Pavement Management Future Directions

Local Perspective from City, County, and MPO

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Future directions

Local agencies are embarking on:

1. Integrated Transportation Asset Management
2. Data-driven Safety Management
3. Artificial Intelligence Technologies
4. Equity-based Transportation Planning
5. Proactive Performance Management

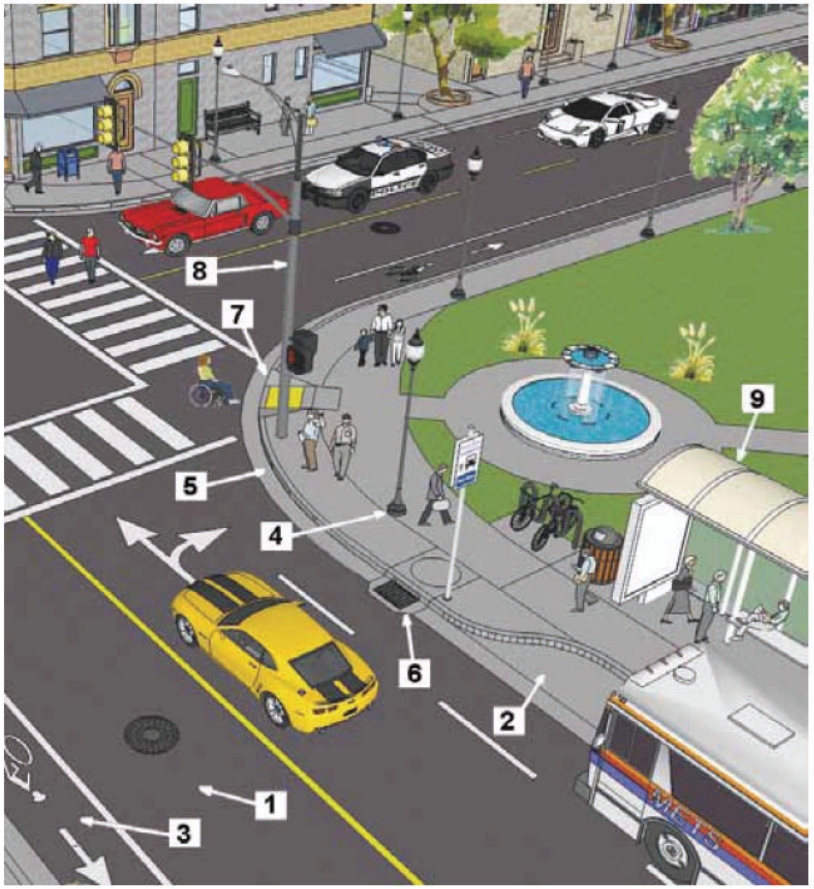
SAN FRANCISCO METROPOLITAN REGION

POPULATION = 7.5 MIL
9 COUNTIES
100 CITIES
43,500 LANE-MILES OF LOCAL STREETS & ROADS
6,850 LANE-MILES OF STATE HIGHWAY (CALTRANS)
23 TRANSIT AGENCIES
7 TOLL BRIDGES

One MPO -
Metropolitan Transportation Commission

1. Integrated Transportation Asset Management

Elements of an Urban Complete Street[8]



Example: Estimated Construction Costs for Urban Complete Street*

	Item	Total Cost Per Block Conventional Street	Total Cost Per Block Complete Street
1	Pavement Costs Attributed to Cars	$152,533	$152,533
2	Pavement Costs Attributed to Buses/Trucks	$238,333	$238,333
3	Pavement Costs Attributed to Bicycles		$47,667
	Subtotal Pavement Costs	***$390,866***	***$438,533***
4	Lights/Signs/ Markings	$41,600	$41,600
5	Curb and Gutter	$42,900	$42,900
6	Storm Drain	$153,439	$153,439
7	Sidewalk and ADA Ramp	$182,000	$182,000
8	Traffic Signal	$390,000	$390,000
9	Street Furniture and Plantings**		$187,590
	Subtotal Non-Pavement Costs	***$809,939***	***$997,529***
	Total Cost	**$1,200,805**	**$1,436,062**

* Estimate provided by city of Santa Rosa.

** Street Furniture and Plantings includes bike racks, street trees, lighted bus shelters, trash and recycle bins, benches and plant pots.

Source: MTC Pothole Report, June 2011

Where are the connections for local government?

