GOVERNMENT OF PAKISTAN

MINISTRY OF COMMUNICATIONS

NATIONAL HIGHWAY AUTHORITY

NHA

FRIENDLY HIGHWAYS

Presentation on

Road Asset Management System of Pakistan

Dr. Muhammad Asif Azam, Deputy Director (RAMS), NHA

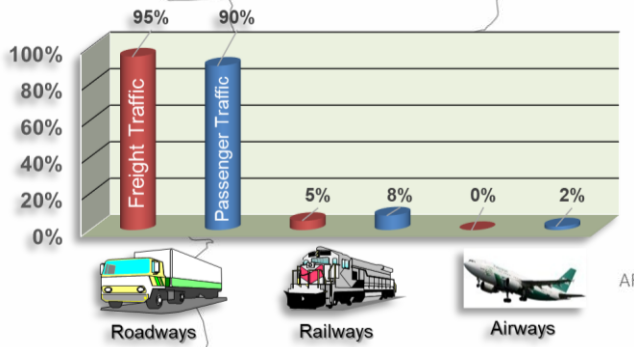
Islamabad – 6nd October 2021

SEQUENCE OF PRESENTATION

- Road statistics in Pakistan
- Creation of NHA and Establishment of RAMD
- Situation of Roads Inherited by NHA
- Computerized Road Asset Management System and its components
  - Bridge Management System
  - Pakistan Road Assessment Program
  - Pavement Management System

Road Statistics in Pakistan

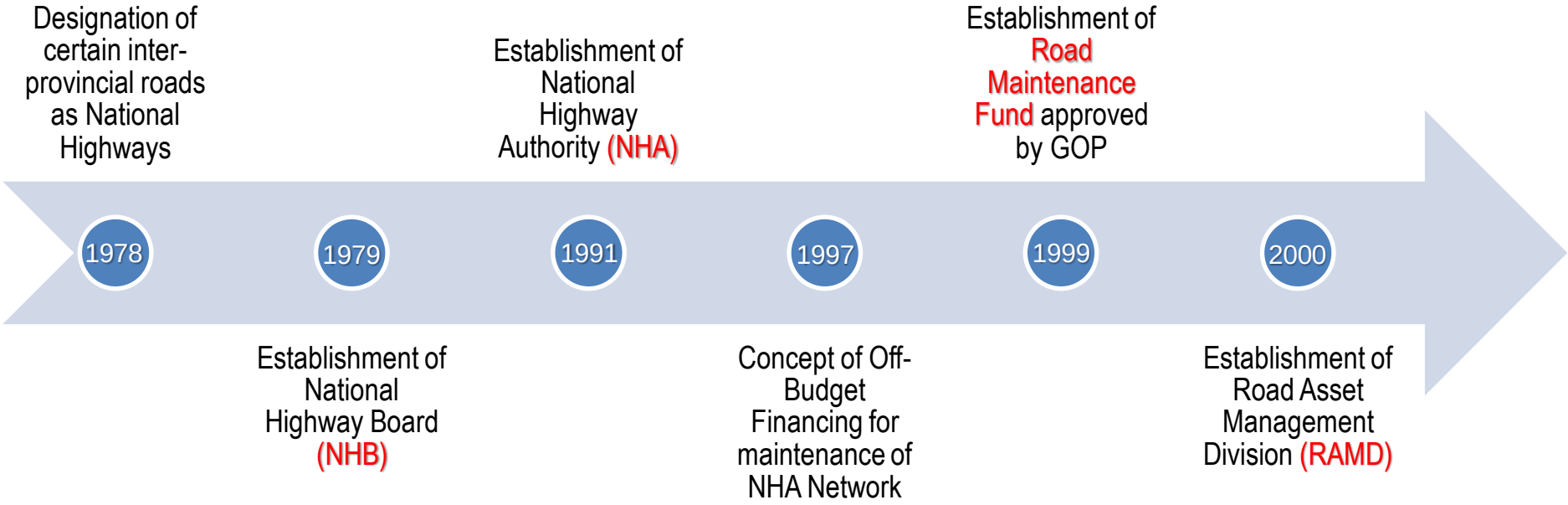
Total Area of Pakistan	**796,096** Sq-Km
Total Road Network	**500,000** Kms
National Highways & Motorways	**13,570** Kms
Road Density	**0.32** km / km2
Roads have dominant share in both transport of passengers **(90%)** and the Goods **(95%)** followed by rail.	
Total Number of Vehicles	**10** Million
55.4% are two Wheelers and **44**% four Wheelers	
Annual growth rate	**9** %



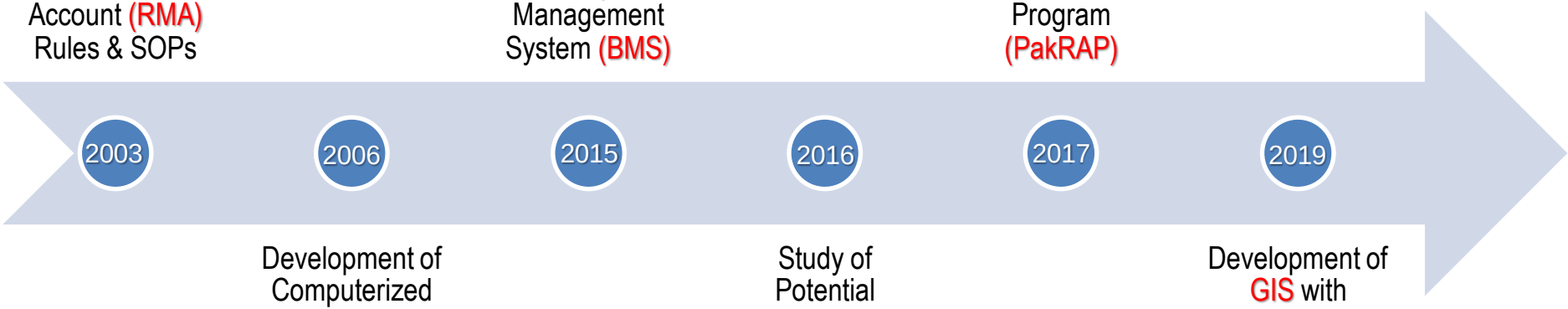
Total Roads 500,000 Km
NHA Network 13,570 Km
Only 2.8% of Total Roads
Carries 80% of Commercial Traffic
N-5 Carries 65% of this load

Road Type	Total
Highways	11,426
Motorway	2,066
Expressway	78
Total:	**13,570**

Establishment of Road Asset Management Division



Establishment of Road Asset Management Division



Mission Statement

- To ensure national integration through an efficient, reliable, safe and environment friendly national highway & motorway network for sustained economic growth and higher quality of life in Pakistan

Tasks

- To maintain and operate the national highway network in worthy and safe condition at optimum expenses, ensuring user satisfaction
- To deliver development program as per the Government's policy and priority with respect to time and cost.

Why Road Asset Management is Essential for NHA

- Aging Infrastructure
- Effect of Axle Load
- Growing Congestions due to Urbanization
- Lower Standard of Roads inherited
- Funding Constraints
- Increasing heavy traffic
- Maintaining Asset at desired level

Roads Inherited by NHA

Deteriorated

Narrow

Poor Maintenance

Poor Safety

Beyond Maintenance

Effect of Overloading

- Narrow, single-lane and poorly designed
- Urbanization congestion / poor geometrics
- Poor maintenance / safety standards

Transformation of Inherited Network by NHA

- Widening and construction of additional carriageways
- Construction of expressways & motorways of high standards
- Construction of 52 x Bypasses to facilitate the through traffic
- Identification and removal of accident prone locations / black spots
- Geometric improvement of sharp curves
- Conversion of treated surfaces to asphaltic roads
- Axle Load Management
- Implementation of Tolling culture

Mission Statement of RAMD

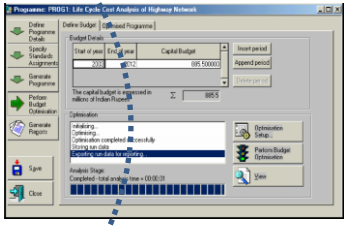
Maintain the National Highway Network to optimal levels at all times & Preservation of National Highways by using the "Fee-for-Service" Concept and generating appropriate funds for Highway Maintenance.

