


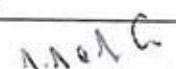
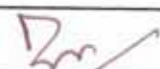
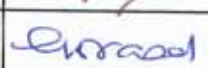



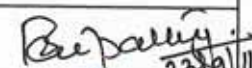

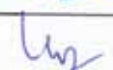



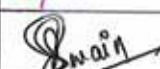
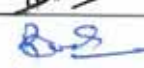

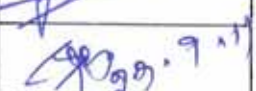



**WORKSHOP ON DATA COLLECTION MANUAL, NEEDS ANALYSIS & SYSTEM ARCHITECTURE**

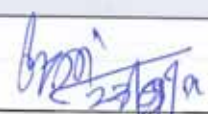
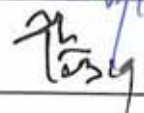
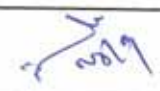
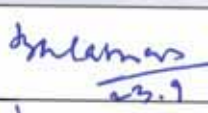

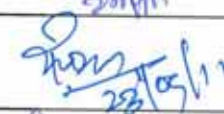
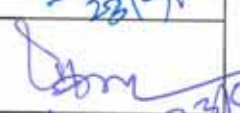
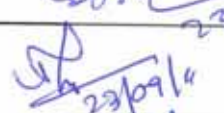
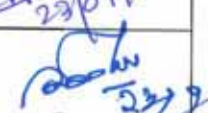

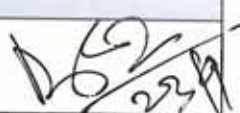

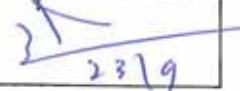
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47	Er. S. N. Acharya	Executive Engineer, Baragarh	9437961822	
48	Er. Ashok Kr. Padhi	Executive Engineer, Bolangir	9861096349	
49	Er. P. K. Sutar	Executive Engineer, Kantabanji	9437042901	
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52	Er. Pradeep Kr. Das	Executive Engineer, Ganjam - II	9437022317	
53	Er. Pradeep Kr. Hota	Executive Engineer, Bhanjanagar	9437356365	
54	Er. N. C. Dora	Executive Engineer, Paralakhemundi	9439262649	
55	Er. Satya Narayan Sahu	Executive Engineer, Phulabani	9437079856	
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59	Er. Home Singh Majhi	Executive Engineer, Sundargarh	9437071759	
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71	Animesh Dash	CSM Technologies	9861045781	
72	Amulpa Pattnayak	SPARC Bargarh	9437725161	
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7	PK. palivani	Director, Town Planning on behalf of S.O. (RWS)	9438620339	
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	S. Mishra + 2	MD SPARC	9437017913	
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	R. K. Rout	AE, o/o CE, N.H. (O), BARGARH	9437277580	
	Er. B. K. Prusty	E.E-I, ADB, o/o C.E. (RWS) BARGARH	9437060237	





Consultancy Services for  
**Orissa Road Asset Management System (O-RAMS)**

**Workshop on  
Conceptual Design & Data Collection**

**Works Department  
Government of Orissa**

**Consultant**

LEA Associates South Asia Pvt. Ltd. (LASA),  
India  
*in joint venture with*  
LEA International Ltd. (LEA), Canada  
*in association with*  
Geo InfoSpace Private Ltd. (GIPL), India



## Overview of the Project

- Part of Orissa State Road Project (OSRP)
- Asset Management System (AMS) for the State Road Network
- Three-year project includes
  - Data collection and system set-up (Year 1)
  - Data collection (Year 2)
  - Support (Year 3)
- Training and skill transfer
  - On-the-job training in Orissa (Year 1 & 2)
  - Exposure visit to other States (Year 2)
  - Exposure visit to Canada (Year 2)



2



## Definition of Asset Management

Asset management is a systematic process of maintaining assets cost-effectively

It combines engineering principles with sound business practices and economic rationale

It provides tools to facilitate a more organised, logical and flexible approach to decisions for handling both short- and long-term planning



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## Drivers of AMS

- Need to know the extent and condition of asset
- Limited budget for preservation
- Justification of demand for funds
- Best utilisation of public funds for public good
- Transparency and credibility in decisions
- Decision making – priorities and policies
- Feedback – effectiveness of actions
  - what should change ?



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## Data



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## Data Collection for O-RAMS

### By OWD

- Pavement, culvert and bridge inventory on NHs, SHs, MDRs & ODRs (20% to be verified by Consultant)
- History of pavement construction and maintenance on SHs & MDRs in the last 5 years
- Right-of-way features

### By Consultant

- GPS survey on NHs, SHs, MDRs & ODRs
- Pavement and bridge condition on SHs and MDRs
- Road roughness survey on SHs and MDRs
- BBD survey on SHs and MDRs
- Traffic volume survey (200 locations) on SHs and MDRs
- Axle-load survey (30 locations) on SHs and MDRs



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## Data Collection Chart

Data Type	Consultant	OWD	Methodology/Comments
GPS Referencing	Year 1 : 18069 km	Nil	Data collected with a handheld GPS receiver
Inventory of Pavements, Culvert, Bridges	Year 1 : 3,614 km (field verification)	Year 1: 18,069 km	20% verification in the field by the Consultant. If any discrepancy, the Client to provide updated data
Roughness on Paved Roads Using ROMDAS	Year 1 : 8,163 km	Year 3: 8,163 km	Road roughness, expressed in IRI, measured using the ROMDAS
Surface Distress Indicators	Year 1 : 8,163 km	Year 3: 8,163 km	Four deficiency types, three severity and extent, by visual inspection



## Data Collection Chart...Contd.

Data Type	Consultant	OWD	Methodology/Comments
Pavement Strength	Year 1 : 6,122 km	Year 2: 2,041 km Year 3: 2,041 km	Benkelman beam test every 500 m
Bridge Condition	Year 1: Major (300), Minor (1,350)	Year 3: 1,650	Condition rating (four levels of damages) of various elements
Traffic AADT	Year 1: 200 locations Year 2: 200 locations	Year 3: 200 locations	3-day vehicle count on SHs and MDRs
Traffic Axle-Loads	Year 1: 30 locations	Year 3: 30 locations	Axle-load surveys at 30 locations on SHs and MDRs



## Asset Inventory



## Location Referencing

- Garmin GPSMAP 78s used as mapping hand-held instrument
- Positional accuracy of 2-5 m
- Records locations of various roadway attributes while travelling along the road
- Automatically records center line of road at regular distance or time interval (every 1 second)