FAST Act requires state DOTs and MPOs to focus on target setting:

- Pavement (locally owned NHS) and bridge condition (2 PMs)
- Highway Safety Improvement Plan (5 PMs/ MIRE FDE)

Pavement is not THE only asset

- Most expensive asset
- Only 30% of the total asset value
- Remaining 70% are non-pavement assets

Integrated Asset Management System

Current: Siloed Management Systems

CASE IN POINT:
PMS recommends Microsurfacing on Main Street –

1. Do you know how many curb ramps on Main Street are in compliance?
2. Do you include ADA compliance costs in your paving budget in advance?

Compliance Requirements

- MUTCD Minimum retroreflectivity
- NPDES/MS4 (Storm Drain asset)
- ADA (Curb ramp and sidewalk assets)

2. Data-driven Safety Management

Traffic Control Devices for Safety Management

- HPMS Reporting
- Inventory of roadway data (Pavement asset) – 9 FDE MIRE elements for local
- Traffic Signs
- Pavement Markings
- Traffic Signals

From Pavement Management database

MIRE FUNDAMENTAL DATA ELEMENTS COST-BENEFIT ESTIMATION

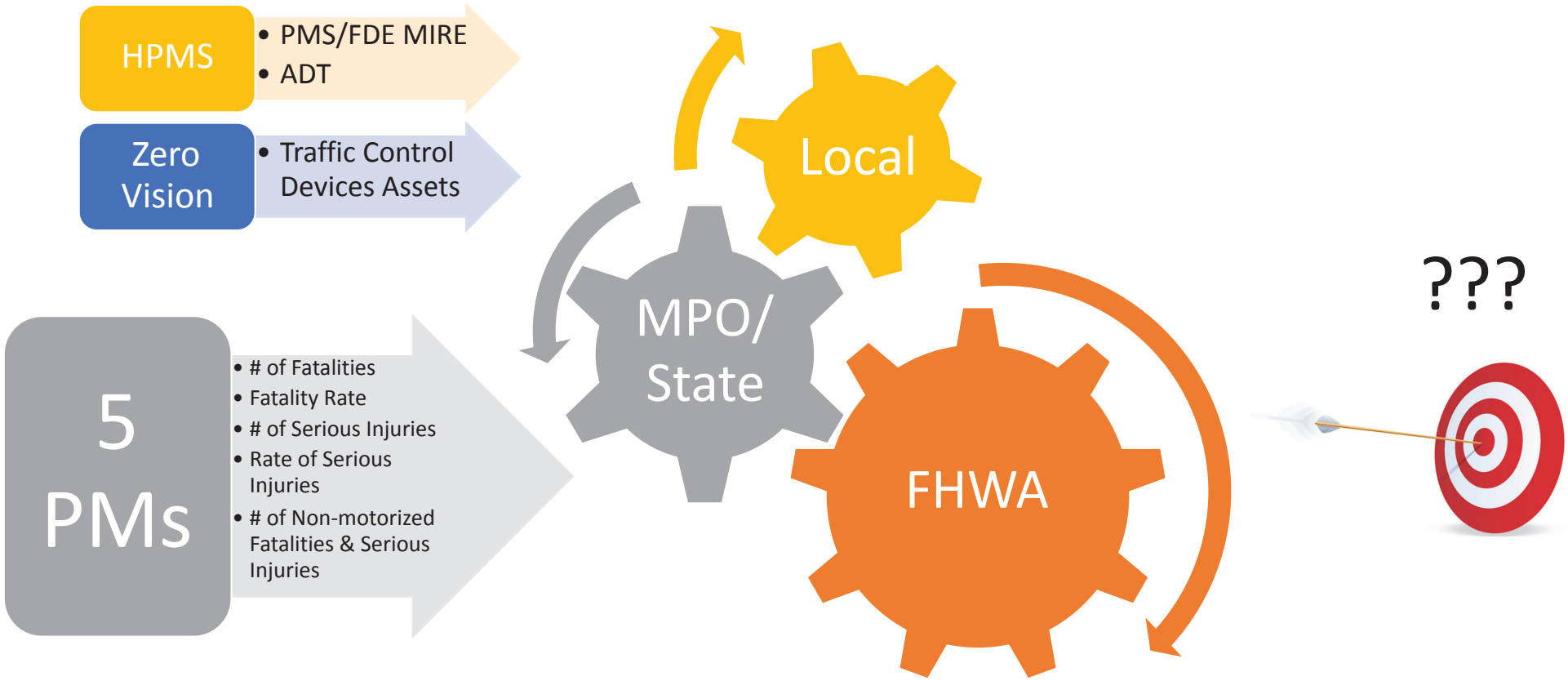
Table 2. MIRE Fundamental Data Elements for Local (based on functional classification) Paved Roads.