Road Asset Management System

GIS

Regional Office Connectivity

Road Database



Bridge Management System

Pavement Management System

PakistanRAP

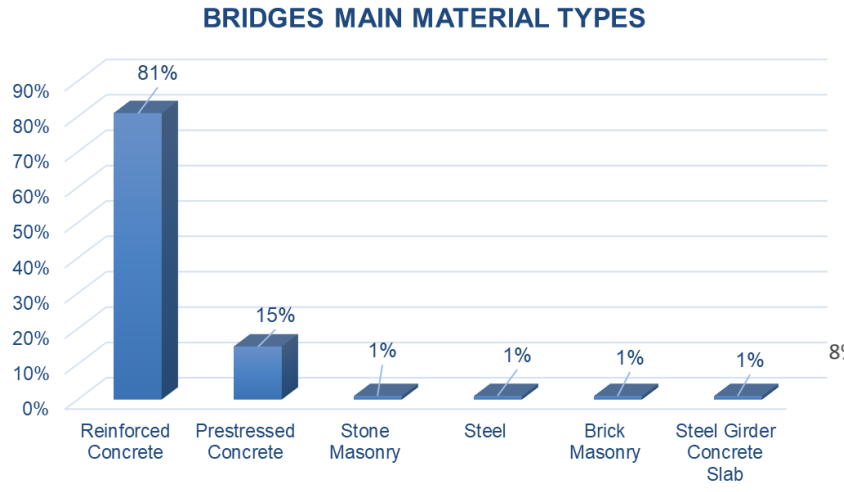
PAKISTAN ROAD ASSESSMENT PROGRAM

BRIDGE MANAGEMENT SYSTEM

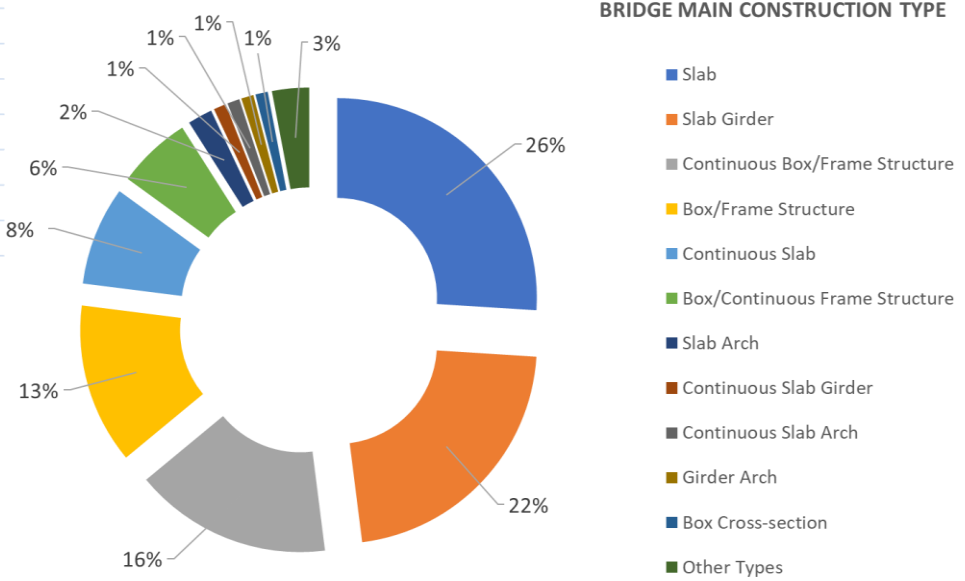
Introduction of Bridge Management System

- Bridges are vital component of a transportation system as their failure can cause excessive public and private losses.
- Bridges structures are required to remain functional through out their service life.
- The continuous inspection and maintenance of bridge structures is very important.
- The maintenance funds are always less than required, therefore maintaining condition of bridge stock at desired level is a challenging task for bridge managing authorities.
- This situation has necessitated implementation of Bridge Management System

Bridge Structures on NHA Network



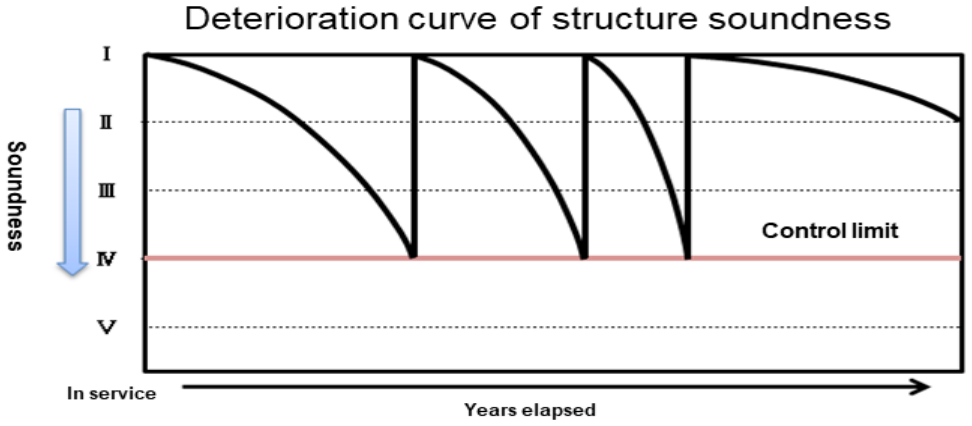
Bridge Length	Percentage
< 30m	75%
30m – 50m	9%
50m – 100m	10%
> 100m	7%