## GPSMAP 78s



## GIS Features Captured

Sl. No.	Captured Feature	Description
1	Centre-Line	Captured automatically every second
2	Kilometer Stone	At exact location of it
3	Cross Road/Junction	Center point of the crossing/junction, and the side, L and/or R
4	Culvert	Centre point of the culvert
5	Bridge	Centre point of a minor bridge; or both ends of a major bridge
6	Village	Beginning and end of the village
7	Pavement Surface	Where surface type changes, e.g., from BT to CC and vice versa Where pavement width changes, e.g., single to intermediate lane
8	Land Use	Where the land-use changes, and the type on both sides



## GPS Referencing: Survey Format (Sample)

Station	Distance	Bearing	Coordinates	Notes
113	✓	✓	25.71	Station 113
114	✓	✓	25.75	
115	✓	✓	25.79	
116	✓	✓	25.83	
117	✓	✓	25.87	
118	✓	✓	25.91	
119	✓	✓	25.95	
120	✓	✓	25.99	
121	✓	✓	26.03	
122	✓	✓	26.07	
123	✓	✓	26.11	
124	✓	✓	26.15	
125	✓	✓	26.19	
126	✓	✓	26.23	

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## GPS Referencing: Sample Map



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## Road Inventory

- R&B divisions to provide road inventory for each km of all roads
- Important features
  - Formation width and embankment height
  - Pavement type and width
  - Shoulder type and width
  - Name of the village & cross roads
  - Land-use
  - Terrain
- Verification done by GPS

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## Road Inventory Data Sheet

ROAD INVENTORY DATA															
ROAD NAME										ROAD NO.					
Bangalore-Bandipur-Kharipur-Kudalpur-Saravali road										101					
Section: Phulbari (P&M) Section: South										From: 142000 To: 142025 Km					
Date of Survey: 10/09/2011										Engineer: A.S. Mishra					
From Km	To Km	Terrain	Land Use	Formation	Width m	ROAD WIDTH			CROSS ROAD					Remarks	
						Type	Type	Type	Width m	Width m	Width m	Location	Road No. / Name		Carriage Way Type & Width
142000	142005	P	Bu	Medhapur	11.00	BT	BT	BT	2.65	0.6	N	1420711	Medhapur	CC 3.60	
142005	142010	H	P	Medhapur	11.00	BT	BT	BT	2.15	1.0	N				
142010	142025	P	P	Medhapur	11.00	BT	BT	BT	2.15	1.2	N				

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## Inventory Verification

- GPS instrument, jurisdiction map and inventory data provided to the survey team.
- Start and end points of roads identified.
- Locations of features recorded as waypoints in GPS instrument.
- Width of pavement and shoulders measured to the nearest 10 cm.
- Change in pavement or shoulder type, or land-use.

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## Pavement Composition

- R&B divisions to provide pavement composition of each road.
- Important features – type and thickness of:
  - Surface course
  - Binder course
  - Base course
  - Sub-base
  - Subgrade (Soil)

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## Pavement Composition Data Sheet

PAVEMENT COMPOSITION																
Road Name: Jalpur Kartikata Road										Division: Jagatsingpur			Road No. : SH2			
Section: South R&B Section										From: 0/0km To: 1/723km			Date of Survey (dd/mm/yyyy) : 26.08.11		Engineer: B.K. Pati	
Chainage		Pavement Composition										Shoulder Type	Right of Way (m)	Remarks		
From km	To km	Surface Course	Binder Course		Base Course		Subbase Course		Subgrade							
1	2	Type	Thickness (mm)	Type	Thickness (mm)	Type	Thickness (mm)	Type	Thickness (mm)	Type	Thickness (mm)	13	14	15		
0/0	1/000	SC	6	PMC	20	WBM	150	Moorum	225	Stabilised soil	500	Gr		25		
1/000	1/723	SC	6	PMC	20	WBM	150	Moorum	225	Stabilised soil	500	Gr		30		

Data Type	Col. No.	Sub Data Type	Explanation
Chainage	1,2		Mention chainage in km/m wherever there is any change of data in any of the columns 3 to 14.
Pavement type	3	Surface	Bituminous concrete- BC, Semi dense bituminous concrete- SDBC, Cement Concrete- CC, Premix carpet-PC, Built up spray- groud- BUSG, Mix seal surfacing- MSS
	4,5,6,8,10	Thickness	Mention thickness of each layer in mm
	5	Binder	Bituminous macadam- BM, Dense bituminous macadam- DBM
	7	Base	Water bound macadam- WBM, Wet mix macadam- WMM
	9	Sub-base	Granular sub-base- GSB, moorum, sandstone, quarry, stone soling
Shoulder type	11	Subgrade	Hard soil, soft soil, lime stabilized soil, clay, any other
	13		Paved- P, Gravel- Gr, Earthen- E
Right of way	14		Right of way (Reserved width of land for roads) in m

## Culvert Inventory

- R&B divisions to provide inventory of every culvert on the road.
- Important data collected
  - Location
  - Culvert type, length, thickness of slab
  - Span arrangement
  - Height above bed level
  - Scour
  - Adequacy of waterway
- Verification of location done by GPS

## Culvert Inventory Data Sheet

INVENTORY SURVEY FOR CULVERTS												
Road Name: Ambikil Bagadi Road										Road No. : SH 22		
Section: South R&B Section										From: 0/152km To: 0/460km	Date of Survey (dd/mm/yyyy) : 17.08.11	Engineer: M. Saboo
Sl. No.	Location (km/m)	Type of Structures (Pipe, Slab, Box, Arch)	Thickness of Slab (m)	Span Arrangement and Pipe Diameter (No. x Length) (m)	Carriageway Width (m)	Length of Culvert (m)	Height Above Bed Level (m)	Scour High-M, Low-L, Nil	Adequacy of Waterway (Yes/No)	Remarks		
1	0/152	Pipe		2X 1.0 m	5.50	10.00	0.60	L	Yes			
2	0/460	Pipe		2X 1.0 m	5.50	10.00	0.75	L	Yes			

Column reference	Description
2	Report location in km/m
3	RCC slab, box, hump pipe, brick arch, stone
4	Thickness of Slab has to be given for stone slab, RCC slab
5	Span arrangement has to be mentioned. In case of hump pipe, internal diameter of the pipe has to be mentioned
6	Record width of carriageway in metres to one decimal place
7	Record width of culvert in metres to one decimal place
8	Depth from the bed level (downstream side) to the soffit of the culvert (Soffit - the highest internal level of pipe / slab)
9	H- high, M- medium, L- low, N- Nil
10	Yes or No

## Inventory Verification

- GPS instrument, jurisdiction map and GPS data entry format, inventory data of the division with the survey team.
- Location of each culvert is recorded with the help of GPS.
- Chainage is verified from the data provided and waypoint updated.
- Information about the type of culvert is obtained by visual observation.
- In the case of slab culvert the thickness of slab, and in the case of pipe culverts the diameter of the pipes and number of rows.

