Road Asset Management Systems (RAMS)
+
Performance-Based Contracting (PBC)

Session 1.2: RAMS Data Collection

Serge Cartier van Dissel
February 2021

Agenda

Day 1 Road Asset Management System (RAMS)	Day 2 Road Asset Management System (RAMS)	Day 3 Performance Based Contracting (PBC)
Session 1.1 **RAMS** **Introduction**	**Session 2.1** **RAMS Data Management & Data Analysis**	**Session 3.1** **PBC Introduction & Performance Standards**
Break	Break	Break
Session 1.2 **RAMS** **Data Collection**	**Session 2.2** **RAMS** **Integration**	**Session 3.2** **PBC Inspections & Payments**

Data

- Needs to be up-to-date (frequency depends on type of data)
- Needs to be complete (entire network)
- Needs to cover the data types required for the function of the RAMS
- Needs to be reliable
- Needs to be sufficiently accurate for the function of the RAMS
- <u>Avoid collecting data that is not needed or that will not be used</u>

Data collection

- Data collection is one of the weakest parts of any RAMS
  - Data collection costs money, time
    - Data collection
    - Data processing
  - New technologies reduce data collection and processing costs
    - Automated traffic counters
    - Automated pothole and crack identification
    - Automated roughness measurements (IRI)
    - Smartphone applications

- RAMS with missing/outdated data becomes useless
  - Especially condition data quickly becomes outdated

Data collection

- Keep data collection to a minimum
  - Avoid high data collection costs
  - Do not collect data unless you expect to use it

- Some data can be collected at no/little extra cost
  - Example: video data together with IRI survey data
  - Data processing still has a cost

- Balance data needs with collection costs

- Start simple – expand data collection gradually

Network vs Project data

- RAMS is a network planning tool (general data for entire network)
  - Identify general needs and related costs
  - Prioritize allocation of available budget to specific roads or links
  - Propose future maintenance, rehabilitation and upgrading projects
  - Requires data for entire (sub-)network
  - Limit data to be collected to avoid high costs
  - Data collection may become more detailed as RAMS evolves and data collection technologies improve and become less costly

- Different from project planning (detailed data for few roads)
  - Project road (link) selected through network planning
  - Project preparation requires data only for the project road (link)
  - Requires more detailed data specific to the project
  - Collecting project data for entire network would be very costly – much of the data would not be used (only for project road links)

Data Accuracy

- More accurate data costs more to collect
  - More accurate data does not necessarily improve the results
  - IRI data can be collected through smartphone or laser profilometer
  - Technology improvements make more accurate data less expensive

- Information Quality Level (IQL)
  - IQL 1 = Research
  - IQL 2 = Detailed programme, project-level engineering (laser profilometer)
  - IQL 3 = Detailed network-level planning (bump integrator)
  - IQL 4 = General network-level planning, pavement performance (smartphone, visual)
  - IQL 5 = Network performance monitoring (visual)

- How accurate do we need the data to be?

• High accuracy level	IRI 3.64 = IRI 3.61-3.67	
• Medium accuracy level	IRI 3.6 = IRI 3.3-3.9	
• Low accuracy level	IRI 3 = IRI 2-4	(Good, Fair, Poor)

Data Reliability

- Data needs to be reliable
  - Keep data errors within the predefined accuracy
  - Poor reliability can reduce the level of accuracy by an unknown factor

- Calibration of survey equipment
  - High accuracy equipment can give wrong data if not properly calibrated
  - Roughness apps have varying accuracies depending on the vehicle used
  - Use equipment in defined operating ranges

- Avoid human errors
  - Avoid manual copying of data – ensure automatic data imports
  - Avoid fatigue - assess surface distress from video instead of directly on the road
  - Ensure replicability of data collection – properly store all raw data
  - Validate resulting data for errors or inconsistencies

Main data types

- General data
- Inventory data
- Condition data
- Traffic (and accident) data
- Project/Contract data (past, ongoing, planned)

General data

- General data
    - Road code
    - Road name (start – end)
    - Administrative road class
    - Construction year
    - Last repaving year
    - Responsible management entity
    - Administrative divisions GIS data (province, municipality, oblast, state, district, etc.)
    - Population data (location, number, density, etc.)
    - Rainfall (by class)
    - City/Town/Village GPS locations
    - Background GIS data (maps, satellite photographs)
    - etc.

- Collected from secondary sources

Inventory data

- Road inventory
  - Length (start + end chainage)
  - GPS location (coordinates)
  - Surface type
  - Carriageway width
  - Number of lanes
  - Terrain class
  - Technical class
  - Shoulder width
  - Drainage type
  - etc.