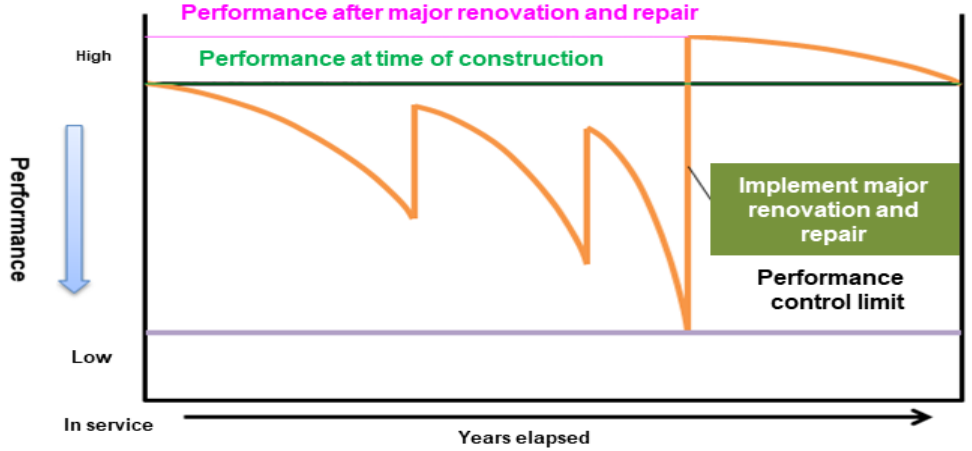
5,000 Bridges 20,000 Culverts

Concept of Soundness and Performance in BMS

Conventional Corrective Maintenance Approach



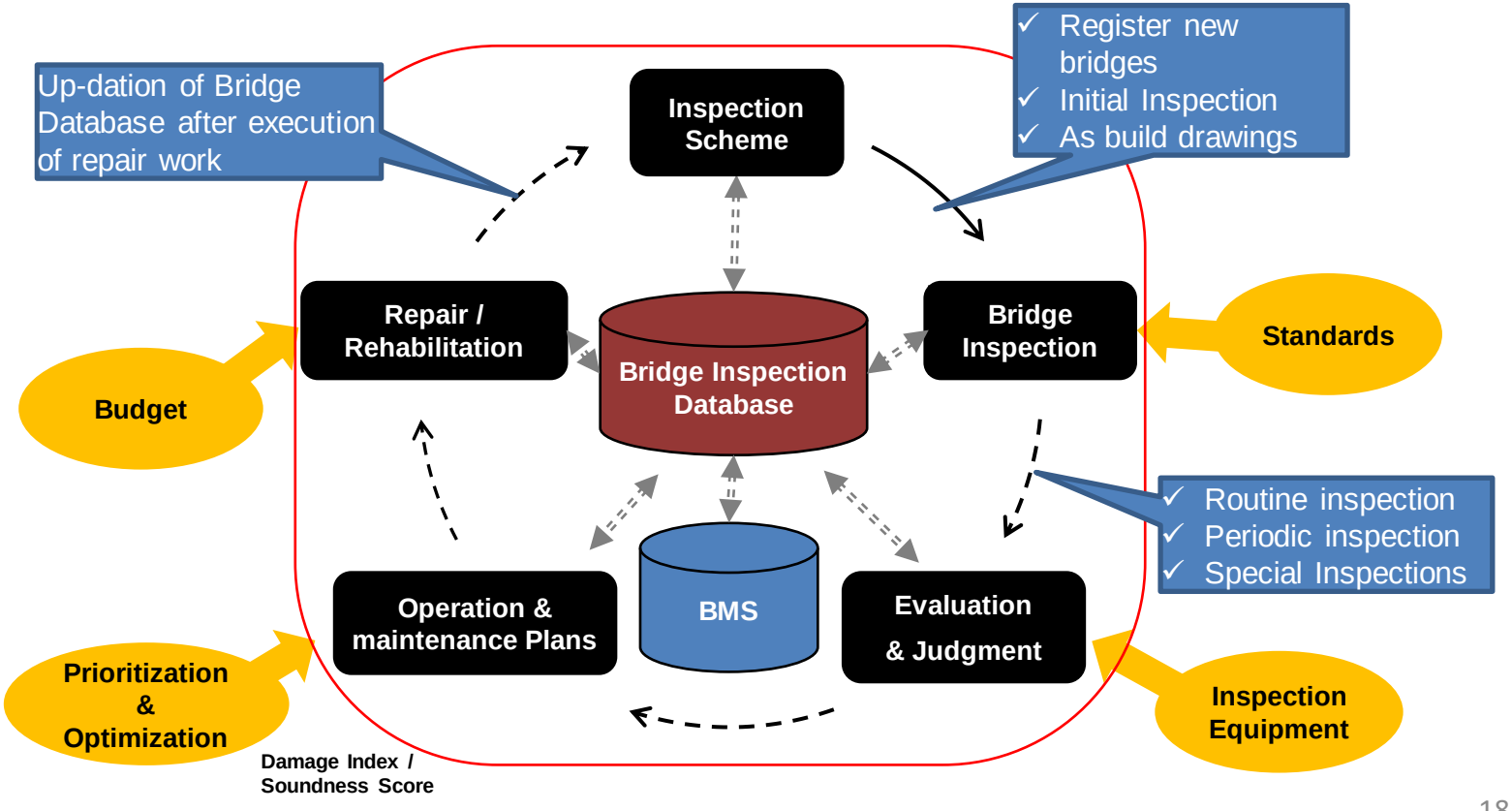
Preventive Maintenance Approach



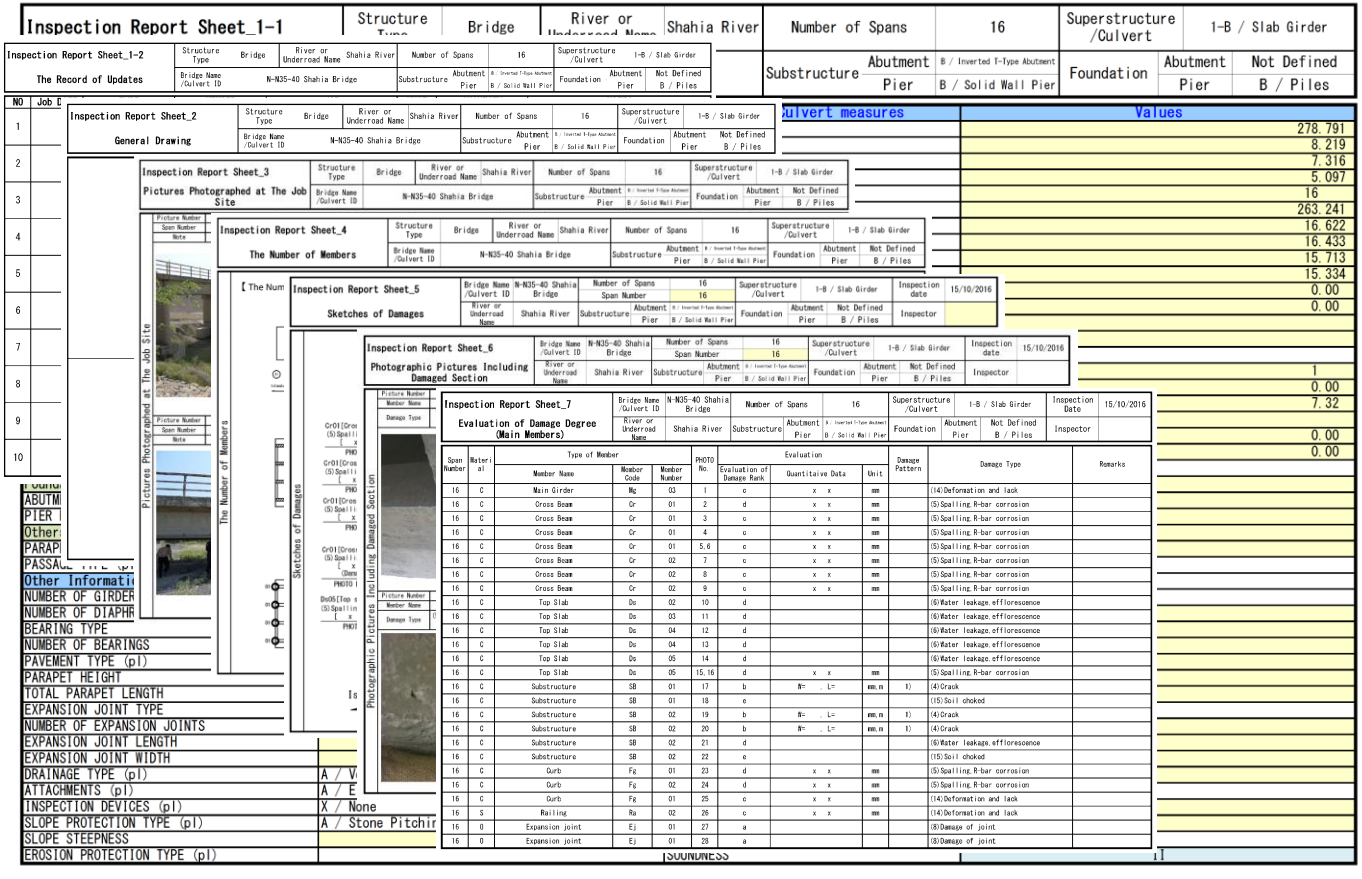
Development of Bridge Management System

- A comprehensive BMS was developed with the Technical Assistance of Japan International Cooperation Agency during 2016-2019.
- The Bridge / Culvert Inspection Proformas, Damage Evaluation Procedure has been developed.
- Based on the inspection data, the bridge structures are evaluated with Soundness Value ranging from I – IV.
- The bridges having Soundness Score IV are prioritized for maintenance.
- After allocation of budget for bridge maintenance in Annual Maintenance Plan, the works are tendered and executed by regional offices.

Components of Bridge Management System



Bridge Inspection and Evaluation



Inspection Report Sheet_1-1

Structure Type	Bridge	River or Underroad Name	Shahia River	Number of Spans	16	Superstructure /Culvert	1-B / Slab Girder
Bridge Name /Culvert ID	N-N35-40 Shahia Bridge	Substructure	Abutment / Pier	A / Inverted T-Type Abutment / B / Solid Wall Pier		Foundation	Abutment / Pier	Not Defined / B / Piles

Inspection Report Sheet_1-2 — The Record of Updates

Inspection Report Sheet_2 — General Drawing

Inspection Report Sheet_3 — Pictures Photographed at The Job Site

Inspection Report Sheet_4 — The Number of Members

Inspection Report Sheet_5 — Sketches of Damages

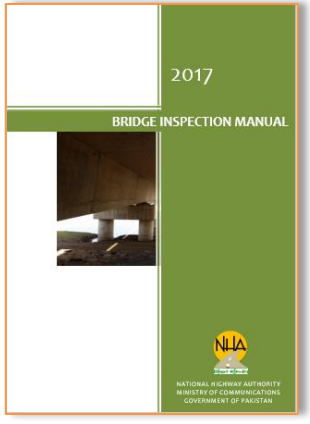
Inspection Report Sheet_6 — Photographic Pictures Including Damaged Section

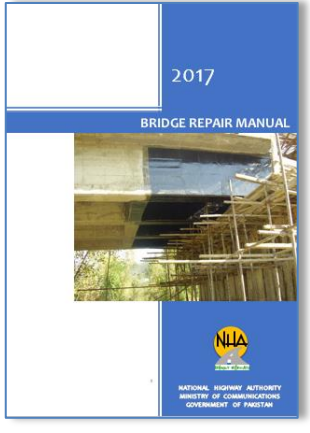
Inspection Report Sheet_7 — Evaluation of Damage Degree (Main Members)

Span Number	Material	Type of Member: Member Name	Member Code	Member Number	PHOTO No.	Evaluation: Evaluation of Damage Rank	Quantitative Data	Unit	Damage Pattern	Damage Type	Remarks
16	C	Main Girder	Mg	03	1	c	x x	mm		(4)Deformation and lack	
16	C	Cross Beam	Cr	01	2	d	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Cross Beam	Cr	01	3	c	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Cross Beam	Cr	01	4	c	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Cross Beam	Cr	01	5,6	c	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Cross Beam	Cr	02	7	c	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Cross Beam	Cr	02	8	c	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Cross Beam	Cr	02	9	c	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Top Slab	Ds	02	10	d				(6)Water leakage,efflorescence	
16	C	Top Slab	Ds	03	11	d				(6)Water leakage,efflorescence	
16	C	Top Slab	Ds	04	12	d				(6)Water leakage,efflorescence	
16	C	Top Slab	Ds	04	13	d				(6)Water leakage,efflorescence	
16	C	Top Slab	Ds	05	14	d				(6)Water leakage,efflorescence	
16	C	Top Slab	Ds	05	15,16	d	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Substructure	SB	01	17	b	W= L=	mm,n	1)	(4)Crack	
16	C	Substructure	SB	01	18	e				(15)Soil choked	
16	C	Substructure	SB	02	19	b	W= L=	mm,n	1)	(4)Crack	
16	C	Substructure	SB	02	20	b	W= L=	mm,n	1)	(4)Crack	
16	C	Substructure	SB	02	21	d				(6)Water leakage,efflorescence	
16	C	Substructure	SB	02	22	e				(15)Soil choked	
16	C	Curb	Fg	01	23	d	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Curb	Fg	02	24	d	x x	mm		(5)Spalling,R-bar corrosion	
16	C	Curb	Fg	01	25	c	x x	mm		(4)Deformation and lack	
16	S	Railing	Ra	02	26	c	x x	mm		(4)Deformation and lack	
16	O	Expansion joint	Ej	01	27	a				(8)Damage of joint	
16	O	Expansion joint	Ej	01	28	a				(8)Damage of joint	

Culvert measures	Values
	278.791
	8.219
	7.316
	5.097
	16
	263.241
	16.622
	16.433
	15.713
	15.334
	0.00
	0.00
	1
	0.00
	7.32
	0.00
	0.00

ABUTMI	
PIER	
Other	
PARAP	
PASSA	
Other Informati	
NUMBER OF GIRDER	
NUMBER OF DIAPHR	
BEARING TYPE	
NUMBER OF BEARINGS	
PAVEMENT TYPE (pl)	
PARAPET HEIGHT	
TOTAL PARAPET LENGTH	
EXPANSION JOINT TYPE	
NUMBER OF EXPANSION JOINTS	
EXPANSION JOINT LENGTH	
EXPANSION JOINT WIDTH	
DRAINAGE TYPE (pl)	A / V
ATTACHMENTS (pl)	A / E
INSPECTION DEVICES (pl)	X / None
SLOPE PROTECTION TYPE (pl)	A / Stone Pitchir
SLOPE STEEPNESS	
EROSION PROTECTION TYPE (pl)	





Pakistan Road Assessment Program (PakRAP)

Establishment of PakRAP

iRAP: Registered charity

Vision: a world free of high risk roads

Inspect high-risk roads and develop Star Ratings and Safer Roads Investment Plans

100+ countries, 2.5 Million km of Assessment

UN Sustainable Development Goals

DECADE OF ACTION FOR
ROAD SAFETY
2021 - 2030

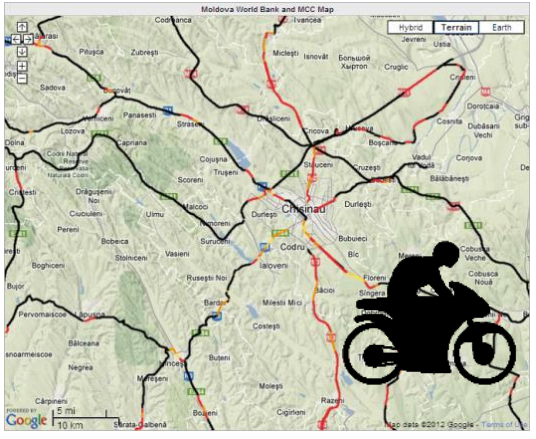
50BY30

HALVE ROAD DEATHS
& SERIOUS INJURIES
BY2030

Target 3: By 2030, all new roads achieve technical standards for all road users that take into account road safety, or meet a three star rating or better.