## Bridge Inventory

- R&B divisions to provide bridge inventory data
- Important data collected
  - Chainage, structure no., river name, year of construction
  - Type of bridge, skew angle
  - Number of spans, clear span length, span arrangement
  - Superstructure, bearing, footpath, railing, wearing coat
  - Substructure, foundation, protection works
  - Clear waterway, design HFL, vertical clearance, discharge & velocity
  - Design live load
  - Road formation level
- Verification of location done by GPS

## Bridge Inventory Data Sheet

BRIDGE INVENTORY																								
Road Name: - Subala-Nagar Road																		Division: - Barangam			Road No. : - SH3			
Section: -																		from: 03136m			Date of Survey: 17.08.11		Engineer: K.Pati	
Sl. No.	Ch. No.	Type	Span no.	Location (km)	Name of river/canal	Year of construction	Span arrangement (No. x length) (m)	Clear span (m)	Length of bridge (from face of abutment) (m)	H.L.	High level of substructure	Other data for width (between rails) (m)	Clear width (bridge) (m)	Type	Super structure				Substructure					
															Material	Thickness (mm)	Span	Wearing coat	Type	Thickness of	Material			
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23		

## Right-of-Way Features Inventory

- R&B divisions to provide ROW features inventory data
- Data collection done using GPS survey
- Location of important features within ROW
  - Built-up area and their use
  - Drains, sewer line etc.
  - Pipelines (water / gas / OFC etc.)
  - Utilities (electric poles, telephone, street light etc.)
  - Traffic sign boards
  - Trees
  - Other utilities (bus shelter, gate, hand pump, well etc.)
- Verification of location done using GPS



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## R-O-W Features Inventory Data Sheet

Right-of-Way Features							Detail Explanation of Assets		
Road Name	Baripada Road	Road No.	SH	MDR	SR	ODR	Asset Code	Remark	
District	Pattadak	Date of Survey	34.07.2011				Surveyor	S.K. Sanyal	
Change	Waypoint	LHS	RHS	Asset Code	Start (S) / End (E)	Remarks	Features		
1/100	183	6.5		BU1	S		House	BU1	
1/400	182	8.5		BU1	E		Shop	BU2	
2/500	186		7.5	SI			Industry	BU3	
2/850	184	6.5		SI			Temple/Mosque/Church	BU4	
3/500	185		5.95	BU3	S		Others	BU5	
							Bus Bay	BB1	
							Bus Shelter	BS1	
							Gate	G1	
							Guard Post	GP	
							Hand Pump	HP	
							Water	WP	
							OFC	OFC	
							Panel Cables	PC	
							Electric	P1	
							Telephone	P2	
							Street Lights	P3	
							ROW Fence	RF	
							Road Side Drains	RSD	
							Information	SI	
							Mandatory	S2	
							Warning	S3	
							Other	S4	
							Tree	T1	
							Misc	W1	



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## Condition Survey



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## Pavement Condition

- Pavement condition survey is done as a measure of the ability of the pavement to continue to provide required service to the public
- Consists of three components
  - Surface distresses
  - Ride quality
  - Structural strength
- Survey conducted on SHs and MDRs



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## Pavement Distresses

- Condition rating is carried out based on four distresses for each type of pavement based on three levels of **severity** and **extent**

Bituminous (BT) or Flexible Pavement	Cement Concrete (CC) or Rigid Pavement	Gravel (GR) or Water Bound Macadam (WBM) Pavement
Cracking	Cracking	Loose gravel
Potholes	Potholes	Potholes
Raveling	Joint deficiencies	Rutting
Rutting	Faulting or stepping	



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## Pavement Condition...Contd.

- Severity**  
'Severity' refers to how bad the problem is. The severity scale has three levels: *low*, *medium*, and *high*. Guidelines give a verbal description of each stage together with pictorial representations.
- Extent**  
'Extent' refers to the size of the problem area. The extent scale has three levels: *intermittent*, *frequent* and *extensive*.

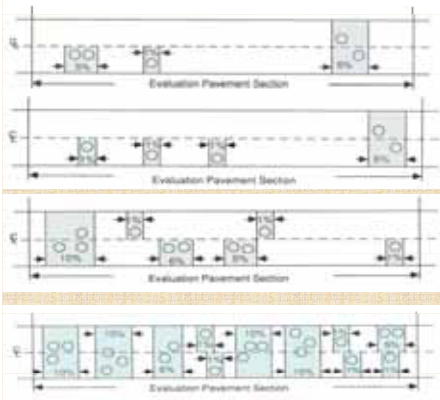
Class	Guidelines
Intermittent	Less than 20% of pavement surface affected. Spotted over localized areas only.
Frequent	20% to 50% of pavement surface affected. May be spotted evenly over length of pavement section or over localized areas only.
Extensive	More than 50% to 100% of pavement surface affected. Spotted evenly over length of pavement section.



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## Extent of Distress - Rating



Intermittent  
( $< 20\%$ )

Frequent  
(20-50%)

Extensive  
( $> 50\%$ )



## Pavement Distress Evaluation

- Drive slowly to visually inspect the surface
- Stop to examine the distresses in terms of type, severity, and extent
- For two-lane highways, average extent and severity in both lanes. On divided highways, evaluation done for each direction separately.



## Flexible Pavement – Severity Rating

Distress	Low	Medium	High
Cracking	Crack up to 10 mm in width	Crack of 10-20 mm in width	Crack more than 20 mm in width, or multiple cracks
Pothole	100 mm or less in width and up to 50 mm in depth	100-300 mm in width and more than 50 mm in depth	More than 300 mm in width and more than 100 mm in depth
Rutting	Depth less than 15 mm	Depth 15-30 mm	Depth more than 30 mm
Raveling	Noticeable loss of pavement material	Surface texture visibly appears as open, slightly disintegrated surface	Wide open texture with loose materials, slightly disintegrated surface with small potholes



## CC Pavement – Severity Rating

Distress	Low	Medium	High
Cracking	Crack less than 10 mm in width	Crack of 10-20 mm in width, or multiple cracks (even if crack width is less than 10mm)	Crack more than 20 mm in width, or multiple cracks with spalling (even if crack width less than 20 mm)
Pothole	Pothole resembles pop-out of coarse aggregate with or without disintegration of surrounding materials	Pothole more than pop-out of coarse aggregate but less than 75 mm in width and depth	Width and depth 75 mm and over, with or without interfering the rideability
Joint Deficiencies	Sealant broken and beginning to pull out; joint separation visible, less than 15 mm	Sealant broken and pulled out by up to 50% of its length; joint separation 15-30 mm	Sealant completely broken and pulled out 80% or more of its length; joint separation more than 30 mm with or without breakdown of slabs adjacent to the joint
Faulting (Stepping)	Less than 10 mm	10-20 mm	More than 20 mm