FDE (MIRE Number)^	Definition
Roadway Segment	
Segment Identifier (12)	Unique segment identifier.
Functional Class (19)*	The functional class of the segment.
Surface Type (23)	The surface type of the segment.
Type of Government Ownership (4)*	Type of governmental ownership.
Number of Through Lanes (31)*	The total number of through lanes on the segment. This excludes turn lanes and auxiliary lanes.
Average Annual Daily Traffic (AADT) (79)*	The average number of vehicles passing through a segment from both directions of the mainline route for all days of a specified year.
Begin Point Segment Descriptor (10)	The location of the starting point of the roadway segment.
End Point Segment Descriptor (11)	The location of the ending point of the roadway segment.
Rural/Urban Designation (20)*	The rural or urban designation based on Census urban boundary and population.

^ Model Inventory of Roadway Elements – MIRE Version 2.0 (July 2017)

* HPMS full extent elements required on all Federal-aid highways and ramps located within grade-separated interchanges, i.e., NHS and all functional systems excluding rural minor collectors and local roads.

Safety Performance Management

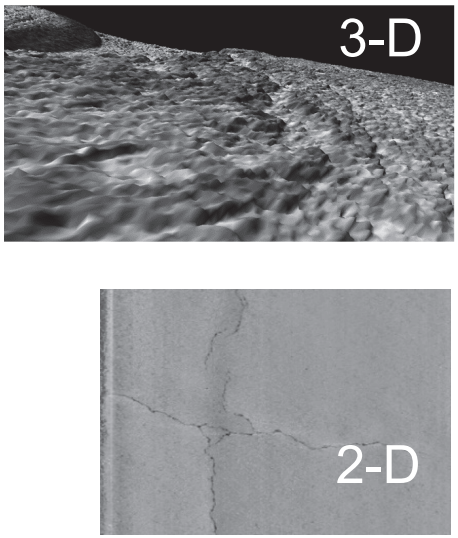


3. Artificial Intelligence Technologies

- Tentative pavement distress rating standard (ASTM) for digital images
- Use of Machine Learning, Artificial Intelligence
  - Pattern recognition
- Smartphone - Low cost, crowd sourcing

Automated Crack Detection and Classification

Hardware:
Data Acquisition

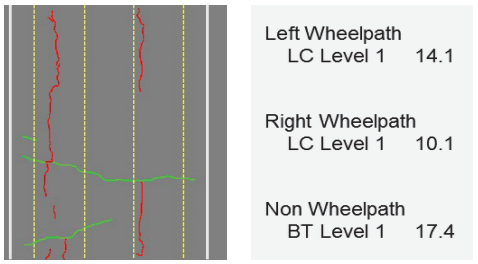


Standard Data Format

Software Analysis:
Crack Detection

Crack Map

Software Analysis:
Crack Classification and Quantification



ASTM Pavement Condition Index Survey for digital images (tentative)

1. Type
2. Severity Level
3. Extent

Source: Jiang*, C. and Tsai, Y. (2015) "Enhanced Crack Segmentation Algorithm Using 3D Pavement Data", ASCE Journal of Computing in Civil Engineering.

Automatic Sign Detection and Recognition

Image containing speed limit

Processed binary image after color segmentation

Final speed limit extraction

A low-cost, sustainable, live curve sign inventory using smart phones and automatic sign detection to ensure roadway safety. (Professor James Tsai, Georgia Tech)