- Collected through surveys
- Does not change rapidly

- Bridge inventory
  - Bridge type
  - Length
  - Width
  - GPS location
  - Chainage
  - Deck material
  - Number of spans
  - Abutment type
  - etc.

- Other structures
  - Culverts
  - Retaining walls
  - etc.

Condition data

- Surface condition
  - Roughness (IRI)
  - Surface distress
    - Potholes
    - Cracking
    - Rutting
    - Edge break
    - Patching
    - etc.
  - Deflection
  - Gravel thickness

- Structure condition
  - Bridge condition
    - Deck
    - Abutment
    - Bearings
    - Beam
    - etc.
  - River/coastal protection condition
  - Culvert condition

- Collected through surveys
- Can change rapidly
- Either measurement or condition class

Traffic and accident data

- Traffic data
  - Number of vehicles per day
    - Preferably by vehicle class
  - Road (link) code
  - GPS location
  - Survey date
  - Survey type
  - Traffic category
  - etc.
- Collected through manual/ automated traffic counts
- For different roads or road links

- Accident data
  - Accident date
  - GPS location
  - Number of fatalities
  - Number of serious injuries
  - Type of accident
  - etc.
- Collected from police?

Project and Contract data

- (Historic) Project/Contract data
  - Project/Contract code
  - Road (link) code
  - Location (start + end chainage)
  - GPS location (coordinates)
  - Treatment type(s)
  - Start/end date
  - Estimated cost/Contract price
  - Funding source
  - Contract documents
  - Contractor registration number
  - Contractor name
  - etc.

- Collected from planning or procurement unit

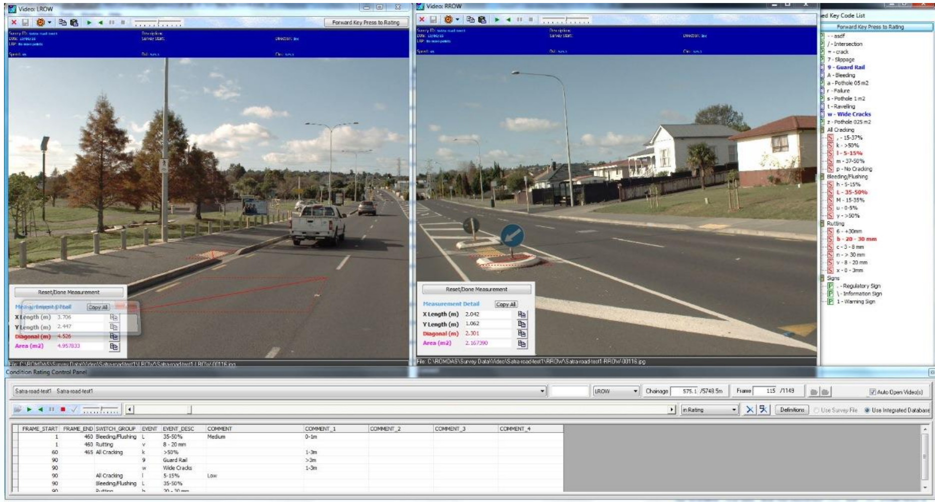
Video and Photo data

- Video and photo data can easily be collected as part of other surveys

- Important that it is georeferenced
  - Possible to indicate location on GIS map or Google Earth

- Allows for post-processing from the office
  - Inventory data (e.g. surface type, bridge, terrain category, etc.)
  - Condition data (e.g. surface distress, damages to structures)
  - Traffic data (e.g. moving traffic counts)
  - High replicability

- Use can be made of specific software for post-processing



Measurement Detail

X Length (m) 3.706
Y Length (m) 2.447
Diagonal (m) 4.526
Area (m2) 4.957833

Measurement Detail

X Length (m) 2.042
Y Length (m) 1.062
Diagonal (m) 2.301
Area (m2) 2.167390

Satra-road-test1 Satra-road-test1

FRAME_START	FRAME_END	SWITCH_GROUP	EVENT	EVENT_DESC	COMMENT	COMMENT_1	COMMENT_2	COMMENT_3	COMMENT_4
1	460	Bleeding/Flushing	L	35-50%	Medium	0-1m			
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90			9	Guard Rail		>3m			
90			w	Wide Cracks		1-3m			
90		All Cracking	l	5-15%	Low				
90		Bleeding/Flushing	L	35-50%					