## GR-WBM Pavement – Severity Rating

Distress	Low	Medium	High
Loose Gravel	Loose aggregate on roadway less than 50 mm in width	Loose aggregate on roadway 50-200 mm in width	Loose aggregate on roadway more than 200 mm in width
Pothole	Less than 100 mm in width and less than 50 mm in depth	100-300 mm in width and more than 50 mm in depth	More than 300 mm in width and more than 100 mm in depth
Rutting	Less than 100 mm in depth	100-200 mm in depth	More than 200 mm in depth



## Flexible Pavement Distress Evaluation

- Pothole  
Bowl, round or irregular shaped holes (depressions) in pavement. It can be unrelated or a direct result of other defects such as raveling, alligator cracking etc.
- Severity

Level	Description
Low	100 mm or less in width and upto 50 mm in depth
Medium	100 mm – 300 mm in width and more than 50 mm in depth
High	Width is more than 300 mm and usually depth is more than 100 mm





## Pothole – Severity Levels



## Flexible Pavement Condition Evaluation Data Sheet

FLEXIBLE PAVEMENT CONDITION EVALUATION FORM																
Road Name		Sahela Nupada Road				Division		Bargarh				Road No		SH3		
Section		From : 0/000km To 5/000km				Date of Survey (dd/mm/yy)		14.08.11				Engineer		B.N. Dutta		
CHAINAGE	From Km	To Km	CRACKING			POTHOLES			RAVELLING			RUTTING			Remarks if any	
			SEVERITY	EXTENT	SEVERITY	EXTENT	SEVERITY	EXTENT	SEVERITY	EXTENT	SEVERITY	EXTENT				
			Low	Medium	High	Low	Medium	High	Low	Medium	High	Low	Medium	High		
			Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)		
	0/000	1/000		Y	Y		Y	Y		Y	Y		Y	Y		
	1/000	2/000	Y													
	2/000	2/850		Y	Y		Y	Y		Y	Y		Y	Y		
	2/850	3/550	Y													
	3/550	5/000		Y	Y		Y	Y		Y	Y		Y	Y		

## Rigid Pavement Condition Evaluation Sheet

CEMENT CONCRETE (RIGID) PAVEMENT CONDITION EVALUATION FORM																
Road Name		Defunct N.H. 23				Division		Angul				Road No.		ODR		
Section		From 0/000km To 2/850km				Date of Survey (dd/mm/yy)		11.08.11				Engineer		P.Mohanti		
Chainage	From Km	To Km	CRACKING			POTHOLES			JOINT DEFICIENCY			FAULTING/STEPPING			Remarks if any	
			SEVERITY	EXTENT	SEVERITY	EXTENT	SEVERITY	EXTENT	SEVERITY	EXTENT	SEVERITY	EXTENT				
			Low	High	Low	High	Low	High	Low	High	Low	High	Low	High		
			Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)		
	0/000	1/000		Y			Y	Y					Y	Y		
	1/100	2/250	Y				Y	Y		Y	Y		Y	Y		
	2/250	2/850		Y			Y	Y		Y	Y		Y	Y		

## Gravel Surface Pavement Condition Evaluation Sheet

GRAVEL PAVEMENT SURFACE CONDITION EVALUATION FORM															
Road Name		Kulad-Yalgher Road				Division		Angul				Road No.		ODR	
Section		From 0/000km To 2/850km				Date of Survey (dd/mm/yy)		15.08.11				Engineer		B.K.Mallik	
Chainage	From Km	To Km	LOOSE GRAVEL			POTHOLES			RUTTING			Remarks if any			
			SEVERITY	EXTENT	SEVERITY	EXTENT	SEVERITY	EXTENT							
			Low	Medium	High	Low	Medium	High	Low	Medium	High				
			Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)	Intermittent (<20%)	Frequent (20-50%)	Extensive (>50%)				
	0/000	1/000		Y			Y	Y		Y	Y		Y		
	1/000	2/085	Y				Y	Y		Y	Y		Y		
	2/085	2/850		Y			Y	Y		Y	Y		Y		

## Pavement Roughness

- Pavement roughness is generally defined as an expression of irregularities in the pavement surface that adversely affect the riding quality of a vehicle and thus the user.

## Pavement Roughness

- Roughness measured on SHs and MDRs using ROMDAS.
- The instrument measures the relative displacement of the vehicle body to the axle.
- Data reported in terms of IRI of the road section



## Pavement Deflection

- Benkelman beam deflections every 500m on SHs and MDRs.



## Traffic Survey

- At 200 locations on SHs, MDRs and selected ODRs
- 3-day vehicle counts classified into 15 vehicle types
- Helps to determine the capacity utilization and forecast
- Used in Traffic Information System (TIS) linked to RIS



## Axle-Load Survey

- At 30 locations on SHs, MDRs and selected ODRs
- To be used in pavement design and strengthening.



## Bridge Condition Survey



## Bridge Condition Survey - Concepts

- It is a misconception that a bridge once constructed does not require any substantial maintenance for the first couple of decades.
- To maintain the serviceability of the bridges and to ensure a reliable level of service, due recognition by the maintenance authorities is essential.
- Large number of bridges are on the verge of un-serviceability due to repeated heavier loading.
- Even high quality of construction without proper maintenance, will lead to early failure of the bridge.



