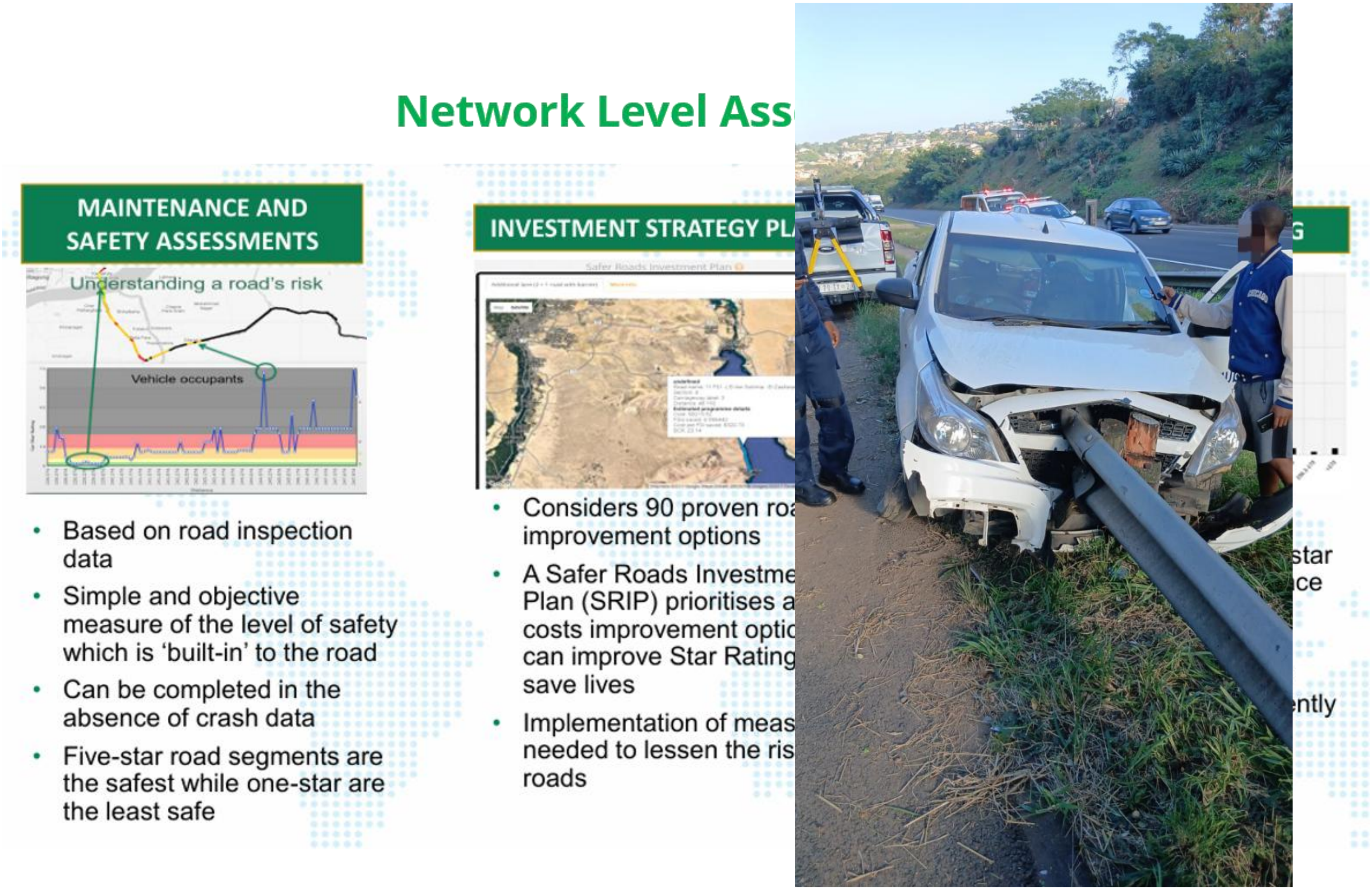
How road maintenance operations can run off the same evidence base