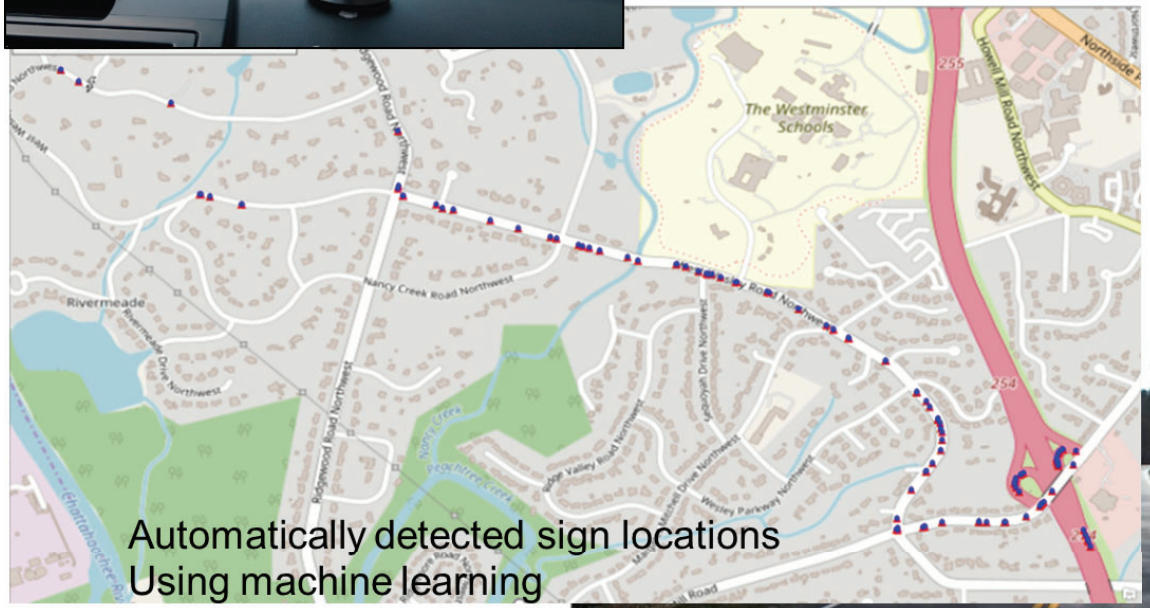
Hu, Z. and Tsai, Y. (2011) "Image Recognition Model for Developing a Sign Inventory" ASCE Journal of Computing in Civil Engineering, Vol. 25(2): 149-158.

Smart Phone for A Live Curve Sign Inventory

1.Smart phones collecting images and GPS data

(Professor James Tsai, Georgia Tech)

2.Automatically extracted sign map



Automatically detected sign locations
Using machine learning

3.Automatically identify the missing curve sign with red

4. Transportation Planning

- Equity Analysis of Transportation Funding
  - Road Condition
  - Safety
  - Equity inputs
    - Underserved pop.
    - Proximity to schools
    - Bike paths

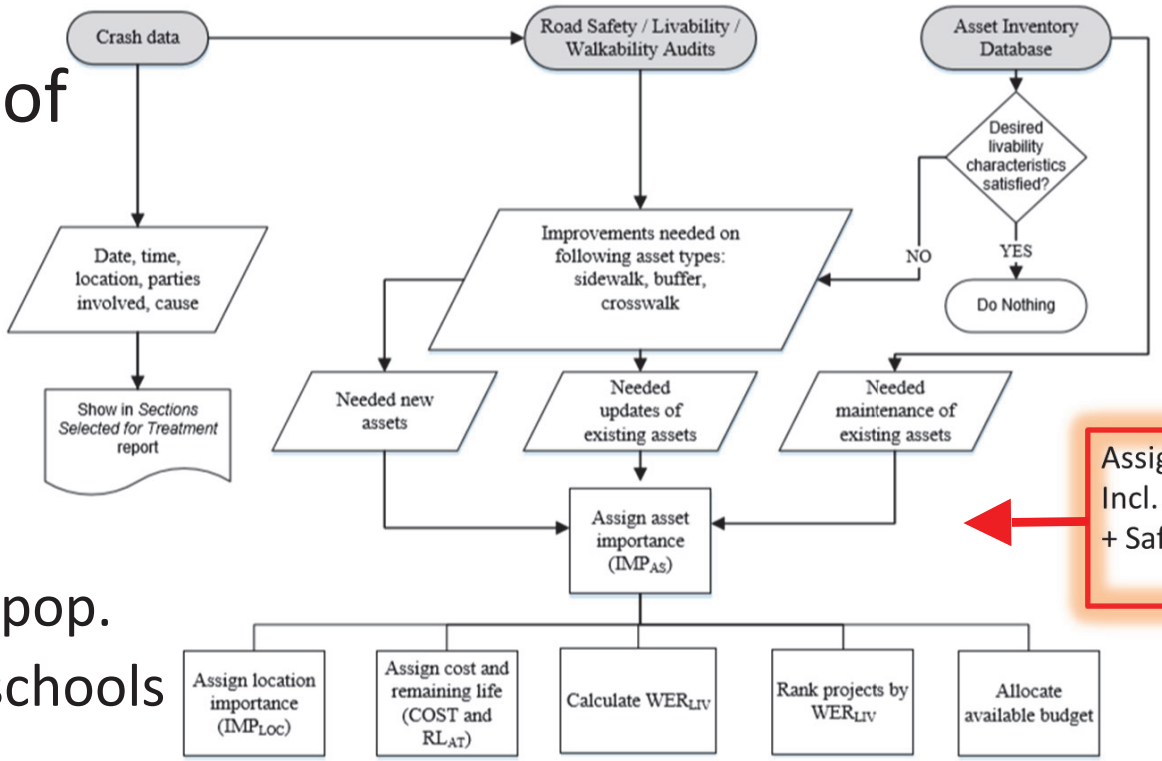


Figure 2. Livability Asset Management Framework to Prioritize Projects.