## Bridge Condition Survey...Contd.

- The steps necessary for a reliable serviceability level of the bridge:

Activity	Achievement
Quality construction	Lesser cost of maintenance
Quality maintenance	Lesser cost of special repair
Quality special repair	Delayed strengthening and rehabilitation
Quality rehabilitation	Delayed reconstruction Least risk of serviceability loss Low cost of future maintenance Delayed future special repair Delayed future strengthening and rehabilitation



## Bridge Condition Survey...Contd.

- Lack of regular maintenance leads to deterioration of the bridges.
- In the absence of regular maintenance normally ad-hoc decisions are taken at crisis for the maintenance, which is not only dangerous but also reduces the life of structure.
- For proper maintenance of bridges, regular inspection data is required.
- Maintenance grants for the bridges are not utilized properly on account of lack of inspection data for bridges



## Bridge Condition Survey

- Bridge condition survey is required :
  - to evaluate structural soundness
  - to establish a database in the BIS
  - to take timely action for maintenance to prevent further deterioration



## Bridge Condition Survey

- Critical attributes of bridge condition survey
  - I. Spalling
  - II. Cracking
  - III. Corrosion
  - IV. Settlement / scour / deformity
  - V. Condition of bearings



## Bridge Condition Survey

- Elements for Evaluation
  - I. Foundation and Protection Works
  - II. Substructure
  - III. Superstructure
  - IV. Bearings



## Bridge Condition Rating

### Severity

Level	Description
Nil	No visible damage
Low	All elements are in good condition with minor deterioration
Medium	Element has only minor/advance section problems
High	Structural capacity of element is affected or jeopardized by advanced deterioration, section loss, spalling, cracking, or other deficiency

### Extent

Level	Description
Nil	No distress visible
Few	Less than 10% surface area affected
Moderate	10 to 25% surface area affected
Extensive	More than 25% surface area affected



## Methodology

### Four-step process

- Identifying the distress types
- Visual observation of distress
- Condition rating for elements
- Overall rating of the bridge





## Scour and Settlement

### Severity

Sl. No.	Description	Rating
1	No Scour visible	No damage
2	Observed depth of scour at foundation location is normal	Low
3	Depth of scour is more and settlement is less	Medium
4	Depth of scour is more and critical. Settlement of sub structure is also more and there is vertical dislodgement of pier and abutment	High

### Extent

Sl. No.	Description	Rating
1	No Scour, No Settlement	Nil
2	Up to 10% of foundations scoured	Few
3	10% to 25% of foundations scoured	Moderate
4	> 25% of foundations scoured	Extensive



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## Spalling of Concrete

### Severity

Sl. No.	Description	Rating
1	No Spalling	Nil
2	Slight spalling. Depth of spalling less than 10mm. Reinforcement not exposed.	Low
3	Extensive spalling of depth < 50mm. Less exposure of reinforcement.	Medium
4	Extensive spalling. Depth > 50mm. Reinforcement exposed and corroded.	High

### Extent

Sl. No.	Description	Rating
1	No Spalling	Nil
2	Up to 10% of surface area affected, mostly localized	Few
3	10% to 25% of surface area affected, mostly localized	Moderate
4	> 25% of surface area affected, either localized or evenly over length	Extensive



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## Cracking (Pattern, Width and Location)

### Severity

Sl. No.	Description	Rating
1	No cracking	No damage
2	Hair Line cracks width <1.6mm	Slight
3	Narrow and medium Cracks width 1.6mm to 4.8mm	Moderate
4	Wide cracks width > 4.8 mm	High

### Extent

Sl. No.	Description	Rating
1	No Cracks visible	No damage
2	Up to 10% of surface area affected, mostly localized	Low
3	10% - 25% of surface area affected, either localized or evenly over structure	Medium
4	More than 25% of the surface area affected, almost evenly over length	High



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## Corrosion

### Severity

Severity of the Corrosion will be adjudged from the location of the corroded reinforcement, percentage of corrosion and pit corrosion.

### Extent

Sl. No.	Description	Rating
1	No corrosion	Nil
2	Up to 10% of surface area affected, mostly localized	Low
3	10% - 25% of surface area affected, either localized or evenly over structure	Medium
4	More than 25% of the surface area affected, almost evenly over length	High



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## Bearings

### Severity

Sl. No.	Description	Rating
1	No damage	Nil
2	Surface cracks in pedestal and slight deformation of bearings	Slight
3	Cracks having <1.6mm wide, and spalling in pedestal, appreciable deformation in bearings	Moderate
4	Slitting and wide cracks in pedestal, Bulging, deformation, bearing not sitting in full length, anchor bolts missing, rusting of bearings	High

### Extent

Sl. No.	Description	Rating
1	No damage	Nil
2	Minor damages in Pedestal and Bearings	Low
3	In 10 to 25% of bearings, there are damages in Pedestal, but no damage observed in Bearings	Medium
4	More than 25% of the Pedestal and bearings are damaged	High



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## Bridge Condition Rating Summary - Extent

Distress	Nil	Few	Moderate	Extensive
Scour and settlement	No Scour visible	Up to 10% of foundations scoured	10% to 25% of foundations scoured	> 25% of foundations scoured
Spalling	No Spalling	Up to 10% of surface area affected, mostly localized	10% to 25% of surface area affected, mostly localized	More than 25% of surface area affected, either localized or evenly over length
Cracking	No cracking	Up to 10% of surface area affected, mostly localized	10% to 25% of surface area affected, either localized or evenly over structure	More than 25% of the surface area affected, almost evenly over length
Corrosion	No corrosion	Up to 10% of surface area affected, mostly localized	10% to 25% of surface area affected, either localized or evenly over structure	More than 25% of the surface area affected, almost evenly over length
Deformation of bearings	No damage	Minor damages in pedestal and bearings	In 10 to 25% of bearings, there are damages in pedestal, but no damage observed in bearings	More than 25% of the pedestal and bearings are damaged



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## Bridge Condition Rating Summary - Severity

Distress	Nil	Low	Medium	High
Scour and settlement	No Scour visible. No damage to protection works	Observed depth of scour at foundation location is normal. Less dislodgement of protection works.	Depth of scour is more and settlement is less. Bed protection works are dislodged.	Depth of scour is more and critical. Settlement of sub structure is also more and there is vertical dislodgement of pier and abutment.
Spalling	No Spalling	Slight spalling. Depth of spalling less than 10mm. Reinforcement not exposed.	Extensive spalling of depth < 50mm. Less exposure of reinforcement.	Extensive spalling. Depth > 50mm. Reinforcement exposed and corroded.
Cracking	No cracking	Hair line cracks width <1.6mm	Narrow and medium cracks width 1.6mm to 4.8mm	Wide cracks width > 4.8 mm
Corrosion	Severity of the Corrosion will be adjudged from the location of the corroded reinforcement, percentage of corrosion and pit corrosion.			
Deformation of bearings	No damage	Surface cracks in pedestal and slight deformation of bearings	Cracks having <1.6mm wide, and spalling in pedestal, appreciable deformation in bearings	Slitting and wide cracks in pedestal, Bulging, deformation, bearing not sitting in full length, anchor bolts missing, rusting of bearings

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## Bridge Condition – Overall Rating