1. Inspect	Collect images, condition, geometry and safety attributes at network speed
2. Diagnose	Sort defects into preservation, patching, shoulder, drainage, line-marking and delineation needs
3. Quantify	Generate lengths, areas, counts, crew outputs and route sections
4. Package	Bundle annual work orders by corridor, depot, contractor, budget and traffic accommodation needs
5. Execute	Issue route sheets, work orders, re-marking schedules, RRPM counts and drain-clearing instructions
6. Close out	Validate quantities, QA the work, update the asset record and report performance

The missing discipline is often not inspection—it is conversion into work orders and packages

Use Road Safety Data To Drive Routine Safety Maintenance

Safer Roads logic can and should inform ordinary road maintenance programmes



A road safety finding is often a maintenance instruction

What this becomes operationally

Road markings, delineation and low-cost route treatments become annual maintenance deliverables—not merely safety observations.

Faded / missing edge lines

Add to annual re-marking programme and night-works plan

Missing RRPMs

Add to route-based replacement quantities and procurement schedule

Poor bend delineation

Package chevrons, guideposts and advisory signs per curve group

Shoulder and edge distress

Repair edge-breaks and reinstate markings together in one lane closure

Implementation of Roller Barriers Utilising Innovative Road Assessments

P5 (Ixopo)
44 lives saved

P47-1 (Empangeni)
The driver was saved

Turn Crack Data Into A Crack Sealing & Patching Programme

PRACTICAL EXAMPLE

Do not let "condition reporting" replace preservation action

1. Segment	Break routes into short homogeneous lengths and classify crack type, severity and activity.
2. Filter	Separate preservable cracks from failed areas that require patching, edge-break repair or stronger treatment.
3. Quantify	Generate lengths for crack sealing, areas for patching, shoulder lengths and traffic-control needs.
4. Bundle	Create corridor-based packages by productivity, material type, depot access and lane-closure windows.
5. Dispatch	Issue route sheets and daily work instructions for crack-seal gangs and patching crews.

Maintenance insight

The value is not only in knowing where cracks are. The value is in dispatching the right preservation treatment before moisture ingress and pumping turn maintenance into rehabilitation.

Practical output: route sheets, crew tasks, quantities and annual packages

One Corridor, One Integrated Work Order

What corridor-level decision-making can look like operationally

INTEGRATED PLAN

Segment 0.0–4.2 km	crack seal + shoulder edge repair + line re-marking
Segment 4.2–6.1 km	localised base repair / strengthening before any overlay
Segment 6.1–9.5 km	surface treatment candidate — reseal / thin surfacing where structure is still adequate
Curves at 2.8 km and 7.4 km	chevrons + RRPMs + advisory speed signing + edge lines
Drainage low point at 5.6 km	clear drains, restore outlets and protect pavement edge

What this means operationally

A corridor programme should combine preservation, structural repair, safety maintenance and drainage actions on the same map and in the same budget.

This is easier to tender, easier to supervise and easier to report than disconnected defect lists.

Move from defect lists to route work orders

KwaZulu-Natal / Durban example

Why this maintenance story is especially relevant in the Durban–Pietermaritzburg–Gauteng freight and safety context

Why KZN matters

The M7 corridor is a major road freight route for the province and SA.

The Port of Durban is a dominant container gateway and a generator of heavy vehicle demand on the regional road system.

What this means operationally for KZN

- Delayed maintenance = lane closures, lost productivity, elevated vehicle operating costs and safety risk.
- Early crack sealing, route patching, shoulder support, drainage upkeep, line re-marking and bend delineation are especially valuable.