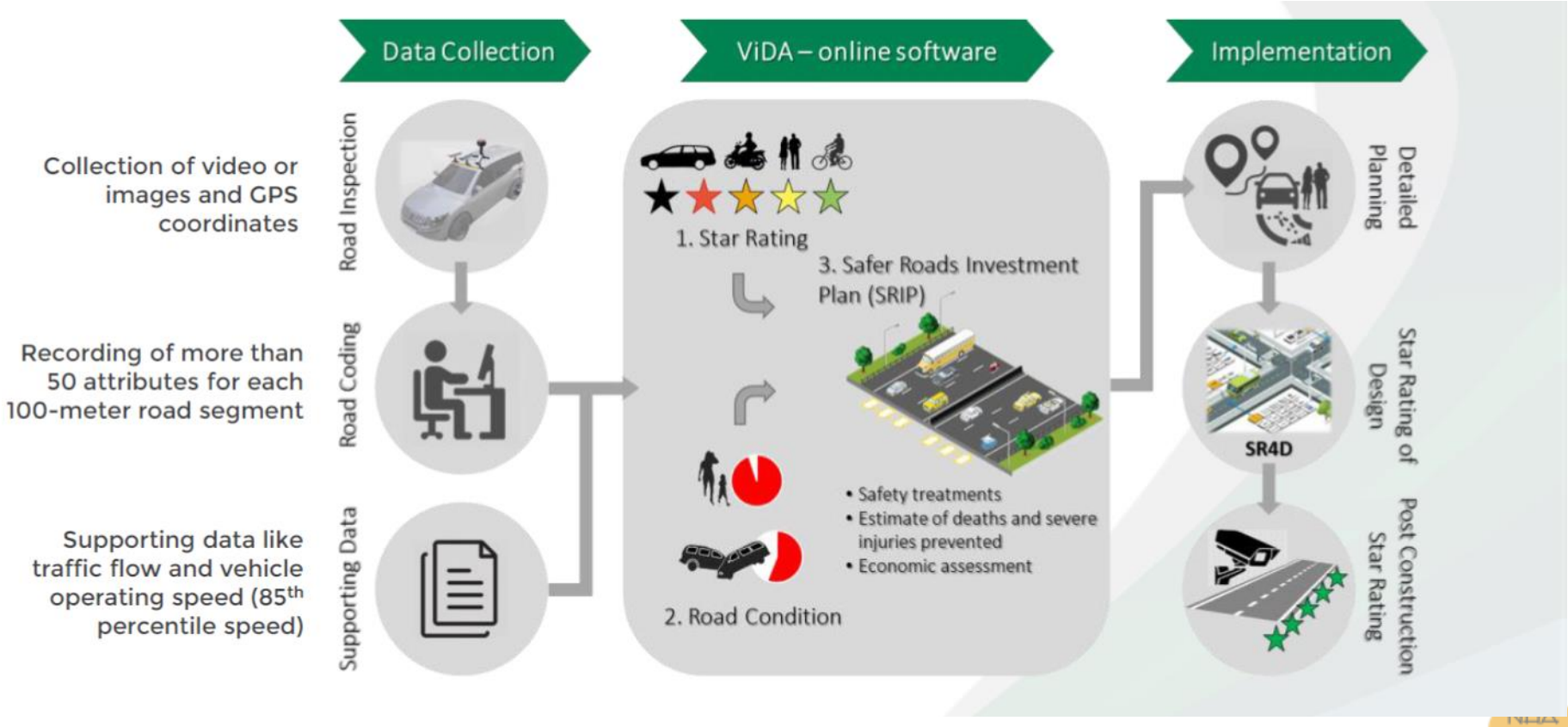
Target 4: By 2030, more than 75% of travel on existing roads is on roads that meet technical standards for all road users that take into account road safety.

Star Ratings Score



Star Rating	Vehicle occupant Star Rating Score
5-Stars	0 to < 2.5
4-Stars	2.5 to < 5
3-Stars	5 to < 12.5
2-Stars	12.5 to < 22.5
1-Star	22.5+

Star Rating and Investment Process



List of all attributes for Star Ratings

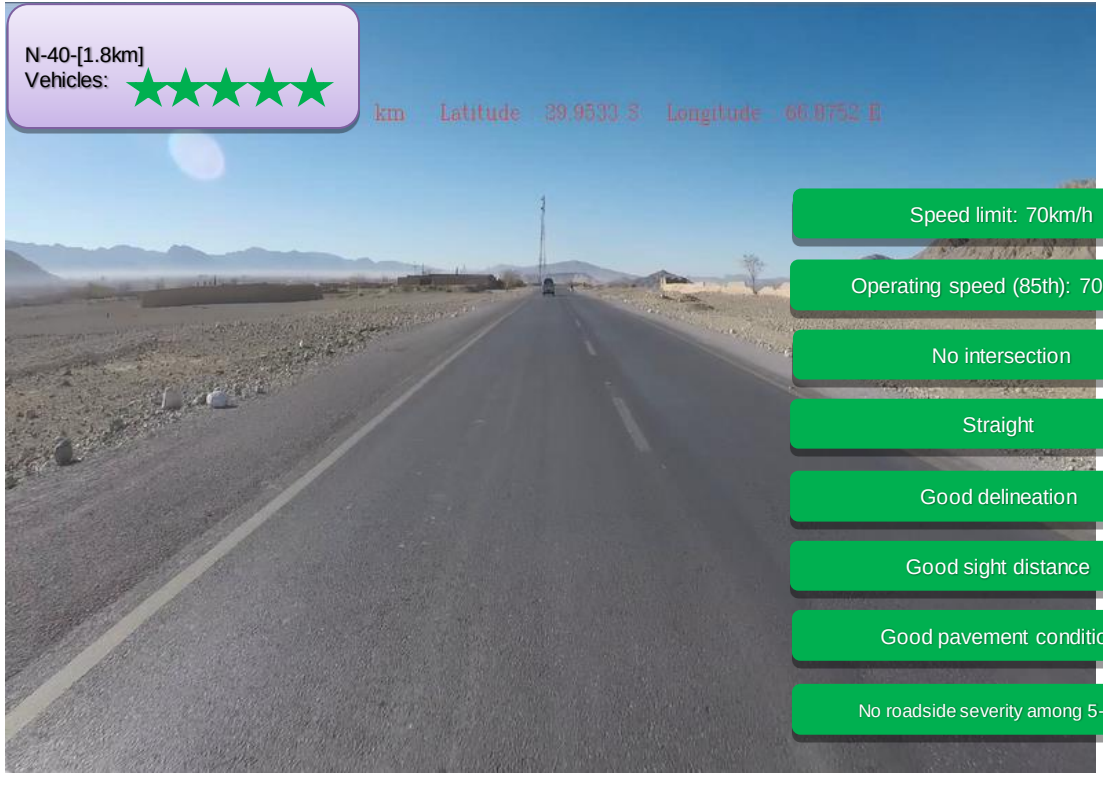
Sr.	Attributes
1	Speed
2	Speed Limit
3	No of Lanes
4	Curvature
5	Quality of Curve
6	Upgrade Cost
7	Median Type
8	Skid Resistance
9	Road Condition
10	Vehicle Parking
11	Grade
12	Road Works
13	Sight Distance

Sr.	Attributes
14	Delineation
15	Street Lighting
16	Service Road
17	Centerline Rumble Strips
18	Roadside Severity
19	Shoulder Rumble Strips
20	Paved Shoulder
21	Intersection Type
22	Intersection Quality
23	Intersection Channelization
24	Property Access Points
25	Intersecting Road Volume
26	Land Use

Sr.	Attributes
27	Area Type
28	Pedestrian Crossing Facility
29	Pedestrian Crossing Quality
30	Pedestrian Fencing
31	Sidewalk Provision
32	Facilities for Motorcycle
33	Facilities for bicycle
34	School Zone Warning

Results of Star Ratings (5 Star Road Section)