Sl No	Condition of Damages (Extent and Severity)					Overall Rating
	Scour / Settlements in Foundation/Protection Works	Spalling	Cracking	Corrosion	Deformity of Bearings	
1	No settlement / less scour	Slight or no spalling	No cracking/ hairline cracking	No corrosion	No deformity	Good Condition
2	No settlement. Normal scour	Both extent and severity are moderate	Both extent and severity are moderate. cracks are narrow	Slight corrosion	No deformity	Fair Condition
3	No settlement. Normal scour	Extensive and deep spalling	Extensive and medium cracks	Moderate corrosion	Damages of pedestal observed. Slight deformation of bearings	Poor Condition
4	Settlement of substructure. Scours in foundation and protection works	Extensive and deep spalling	Extensive and wide cracks	Heavy corrosion	Bearings out of sitting. Pedestal damaged	Severe Condition

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## Bridges: Action Needed

### GOOD CONDITION

**Minor repair may be done on short-term basis**

### FAIR CONDITION

*All primary structural elements are in good condition but have minor section losses.*

**Immediate repairs are required.**

### POOR CONDITION

*Losses of section, deterioration, spalling, cracking or scour have seriously affected primary structural components.*

**Local failures are possible. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.**

### SEVERE CONDITION

*Major deterioration or section loss present in critical structural components.*

**Bridge has to be closed to traffic, requires rehabilitation or reconstruction.**

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## Bridge Condition Data Sheet

Road Name:		BRIDGE CONDITION DATA												Division -													
Bridge No.:		Bridge Location:												Date of Survey:													
Sl. No.	Bridge Element	Spalling						Cracking						Corrosion						Settlement/Scour/Deformity							
		SEVERITY		EXTENT		EXTENT		SEVERITY		EXTENT		EXTENT		SEVERITY		EXTENT		SEVERITY		EXTENT							
		Nil	Low	Medium	High	Nil	Low	Medium	High	Nil	Low	Medium	High	Nil	Low	Medium	High	Nil	Low	Medium	High	Nil	Low	Medium	High		
1	Foundation																										
2	Protective Works																										
3	Substructure (Abutments/Piers)																										
4	Substructure (Wing Walls/Stream Walls)																										
5	Superstructure (Girders / Beams / Slab/Girder)																										
6	Superstructure (Deck Slab/Heavy Arch)																										
7	Bearings																										
8	Additional Comments																										
Overall Condition Rating		Good	Medium	Poor	Severe																						

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Consultancy Services for  
**Orissa Asset Management System (O-AMS)**

**Workshop on  
Needs Analysis and System Architecture**

**Works Department  
Government of Orissa**

**Consultant**  
LEA Associates South Asia Pvt. Ltd.  
(LASA), India  
*in joint venture with*  
LEA International Ltd. (LEA), Canada  
*in association with*  
Geo InfoSpace Private Ltd. (GIPL), India

## AMS is a Planning Tool

### Deals with planning of :

- Maintenance, rehabilitation & improvement of road assets in the most cost effective manner

### What do we need for planning :

- What is the condition now ?
- What may happen in the future ?
- What needs to be done and when ?
- How much it will cost ?
- What will be the improvement / result ?
- What are the alternatives and their impact ?

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## Uses of AMS

- Determine the health of the network
- Establish the needs
- Answer 'what if' in terms of budget levels, treatment choices or external factors

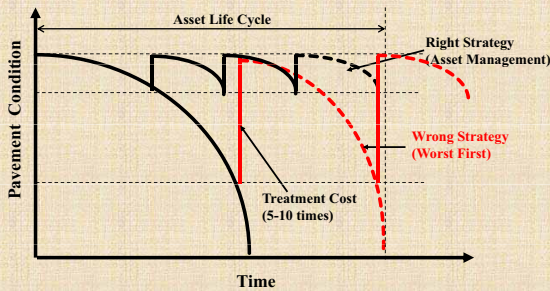


## Process

- Inventory data
- Present condition assessment
- Target
- Performance prediction
- Techno-economic analysis
- Plan (short- & long-term)



## Pavement Performance

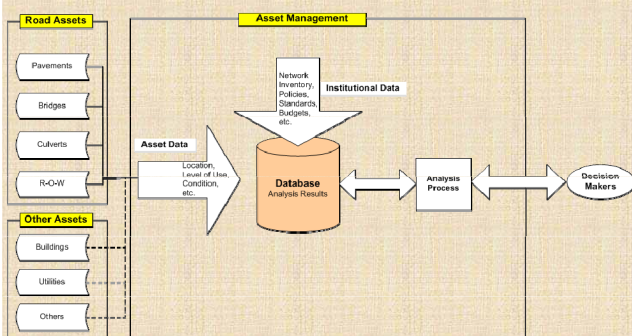


## Elements of AMS – Steps Necessary

1.	Network definition	location
2.	Database	inventory, construction, maintenance, cost data
3.	Condition evaluation	data collection
4.	Maintenance & rehabilitation strategies	policies, standards and target
5.	Prioritization	ranking
6.	Optimization	maximise effectiveness
7.	Plans	short-term and long-term



## Asset Management System



## O-RAMS SYSTEM COMPONENTS

- Geographic Information System (GIS)
- Road Information System (RIS)
- Bridge Information System (BIS)
- Right-of-Way Features Information Management System (RWFIMS)
- Pavement Management System (PMS)
- Routine Maintenance Management System (RMMS)
- Traffic Information System (TIS)





## Needs Analysis

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## Purpose of Needs Analysis

### To Review

- OWD institutional set-up
- Maintenance management practices
- IT set-up

### To Recommend

- Overall O-RAMS system architecture

### To Evaluate and Inform

- Software to be developed / configured for O-RAMS
- Road information / management systems working in India and outside
- Confirm the software and hardware needed

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## We Have Reviewed

- OWD institutional set-up
- Functions and responsibilities of each wing / office
- Planning process
  - Plan and Non-Plan works
  - Special studies and design activities
  - Estimating and costing
  - Approvals
- Procurement of construction services
  - Registration of contractors
  - Procurement of works
  - Forms of agreement
  - Work execution and supervision
- Annual Budget

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## Planning Process

### Concerns

- Strategic planning activity in the Department -
- Tools for road planning / network improvement -
- Data collection and processing capabilities-

### Findings

- Lacking
- Lacking
- Limited

### Recommendations

- Prepare strategic plans, policies and master plan for the state road network based on sound engineering principles
- Re-classify the state road network
- Redefine Core Road Network (CRN)
- Develop prioritization criteria for road works
- Standardize procedures for maintenance of re-classified network

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## Road Maintenance

### Concerns

- Non-plan budget not need-based and inadequate
- Lack of measured physical condition of roads
- Lack of attention to shoulder grading, drainage, etc.
- Pipes and culverts blocked

### Recommendations

- Adopt a systematic approach to informed decision making
- Use techno-economic criteria
- Allocate resources where most effective
- Develop policies and standards
- Measure the effectiveness of programs
- Establish a Road Maintenance Management System