A simple Durban / KZN use case

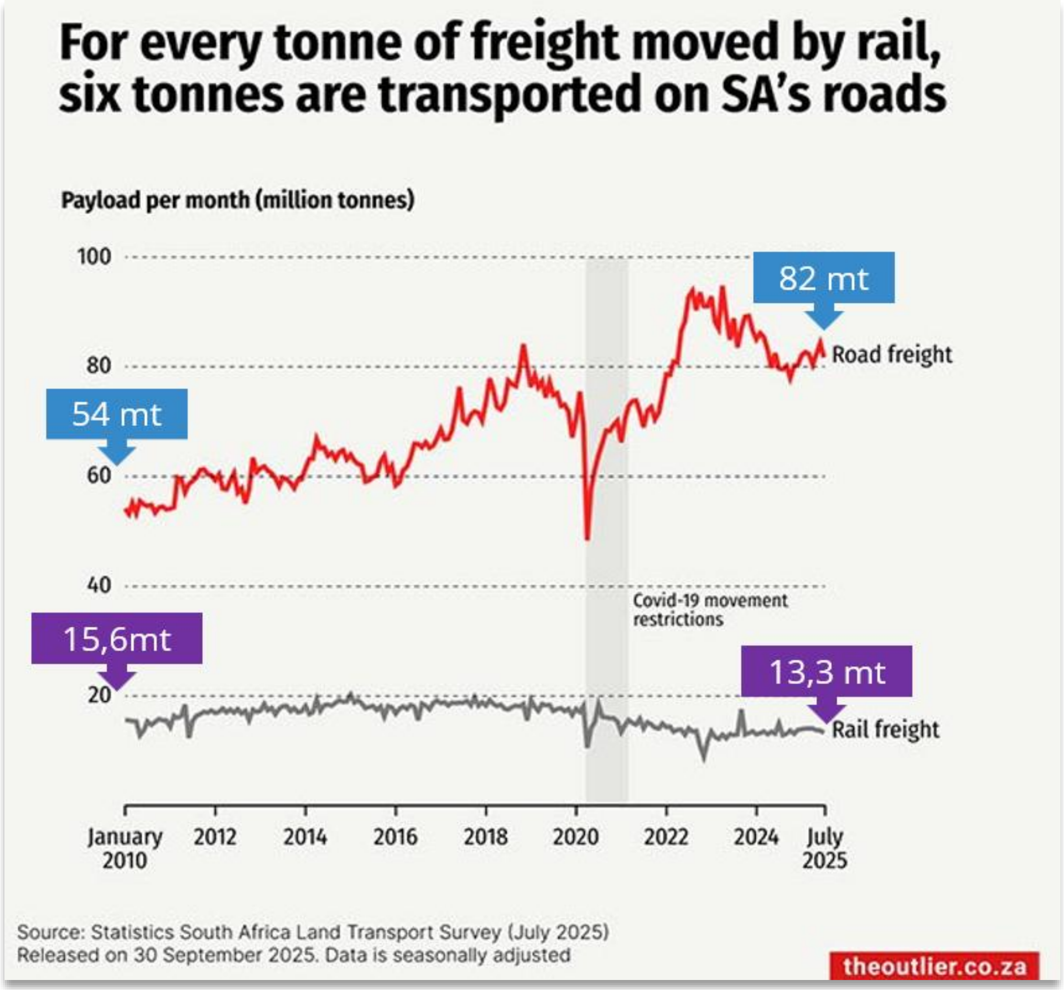
Route-level surveys identify where freight demand, distress and safety risk overlap.

Convert the data into scheduled work: crack-seal lengths, patch areas, shoulder runs, RRPM counts, line-marking quantities and traffic accommodation windows.

Pavement data, road safety data and operations planning become one corridor maintenance programme.

Freight Changes The Maintenance Equation

Where heavy traffic concentrates, timing and treatment selection matter more



Pavement implication

Accelerated pavement wear such as rutting, edge-breaks and structural fatigue. Increased need for timely maintenance.

Operations implication

Prioritise inspection frequency, patching cycles, shoulder reinstatement, marking refresh intervals, wet weather resilience, etc.

Road safety implication

Increased exposure on high-speed corridors. High risk and severity of run-off-road and head-on crashes where markings, delineation, shoulders or roadside protection are poor—especially at night, in wet weather and on curves.

Use freight exposure to prioritise corridor timing and inspection frequency

Cost-benefit Analysis: Why Early Maintenance & Safer Road Treatments Pay

COST-BENEFIT

The best business cases combine preservation, operations and safety

Cost side of the equation

Direct treatment cost: crack sealing, route patching, line marking, RRPMs, chevrons, shoulder repairs, drainage clearing and traffic accommodation.

Programme cost: supervision, lane closures, mobilisation, quality control and contractor management.

Benefit side of the equation

Asset preservation: delay of costly rehabilitation and lower LLC

Operations benefit: fewer emergency repairs, fewer unplanned closures and smoother route serviceability.

Safety benefit: lower exposure to run-off-road and head-on risk where delineation, markings and barriers are improved.