Example of a vehicle occupant 5-Star road section: N-40-1.8km

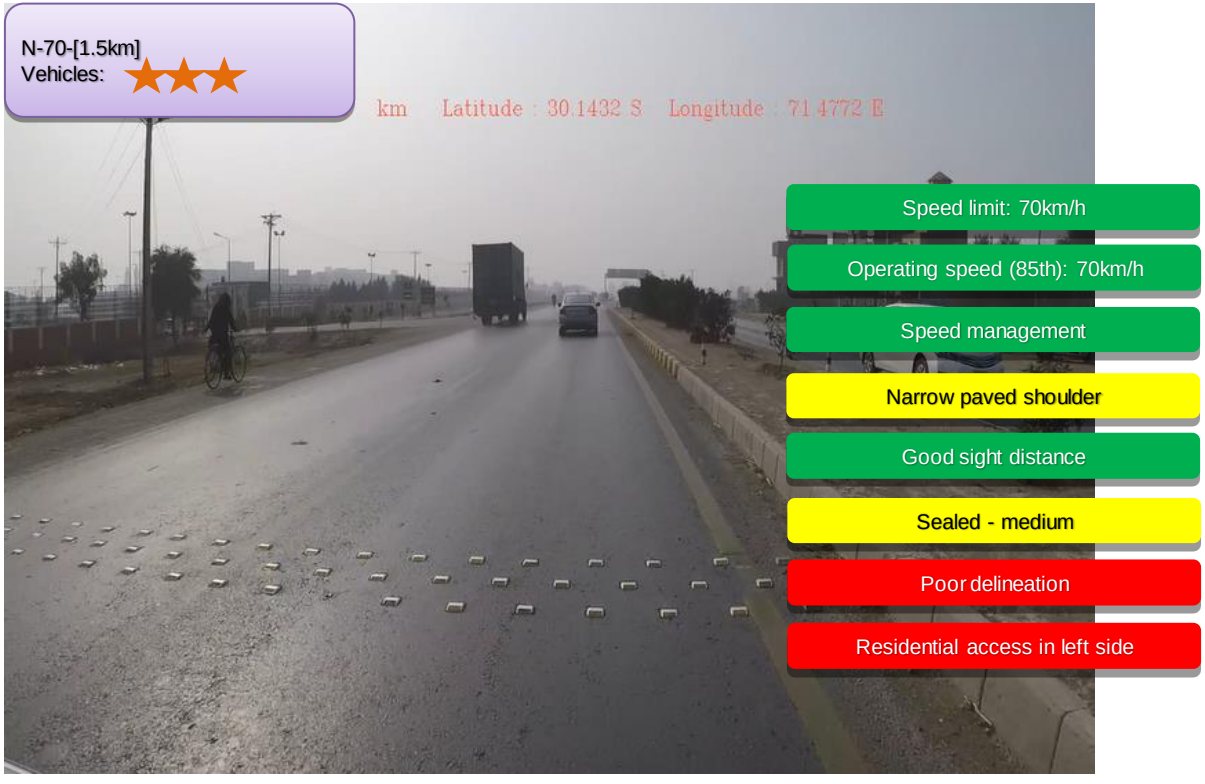


Results of Star Ratings (4 Star Road Section)

Example of a vehicle occupant 4-Star road section: N-70-21.7km

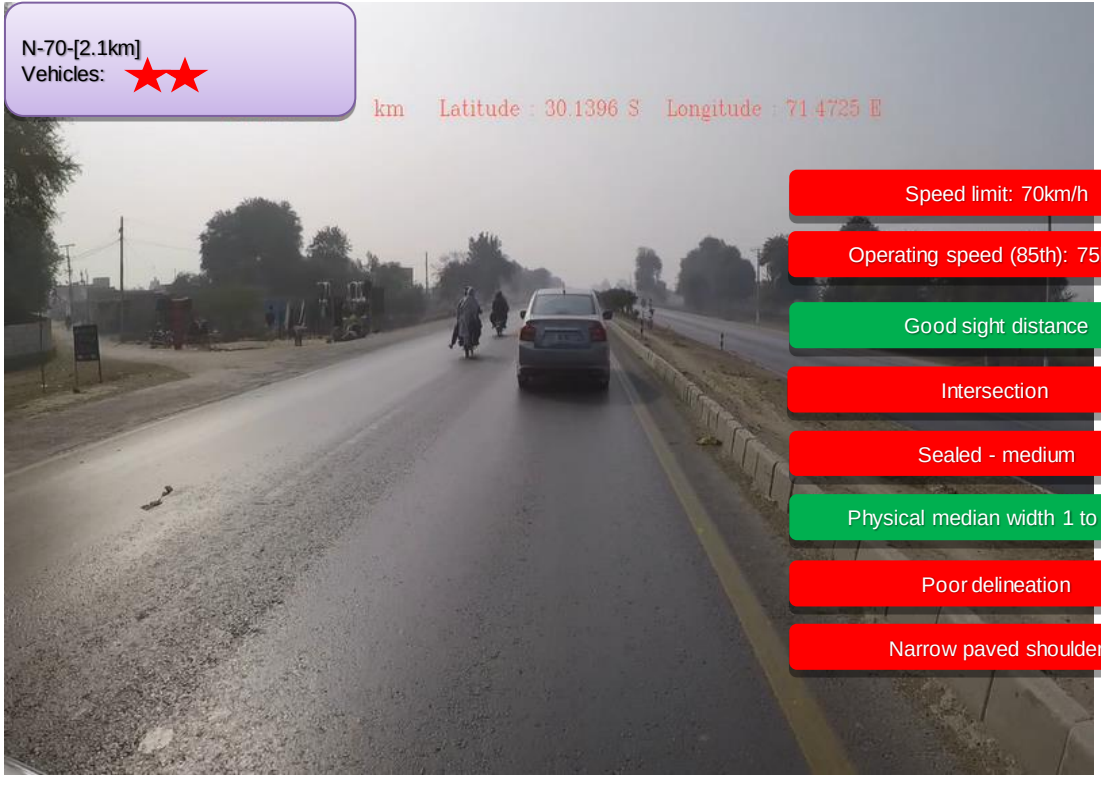
Results of Star Ratings (3 Star Road Section)

Example of a vehicle occupant 3-Star road section: N-70-1.5km



Results of Star Ratings (2 Star Road Section)

Example of a vehicle occupant 2-Star road section: N-70-2.1km



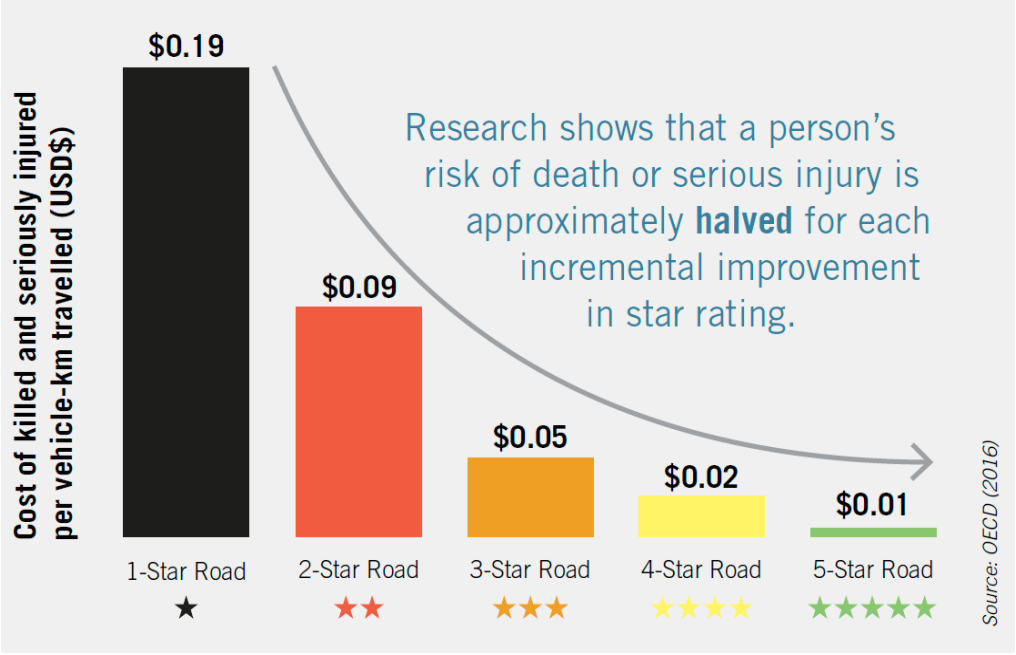
Results of Star Ratings (1 Star Road Section)

Example of a vehicle occupant 1-Star road section: N-95-95.5km

List of Countermeasures

Delineation
Roadside Safety - Barriers
Median Barrier
Road Surface Upgrade
Duplication
Intersection – Delineation
Intersection - Right Turn Lanes (Unsignalised)
Lane Widening
Shoulder Widening
Motorcycle Lanes
Intersection - Grade Separation
Pedestrian Footpath
Pedestrian Crossing
Traffic Calming
Bicycle Facilities
Roadside Safety - Hazard Removal
Central Hatching
Restrict/Combine Direct Access Points
Intersection - Roundabout
Intersection - Right Turn Lanes (Signalised)

Star Ratings VS Crash Costs



Economic cost of a death (low & middle income countries)
= 70 x GDP per capita;

Economic cost of a Serious Injury
= 0.25 x economic cost of a death.

Economic cost of a Fatality in Pakistan is
70 x PKR 171,160 = PKR 11,981,200

Economic cost of a Serious Injury
0.25 x PKR 11,981,200 = PKR 2,995,300

The B/C ratio of each Countermeasure is evaluated with its application cost and benefits in terms of savings in FSI (Fatality & Serious Injuries)

Safer Road Investment Plan

iRAP Star Rating Scores (Existing Road and With Selected Safety Enhancements)

Scenario	Vehicle occupants	Motorcyclists	Pedestrians	Bicyclists	Assumed speed (km/h)
Existing road	5.37	7.16	121.22	47.80	70
+ New pavement *	3.83	4.85	86.59	29.87	70
+ Pavement shoulder	3.48	4.50	81.73	26.89	70
+ Delineation	2.90	3.92	68.36	21.16	70
+ Sidewalk	2.90	3.92	38.19	21.16	70
+ Pedestrian crossing facilities	2.90	3.92	7.29	21.16	70
+ Reduce operating speeds to 60km/h **	1.57	2.21	4.33	12.55	60

* Since the existing pavement condition is good, it is assumed there would be no change in speed. Skid resistance would improve.
** Requires enforcement.