(after Chang et al. 2015).

Permission from Prof. Carlos Chang, University of Texas, El Paso

4. Transportation Planning

- Cross-Asset Optimization
  - Benefit-Cost Analysis/ Multi-Criteria Analysis/ Risk-Based Decision
    - Risk
    - Environmental
    - Social
    - Economic
    - Cultural

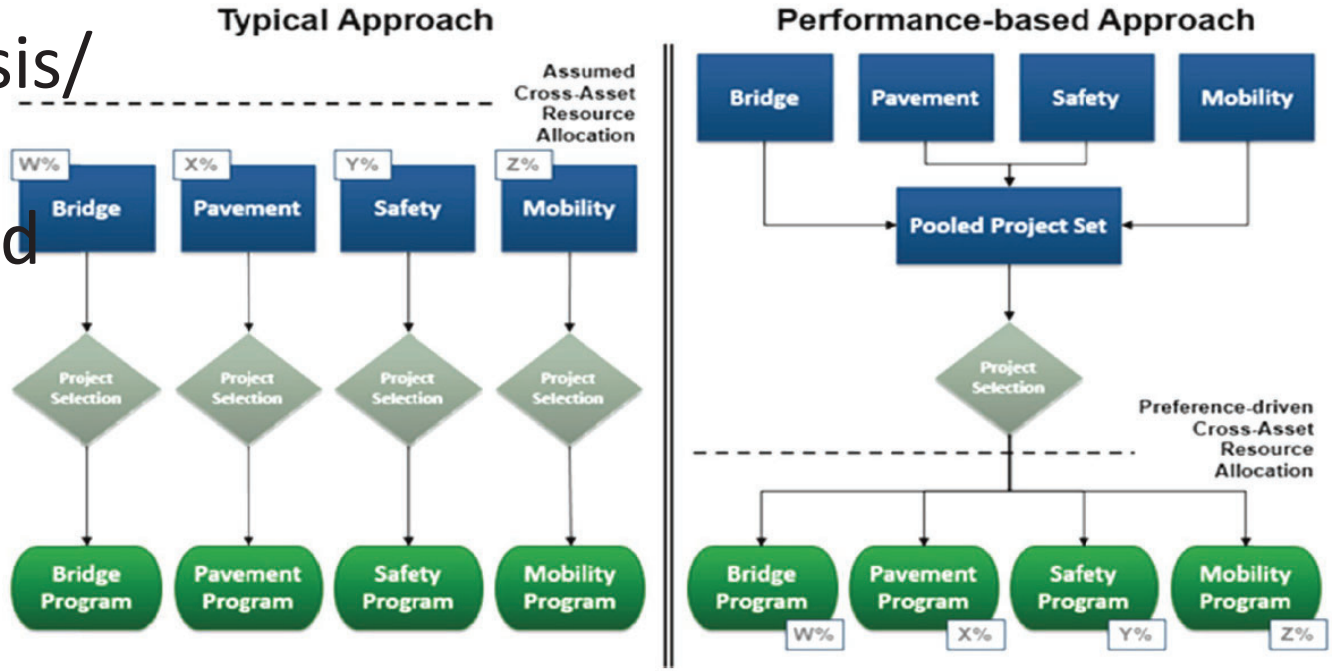


Figure 6. Typical siloed investment planning versus a performance-based approach.