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## Data / Information Systems

### Concerns

- Insufficient, irregular data, not accessible to all
- Lack of centralized data depository and processing
- Lack of skills to process the data for planning, design, construction and maintenance

### Recommendations

- Collect traffic data including classified and origin-destination
- Collect riding quality and distress survey data
- Collect road accident data from secondary sources, e.g. police
- Establish a centralized GIS-based database containing all inventory, condition, traffic and maintenance history data

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## Review of IT Infrastructure

### IT Policy

- OWD does not have any IT Policy

### Software

- Limited use of software, only word processing / spread sheet / CAD

### Hardware

- HQ 30 Pentium IV computers
- Division 2-3 computers each
- No database, email / exchange server

### Communication

- HQ High-speed LAN with broadband internet connection
- Division Broadband / dialup connection
- Information dissemination to public through Department and OSRP website



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## Overall Assessment of IT Infrastructure

Level	Description
A	little IT infrastructure, no communications network, little ability to plan and manage IT, Infrastructure and organizational assistance required.
B	some IT infrastructure & limited LAN, little organizational capacity to plan and manage IT, Infrastructure and organizational assistance required.
C	<b>significant IT infrastructure including LANs, has multiple users in Central Office that would benefit from AMS, IT organizational assistance may be necessary for policies and procedures.</b>
D	significant IT infrastructure including LANs and WAN, strong policies and procedures, has multiple users in many locations and job functions
E	significant IT infrastructure, including WAN, strong policies and procedures, multiple applications that need to be integrated to AMS

Source: "Generic Terms of Reference for Supply and Installation of Road Management Systems" Version 1.0 – 31 January, 2007. East Asia Pacific Transport Unit, The World Bank, Washington, D.C.



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## Features in Asset Management Systems

AMS Level	Description
A & B	Typically limited to 1-4 concurrent users, stand-alone relational database (not a spreadsheet), minimum function to store, retrieve and apply data.
B & C	<b>Typically 5 – 25 concurrent users</b> Has all basic functions required of an effective AMS, but lacks some of the advanced features
D	Typically over 25 concurrent users Has all advanced functionality including features such as web-mapping Multi-user system with scalable enterprise level database
E	Advanced system with ability to access program features through custom developed software. Enables other applications to read RMS data, to store data, or external references to that data in the RMS



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## System Architecture



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## O-RAMS SYSTEM ARCHITECTURE

### Encompasses:

- Conceptual model
- System components
- Functions of system components
- Relationships between the components
- Plan for procurement / development



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## O-RAMS SYSTEM COMPONENTS

- Geographic Information System (GIS)
- Road Information System (RIS)
- Bridge Information System (BIS)
- Right-of-Way Features Information Management System (RWFIMS)
- Pavement Management System (PMS)
- Routine Maintenance Management System (RMMS)
- Traffic Information System (TIS)



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## Geographic Information System (GIS)

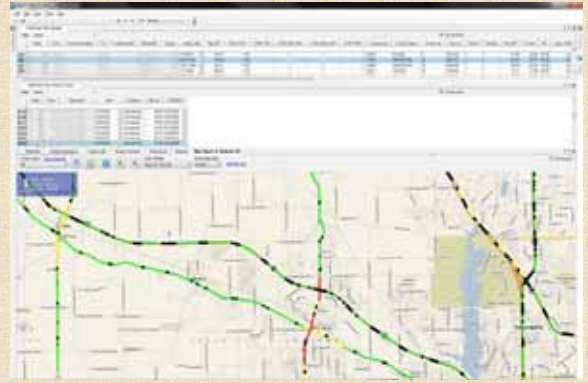
- GIS is a powerful presentation tool to display on a map data e.g.
  - point features such as bridge, culvert, km stone segment / line features such as the pavement
- GIS will be linked to RIS / BIS / RWFIMS
- Two most popular GIS Technology are ESRI and MapInfo
- Major off-the-shelf AMS software support files from ESRI
- Also used by ORSAC and other departments for map preparation

### Recommendation:

ESRI : ArcGIS - ArcInfo



## Geographic Information System (GIS)



## Road Information System (RIS)

- It forms the basic framework of the O-RAMS, and will contain:
  - Location of roads and assets
  - Inventory information
- The location will be defined using a linear reference system similar to the system used in OWD
- RIS will have data management functions like input / import, view, modify, export generation of charts
- This will be linked to GIS for display of maps



## Bridge Information System (BIS)

- It will contain inventory and the condition data on 1650 bridges
- Linear reference system in RIS will be followed in BIS
- It will have data management functions like input / import, view, modify, export generation of charts
- This will be linked to GIS for display of maps



## Right-of-Way Features Information Management System (RWFIMS)

- It will contain right-of-way features, e.g.,
  - Traffic signs, poles, trees, ditches / drainage channel
  - Guard posts, fencing, buildings, land details
- Linear reference system in RIS will be followed in RWFIMS
- It will have data management functions like input / import, view, modify, export generation of charts
- This will be linked to GIS for display of maps



## Pavement Management System (PMS)

- Planning tool to predict periodic maintenance and rehabilitation requirements
- Used to prepare a multi-year maintenance plan optimized for the budget
- Analysis is based on techno-economic analysis
- PMS process
  - Inventory data
  - Present condition assessment
  - Target
  - Performance prediction
  - Techno-economic analysis
  - Plan (short- & long-term)
- Functions like data input / import, view, modify, export generation of charts / reports







## O-RAMS Software

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## O-RAMS

An asset management system (AMS) for roads must include

- Asset inventory - including location referencing
- Asset condition data
- Maintenance strategies
- Deterioration, remaining life and road-user cost models
- Prediction models – future condition, traffic forecast and growth rate etc.
- Life-cycle cost analysis
- Decision and tools – multi-criteria analysis, prioritizing and optimizing, trade-off analysis, risk analysis etc.
- Strategy – heritage management, accounting principles, asset valuation and capitalization of road infrastructure, policies.

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## O-RAMS Software

There are two possible ways to put an AMS in place:

1. Develop a system from scratch/modify an existing one, or
2. Acquire a ready-made commercial-off-the-shelf (COTS) software

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## O-RAMS Software – Development from Scratch

- Necessary team requirement (full time – in-house or external)
  - Pavement Engineers, Bridge Engineers, Planning Engineers
  - Maintenance/Construction and Operations Engineers
  - Database Experts, Software Design Engineers, Modelling Experts
  - Accounting and Costing Experts, Strategy and Policy Experts
- Developing a new asset management system is a complex and expensive undertaking and requires a high level of expertise and time
- Expertise not available locally
- Developing an AMS from ground-up is neither practicable, nor advisable
- Experiences of Gujarat & Ontario confirm the complexity of the task

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## O-RAMS Software – Commercial off-the-Shelf Software

In view of the time-frame available and the costs involved, the best course of action for a successful implementation of the system is to acquire a commercially available-off-the-shelf software.