5 star	4 star	3 star	2 star	1 star

Road Asset Management System

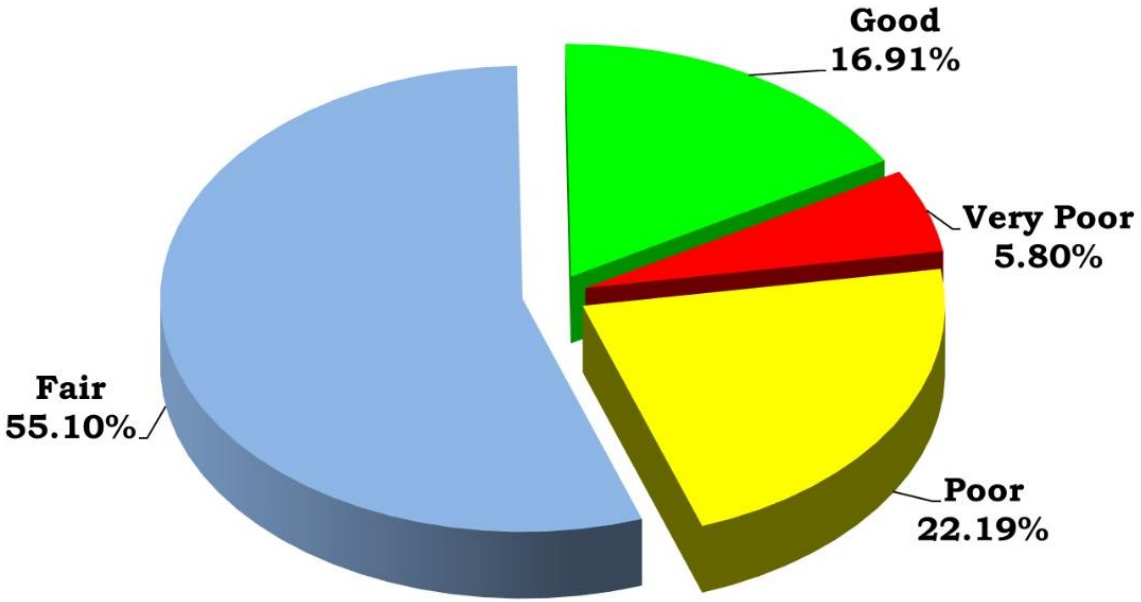
Introduction

- **The Road Asset Management Division is responsible for maintenance and preservation of NHA network worth 3.4 Trillion Rupees.**

- **For maintenance of NHA network, RAMD prepares an Annual Maintenance Plan and budget in consultation with regional offices and various stake holders using the RAMS System described in RMA SOP.**

- **The planned / approved road maintenance schemes are implemented by NHA field offices in accordance with provisions in NHA Code and Public Procurement Rules**

Current Condition of NHA Network



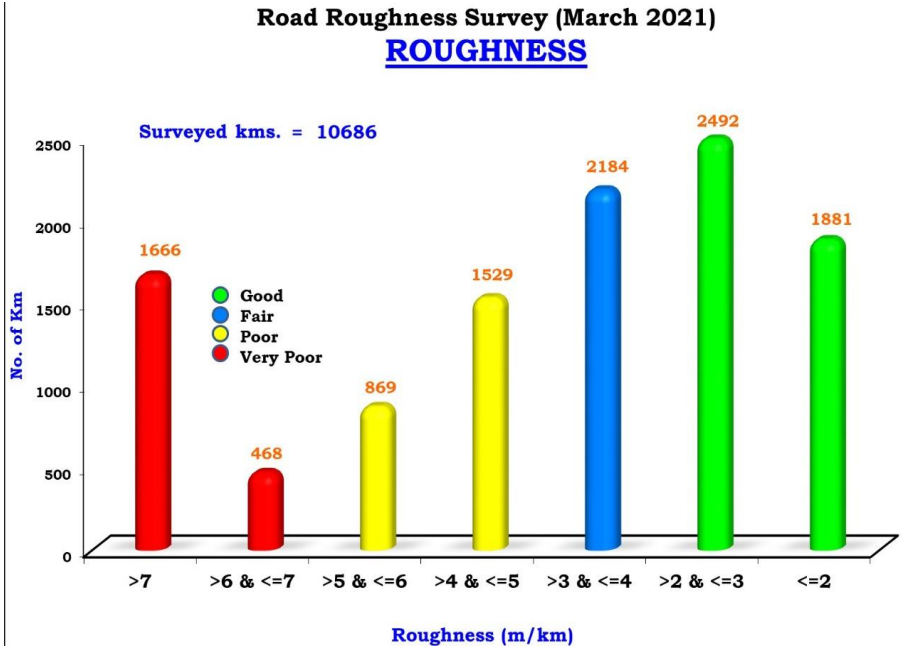
An empirical relationship based on severity and extent of distresses with following weightages

Distress	Weightage
Rutting	20%
Structural Cracking	36%
Thermal Cracking	4%
Raveling	10%
Roughness	30%

REMAINING SERVICE LIFE (RSL)

Good	Fair	Poor	Very Poor
RSL >=4	RSL >=2.5 & <4	RSL >=1 & <2.5	RSL >=0 & <1

Current Condition of NHA Network



Roughness (IRI)	Length (km)	Percentage
Good	4,373	39%
Fair	2,184	20%
Poor	2,398	22%
Very Poor	2,134	19%

Good	Fair	Poor	Very Poor
IRI <=3 m/km	IRI >3 & <=4	IRI >4 & <=6	IRI >6

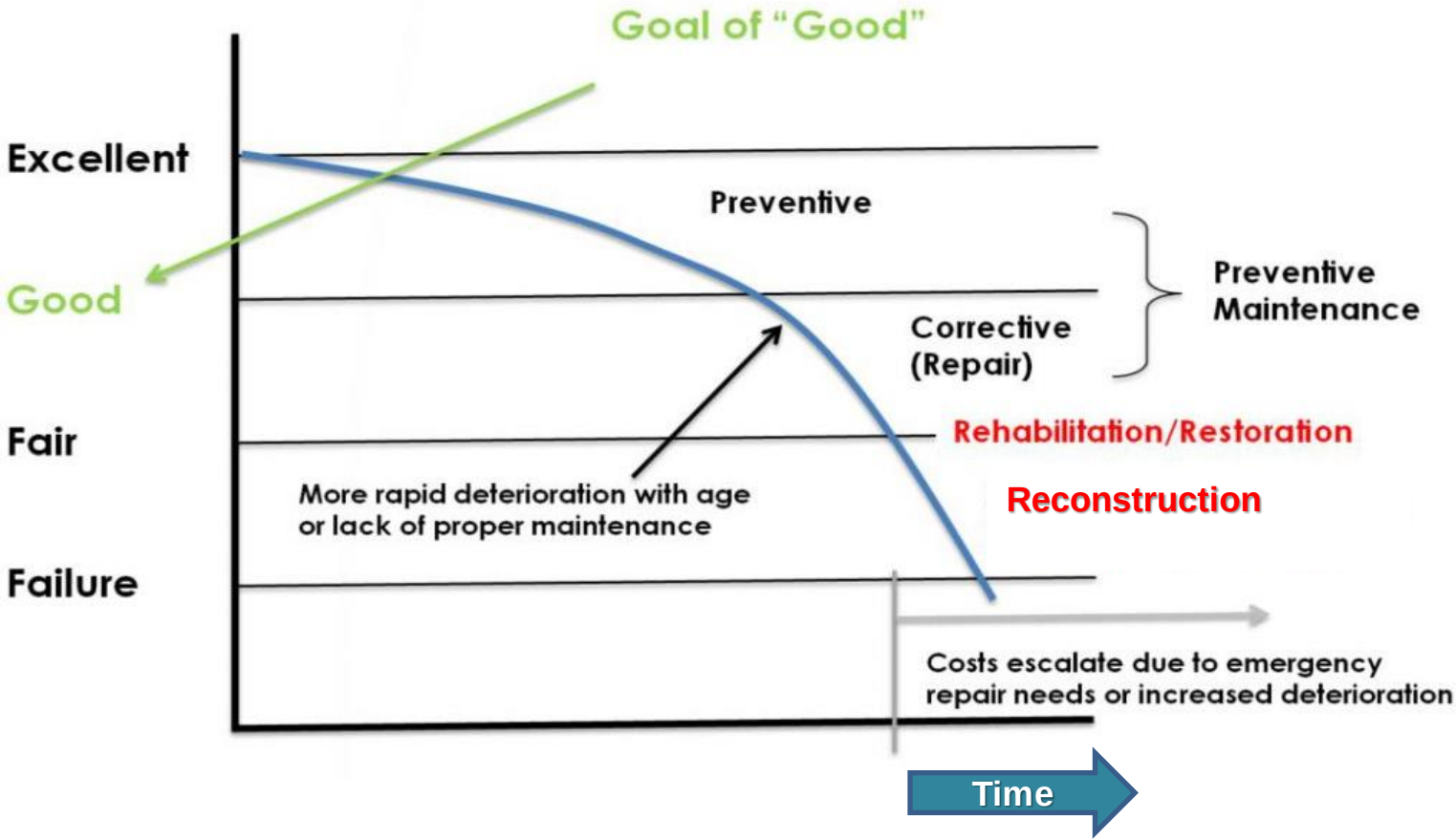
Types of maintenance schemes

Sr. No.	Maintenance Scheme	Scope of Work
1	Routine Maintenance	• Potholes repair, • Patchwork with Bitmac /asphalt, • Repair / cleaning of drainage system, • Cut vegetation, • Machinery hours for haulage of slide clearance, clearing of debris / median / drains / encroachment removal etc., • Installation of missing kilometer posts, traffic signs and cat eyes • Repair of rain cuts on shoulders • Repair of damaged shoulders through DST • Maydays for clearance of garbage/debris in medians, inner shoulders, disposal of dead animals, cleaning of sign boards, delineators etc. • Structural repair (bridge/culverts/drains/retaining walls), • Painting of kerb stones, New Jersey Barriers and Kilometer posts • Signage repair etc.
2	Periodic Maintenance (Functional Overlay)	Milling and Overlay of Asphaltic Wearing Course
3	Periodic Maintenance (Structural Overlay)	Milling and Overlay of Asphaltic layers (AWC + ABC+ crack relief layer), installation of pavement markings/cat eyes.
4	Rehabilitation	• Removal of existing asphalt • Ploughing and re-compacting of existing aggregate layers • Provision of asphaltic layers (Asphaltic Base Course + Asphaltic Wearing Course).