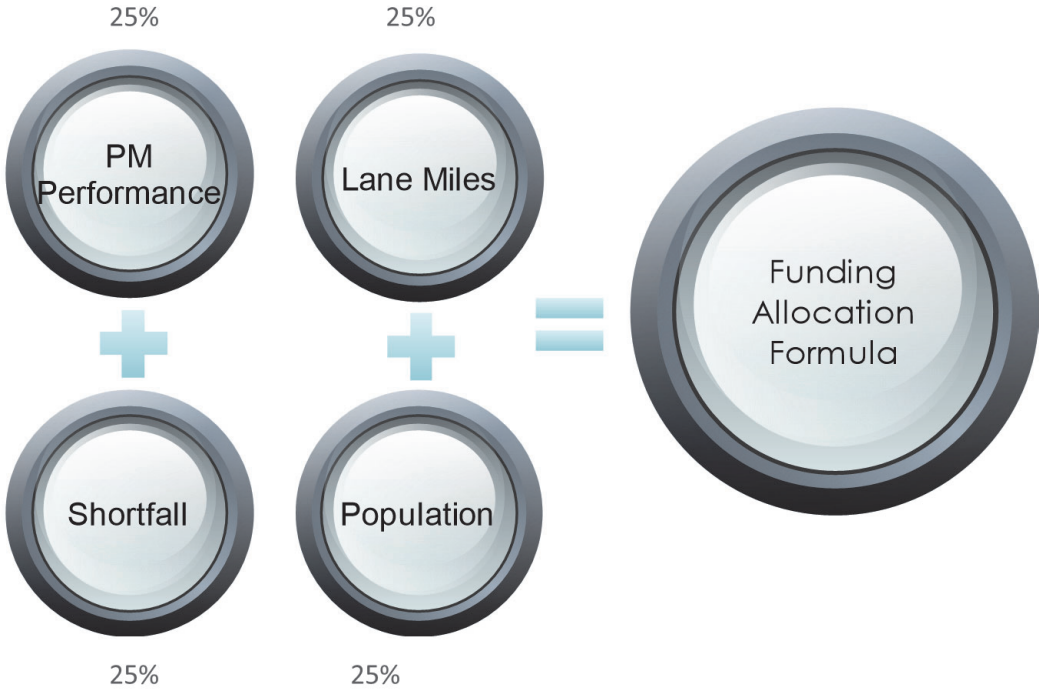
Source: NCHRP Report 806

5. Proactive Performance Management

- Outcome-driven performance metrics
  - Not quantitative, but behavior changing
    - e.g. Pavement Preservation Effort

Pavement Preservation Index (PPI)

$$\frac{\text{Actual PM \%}}{\text{Recommended PM\%}}$$



Source: https://www.pavementpreservation.org/icpp/paper/70_2010.pdf

5. Proactive Performance Management

- Leading indicator, not lagging indicator
  - Weight loss

Leading Indicator	Lagging Indicator
Activities you must undertake to achieve the desired outcome	"output" oriented, easy to measure but hard to improve

VS

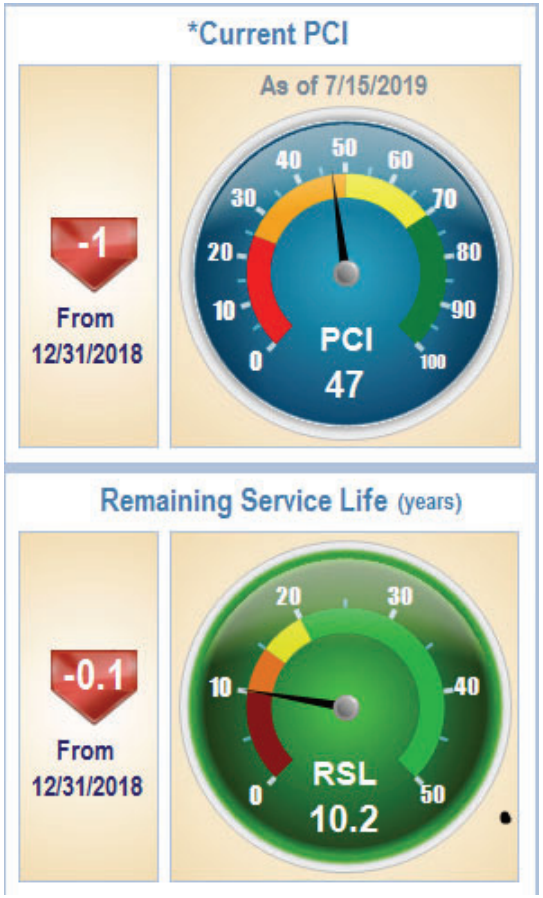
Performance Management

For Comparison of Pavement Preservation Effort:

Leading Indicator	Lagging Indicator
PCI	IRI
Detect low severity cracks early	Will only detect cracks when they are sizable

5. Proactive Performance Management

- Active management
  - Monthly vs Annually
- Data Visualization – performance dashboard
- Data Quality Management Plan
  - Focus on QC and QA on data collection
  - Develop tools and BMPs for network-level analysis



Source: MTC StreetSaver