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## Commercial off-the-Shelf Software Providers

- Confirm Pavement Manager, MapInfo Corp, USA
- dTIMS, Deighton Associates Ltd, Canada
- EXOR, Bentley Systems, UK
- ICON, GoodPoint Technologies, USA
- HIMS, HIMS Ltd, New Zealand
- Symology, Symology Ltd, UK

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## Criteria for Evaluation

As per functional and technical requirement of the software - Annexure 1 of Appendix A : Description of Services

- Widely used & high level of credibility / acceptability (No. of installations)
- Comprehensive, to include modules other than roads
- Web-based / ability to support multiple users
- Has all 5 modules
- GIS interface / link (To RIS, BIS and RWFIMS)
- HDM-4 interface / link (To PMS)
- Alternate models (better confidence in results)
- Support field data collection devices
- Purchase and maintenance cost



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## Evaluation of COTS Software

Feature	CONFIRM	dTIMS	EXOR	HIMS	ICON	SYMOLOGY
No. of installations	25+	180+	100+ <sup>1</sup>	10+	N/A (but small)	25+
Web-based / Support multiple users	N/A	Yes	Yes	No <sup>2</sup>	Yes	Yes
Has all 5 modules	Yes	Yes	Yes	No <sup>3</sup>	Yes	Yes
GIS interface / link	Yes	Yes	Yes	Yes	Yes	Yes
HDM-4 interface / link	Yes	Yes	Yes	Yes	Yes	N/A
Alternate models	Yes	Yes	Yes	No	Yes	Yes
Support field data collection devices	Yes	Yes	Yes	Yes	Yes	Yes
Approximate cost		\$978,600 \ \$583,600 <sup>4</sup>	\$1,200,000			
Approximate maintenance cost		\$ 68,900 \ \$ 41,100 <sup>4</sup>	\$ 270,000			

1. Most EXOR installations are in the UK.
2. HIMS had no web-based version available. It is in the process of developing one.
3. HIMS's application is limited to road and bridge inventory, and road maintenance and planning using HDM-4. There is no right-of-way information system
4. Recommended configuration



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## COTS Software Evaluation Results

- dTIMS and EXOR are the only world-class software meeting all requirements for the proposed system.
- All others have a small footprint and are more local in nature.
- CONFIRM, ICON and SYMOLOGY have no facility to provide post-implementation support in India.
- SYMOLOGY does not appear to have any link to HDM-4.
- HIMS is:
  - Not web-based
  - No Right-of-Way Features Information Management System (RWFIMS)
- dTIMS and EXOR include HDM-4 deterioration models and analytical tools as well as their own experience-based models and tools as an alternative



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## Selection of COTS Software

- Significant difference in the in-built models in dTIMS and EXOR. While dTIMS is amenable to modifications, EXOR is relatively rigid or 'black box'.
- For a similar configuration the initial cost of EXOR is about 25% more than that of dTIMS
- Maintenance costs of EXOR are 22% of the original licensing fee, dTIMS charges only 6%
- dTIMS has more world-wide installations, a longer proven record of more than 25 years
- dTIMS is being implemented at World Bank projects:
  1. Lesotho Ministry of Works
  2. Uganda National Road Authority
  3. Ethiopia Road Authority
- ADB procured dTIMS for Mongolia's RMS now in progress



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## O-RAMS Implementation



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## O-AMS System Implementation

COTS Software	Function	Where Used
dTIMS CT (Core)	Data repository and full-featured data management and analysis tool.	Head Office
dTIMS md (Management Dashboard)	Browser-based tool for presenting results of analysis from dTIMS CT.	Head Office, Circles, Divisions
dTIMS wf (Work Flow)	Browser-based tool for browsing/ importing data, executing queries, data transformation, etc.	Head Office, Divisions
dTIMS mm (Maintenance Management)	Browser-based tool for planning, budgeting and management of day-to-day roadway maintenance operations.	



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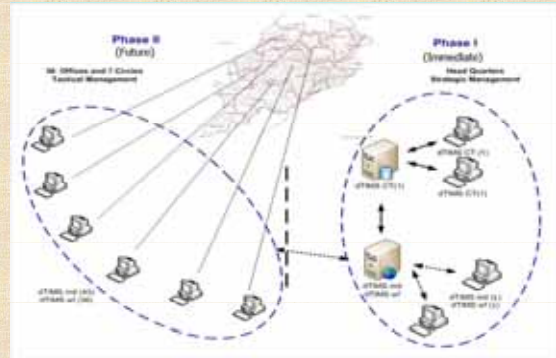


## COTS Software Implementation Phases

The licenses for the COTS software should be implemented in two stages, as a prudent fiscal approach.

- Phase – I (Immediate): Few user licenses for each type of dTIMS software (CT / md / wf) need to be required for systems development and testing at the head office
- Phase – II (future): roll-out to all circles and divisions will require more licenses for dTIMS software (md / wf)

## Software Implementation Phases



## COTS Software Licensing Options

### Immediate

COTS Software	HQ	Circles	Division	Total
dTIMS CT	3			3
dTIMS md	2			2
dTIMS wf	2			2

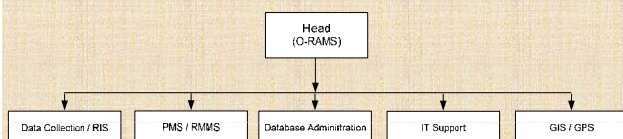
### Future

COTS Software	HQ	Circles	Division	Total
dTIMS CT				
dTIMS md		7	36	43
dTIMS wf			36	36

## Other Software , Hardware, Networking Requirements

- ArcGIS (ArcInfo) - One
- Microsoft SQL Server 2008 – Enterprise Edition–One
- Internet Information Services (IIS 7.0 – For Web Server)–One
- Office Productivity Tools (Microsoft Office 2010– Home & Business Edn.)
- AntiVirus Software
- Server Computer (Xeon 2 Processor 2.4 GHz 48 GB RAM)–Two
- Microsoft Windows Server 2008 (Operating System)–Two
- Client computers (Windows 7 OS, Office Productivity Tools)
- Windows 7 – Professional Edition (Client Operating System)
- Printers and plotters
- OSWAN and 100 mbps LAN connectivity

## O-RAMS Support Team



## Asset Management

It is just what we are supposed to do