Types of maintenance schemes

Sr. No.	Maintenance Scheme	Scope of Work
5	Highway Safety	Removal of back spots (accident prone locations), installation of traffic safety signage and safety barriers etc.
6	Toll Plazas and Weigh Stations	Construction and maintenance of Toll Plazas / Weigh Stations
7	Emergency Maintenance Allocation	For corrective maintenance works required on urgent basis to restore the traffic operations
8	Special Maintenance	Unforeseen Road improvement works required
9	Geometric Improvement	Identification and removal of poor geometric locations to prevailing international standards (straightening of sharp dangerous horizontal as well as vertical curves etc.)
10	Bridge/Culvert Structural Maintenance	Repair, maintenance and retrofitting of damages occurred on bridges and culverts on requirement basis

Pavement Deterioration Curve



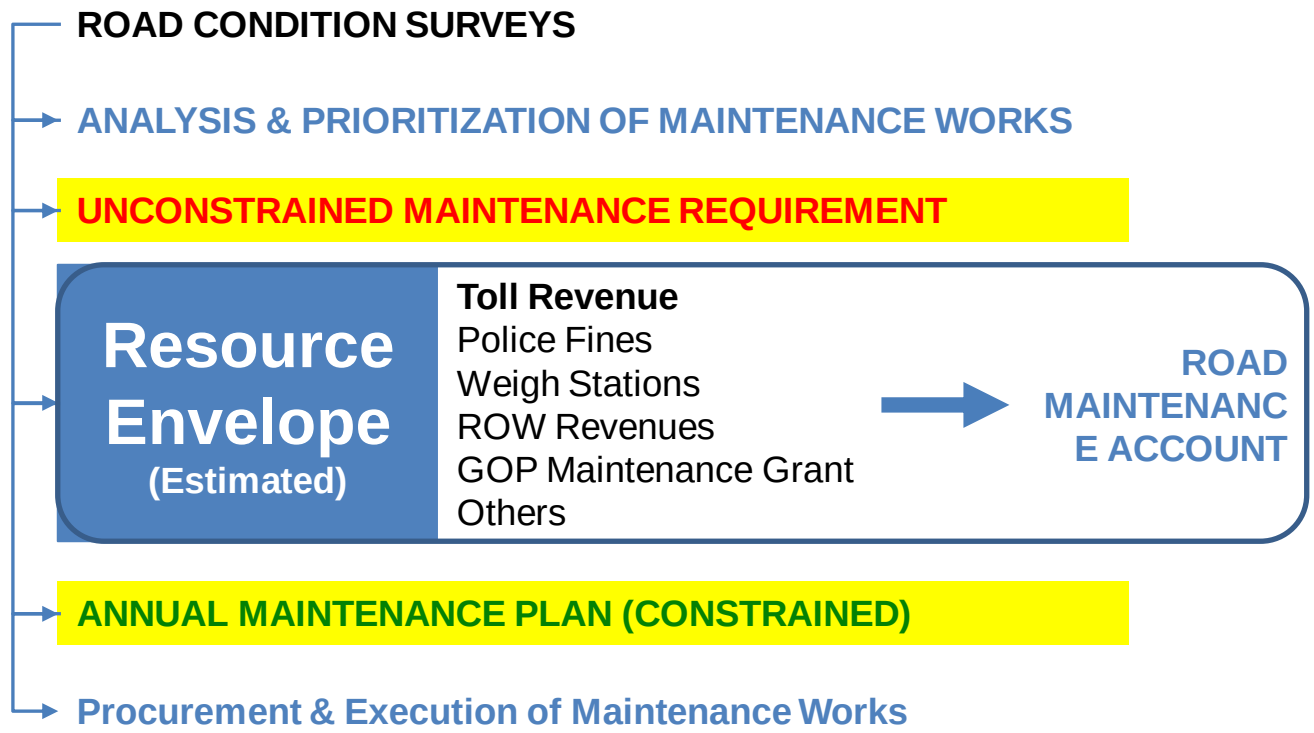
Process for Preparation of AMP

- **Estimation of Revenue Envelope**
  - **Toll collection, Police fine, ROW, Maintenance Grant etc.**
- **Road Data Collection Surveys**
  - **Pavement Condition Survey**
  - **Pavement Roughness Survey**
  - **Pavement Strength Evaluation Survey**
  - **Traffic Survey**
  - **Historical Data**
- **Analysis and Prioritization of Maintenance Schemes**
  - **Economic Analysis**
  - **HDM Network Level Analysis**

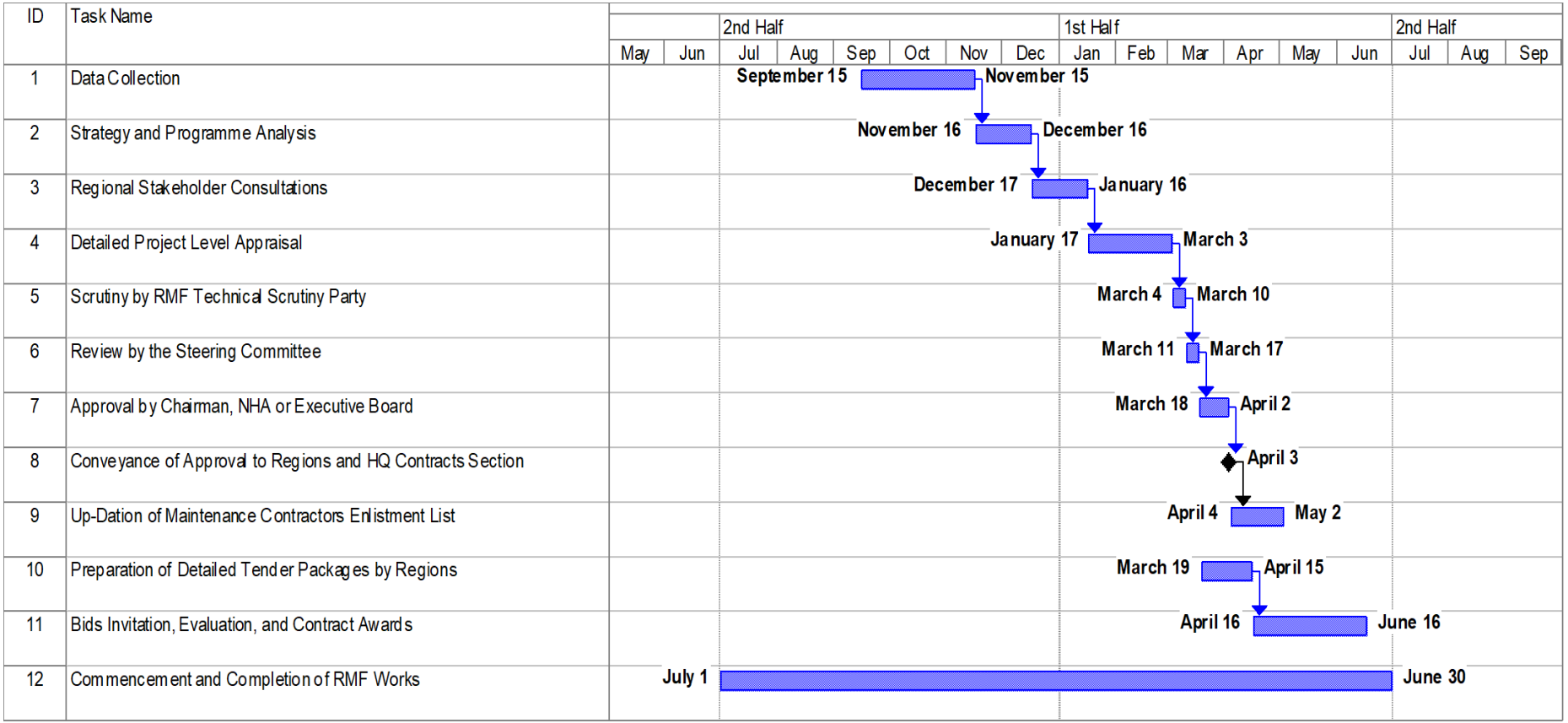
Process for Preparation of AMP

- **AMP Approval Process**
  - **Technical evaluation by Technical Scrutiny Party**
  - **Consultation with Stake holders**
  - **Review by RMA Steering Committee Meeting**
  - **Approval by National Highway Executive Board**
- **Procurement of approved maintenance works**
- **Execution of awarded maintenance works by regional offices**

Process for Preparation of AMP



Annual Work Cycle



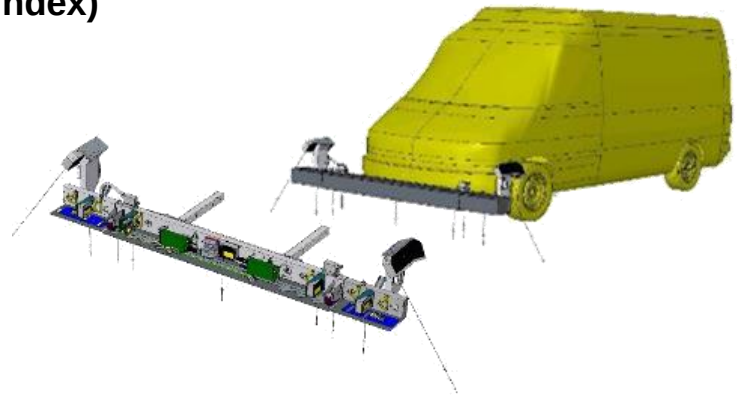
Pavement Condition Surveys (Visual)