Decision rule for local authorities

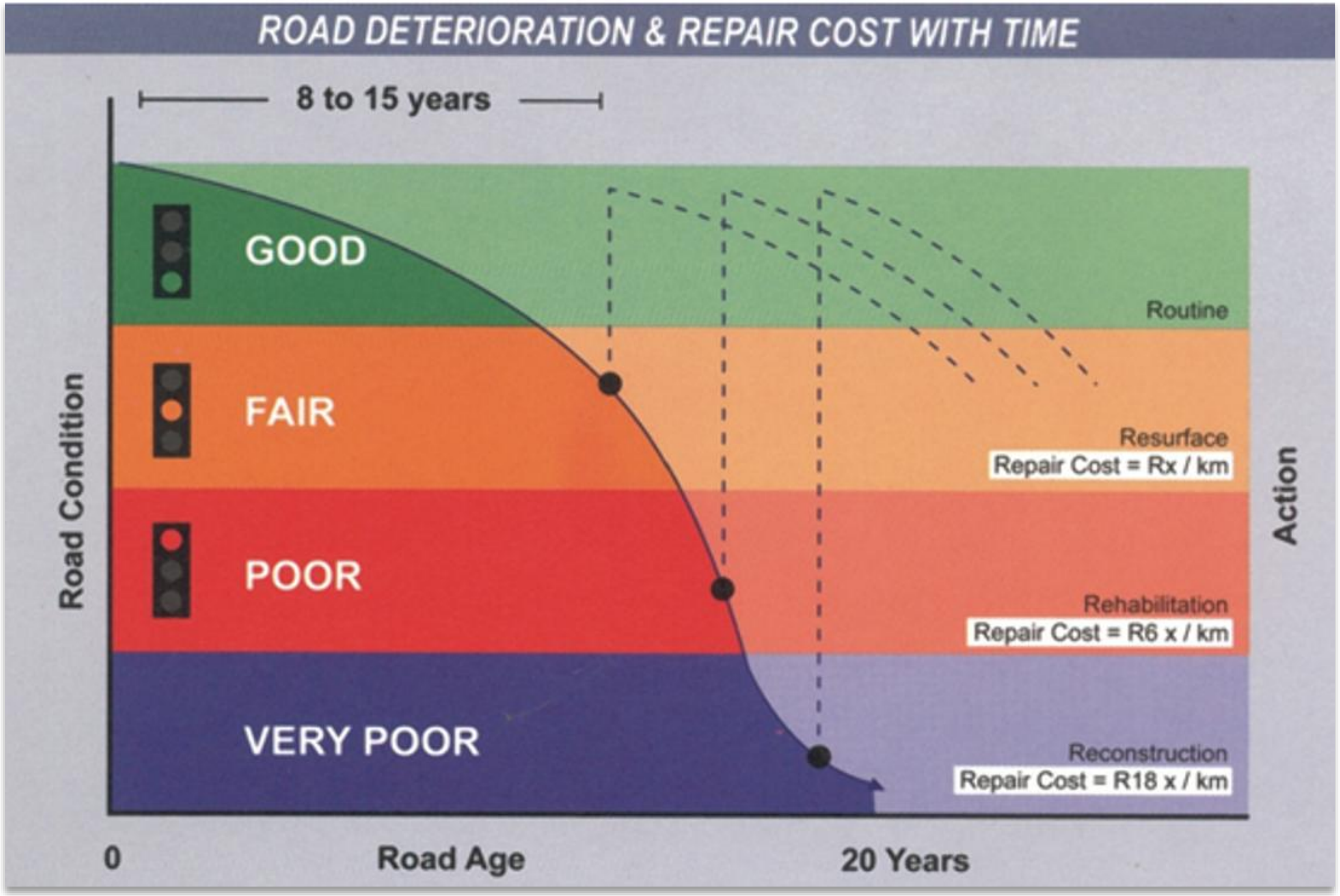
Favour treatments that are low unit cost, quick to deploy, network wide in reach and defensible in both pavement and safety terms.

Crack sealing, route patching, shoulder support, line re-marking, RRPM replacement and bend delineation often provide a strong early return.

The strongest business case is often not "pavement only" or "safety only" — it is both together

From Data to Action — or From Delay to Decline

The future of road maintenance is not just fixing roads later — it is using better data to intervene sooner.



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