- **Pavement Distress type, Extent and Severity is recorded for EACH KM of the network.**
- **Following Distresses with measuring units are identified for Data Collection**

• Cracking	(%age of length effected & Crack Width)
• Rutting	(Length of Rutted Portion & Rut Depth)
• Potholes	(Number of Potholes in KM)
• Ravelling	(%age of length effected & Disintegration Type)
• Edge Step	(%age length effected & Depth)
• Erosion from Original Edge	(%age length effected & Depth)
• Drainage Condition	(Performance Indicator)

Pavement Condition Surveys (Mechanized)

Profilometer is used to measure the road roughness (International Roughness Index)

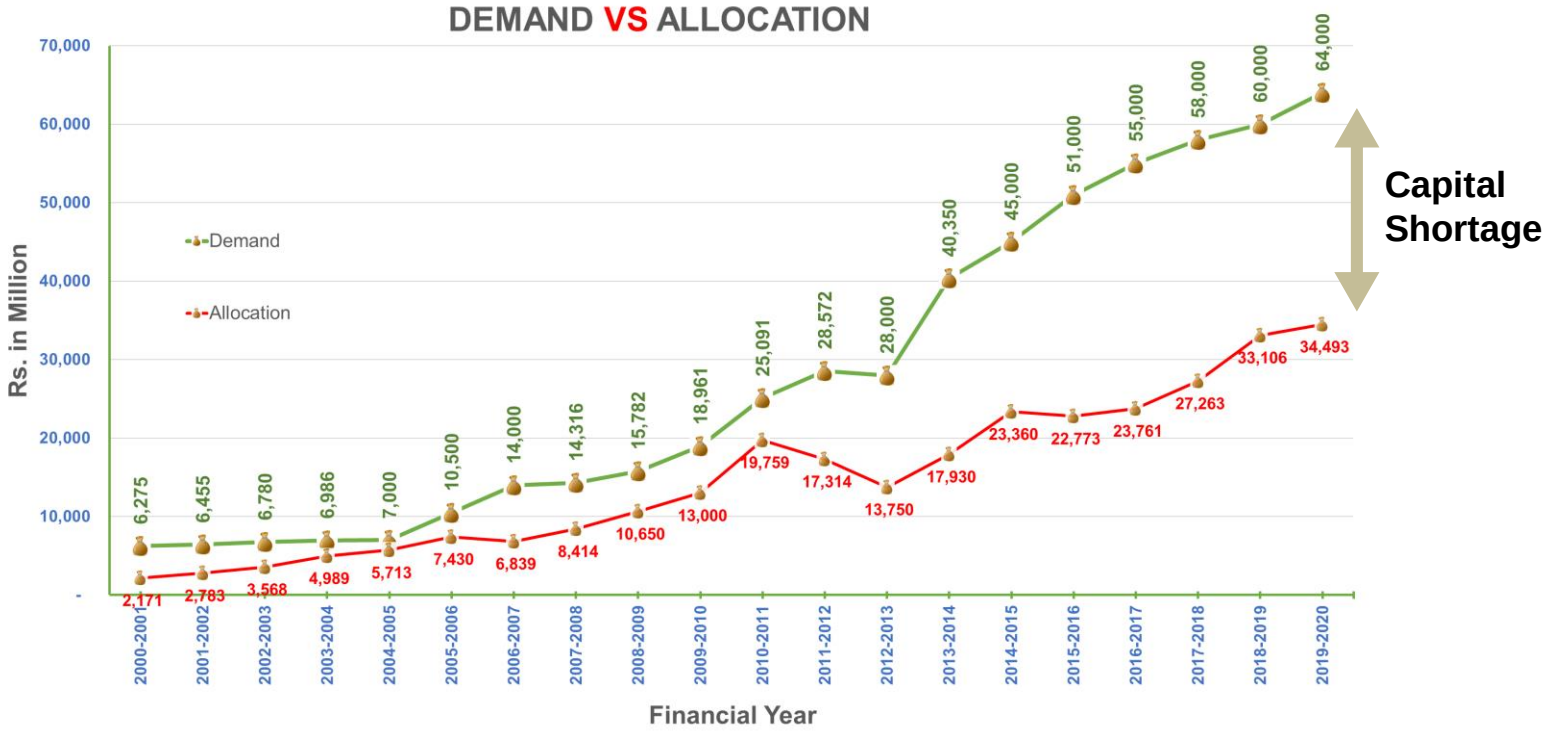


Laser Crack Scanner is being procured to perform the mechanized condition surveys instead of Visual Inspection. The LCS will be capable of autodetecting the distresses and will increase the survey results reliability and reduce the survey time.

Heavy Weight Deflectometer (HWD) is used to measure the Structural Capacity

Maintenance Demand VS Allocation

A comparison of maintenance budget requirement vs allocation depicts the accumulation of maintenance backlog



HDM Analysis

Analysis Tools

Project Program Strategy

Central Data Bank

Data Managers

Road Network Vehicle Fleet Road Works HDM Config .

Budget

APPLICATION OF HDM MODEL

Funds Allocation for Maintenance Works

The approved Annual Maintenance Plan comprises of allocation under various maintenance categories enlisted as under

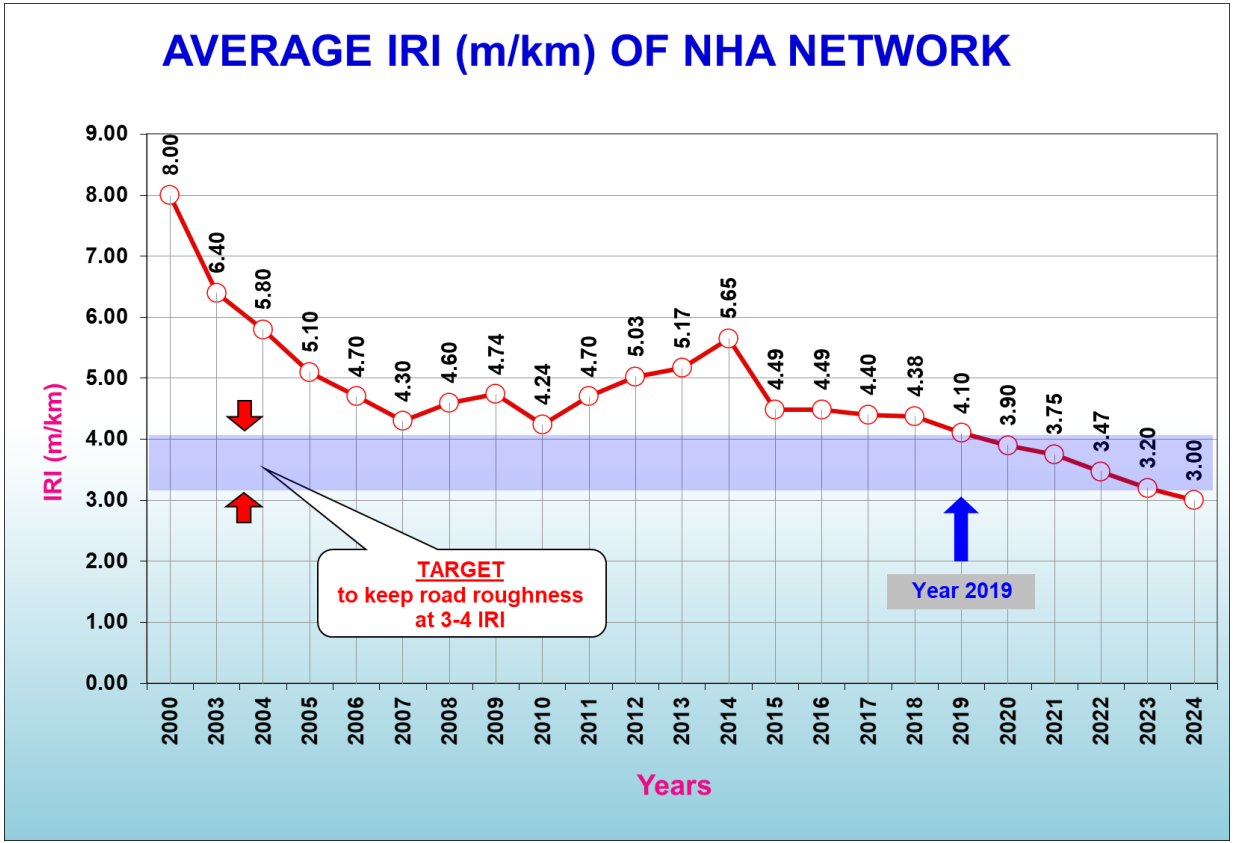
Maintenance Categories	
• Periodic Maintenance (Functional Overlays)	**Pavement Management System (HDM Analysis)**
• Periodic Maintenance (Structural Overlays)	
• Rehabilitation	
• Routine Maintenance	
• Bridge / Culvert Maintenance	(Global Allocation)
• Highway Safety Works	(Global Allocation)
• Geometric Improvements	(Global Allocation)
• Toll Plazas & Weigh Stations	(Global Allocation)
• Corridor Management	(Global Allocation)
• Special Maintenance	(Global Allocation)
• Emergency Maintenance	(Global Allocation)

Preventive Maintenance

Bridge Management System
Pak Road Assessment Program

Corrective Maintenance

Performance of RAMS on NHA Network



Impact on International Roughness Index (IRI)

THANKYOU