Data needs overview

ROADS	TYPE	UNIT	SOURCE	REMARKS	FREQUENCY
Administrative class	Link	Category	DRBFC data, legal documents	A, C, D, E	5 years
Management entity	Link	Category	DRBFC data, legal documents	MPW/DRBFC, Municipality, Private	5 years
Municipality	Segment	Category	GIS administrative boundary data	Municipality list	5 years
Administrative Post	Segment	Category	GIS administrative boundary data	Administrative Post list	5 years
Suco	Segment	Category	GIS administrative boundary data	Suco list	5 years
Road code	Link	X##	DRBFC data, legal documents	Existing codes	5 years
Road name	Link	Text	DRBFC data, legal documents		5 years
Link code	Link	X##-##	DRBFC data, legal documents	Road code-two digit link number	5 years
Link name	Link	Text	DRBFC data, legal documents		5 years
Start name	Link	Text	DRBFC data, legal documents		5 years
Start chainage	Link	#+### m	ROMDAS odometer survey		5 years / After project
Start GPS coordinate	Link	X,Y,Z	ROMDAS GPS survey		5 years / After project
End name	Link	Text	DRBFC data, legal documents		5 years
End chainage	Link	#+### m	ROMDAS odometer survey		5 years / After project
End GPS coordinate	Link	X,Y,Z	ROMDAS GPS survey		5 years / After project
GPS track	Link	X,Y,Z	ROMDAS GPS survey		5 years / After project
Link length	Link	km (m)	ROMDAS odometer survey		5 years / After project
Terrain class	Segment	Category	ROMDAS video data post-processing	Flat, Rolling, Mountainous	5 years
Rainfall class	Segment	Category	Rainfall maps	<1000mm, 1000-2000mm, >2000mm	5 years
Technical class	Segment	Category	DRBFC data	R1,R2,R3,R4,R5,RR1,RR2, underclass	1-2 years / After project
Surface type	Segment	Category	ROMDAS video data post-processing, contract data	AC,PM,ST,CC,SM,GR,ER	1-2 years / After project
Pavement Class	Segment	Category	ROMDAS video data post-processing, contract data	Sealed, Unsealed	1-2 years / After project
Carrageway width	Segment	m	ROMDAS video data post-processing, contract data		1-2 years / After project
Number of lanes	Segment	#	ROMDAS video data post-processing, contract data		1-2 years / After project
Video data	Link	Video/GPS	ROMDAS video survey	.xls/.mp4	1-2 years
Roughness	100m	IRI	ROMDAS profilometer / ROMDAS bump integrator	For network analysis	1-2 years
Roughness survey date	100m	Date	ROMDAS profilometer / ROMDAS bump integrator		1-2 years
Surface distress class	Segment	SDI	ROMDAS video data post-processing	For network analysis	1-2 years
Surface survey date	Segment	Date	ROMDAS video data post-processing		1-2 years
Last treatment	Segment	Year	DRBFC data		1-2 years / After project
Last treatment	Segment	Contract	DRBFC data	Link to contract database	1-2 years / After project
Five Year Plan	Segment	Year	Five Year Plan	Year of planned works	5 years
BRIDGES	TYPE	UNIT	SOURCE	REMARKS	FREQUENCY
Bridge code	Point	X##-B##	Appoint	Based on road code+B+two-digit code	5 years / After project
Bridge name	Point	Text	DRBFC data		5 years / After project
River name	Point	Text	DRBFC data		5 years / After project
GPS location	Point	X,Y,Z	Bridge survey / ROMDAS video post-processing	Start of the bridge	5 years / After project
Chainage	Point	#+### m	Bridge survey / ROMDAS video post-processing	Start of the bridge	5 years / After project
Bridge type	Point	Category	Bridge survey / ROMDAS video post-processing	Beam,Arch,Truss,Suspension,Cable,Other	5 years / After project
Deck material	Point	Category	Bridge survey / ROMDAS video post-processing	Concrete, timber, steel	5 years / After project
Bridge length	Point	m	Bridge survey / ROMDAS video post-processing		5 years / After project
Bridge width	Point	m	Bridge survey / ROMDAS video post-processing		5 years / After project
Bridge spans	Point	#	Bridge survey / ROMDAS video post-processing		5 years / After project
Upstream protection	Point	Category	Bridge survey	None, Concrete, Stone masonry, Gabion	5 years / After project
Downstream protection	Point	Category	Bridge survey	None, Concrete, Stone masonry, Gabion	5 years / After project
Construction year	Point	Year	DRBFC data		5 years / After project

Example: Afghanistan

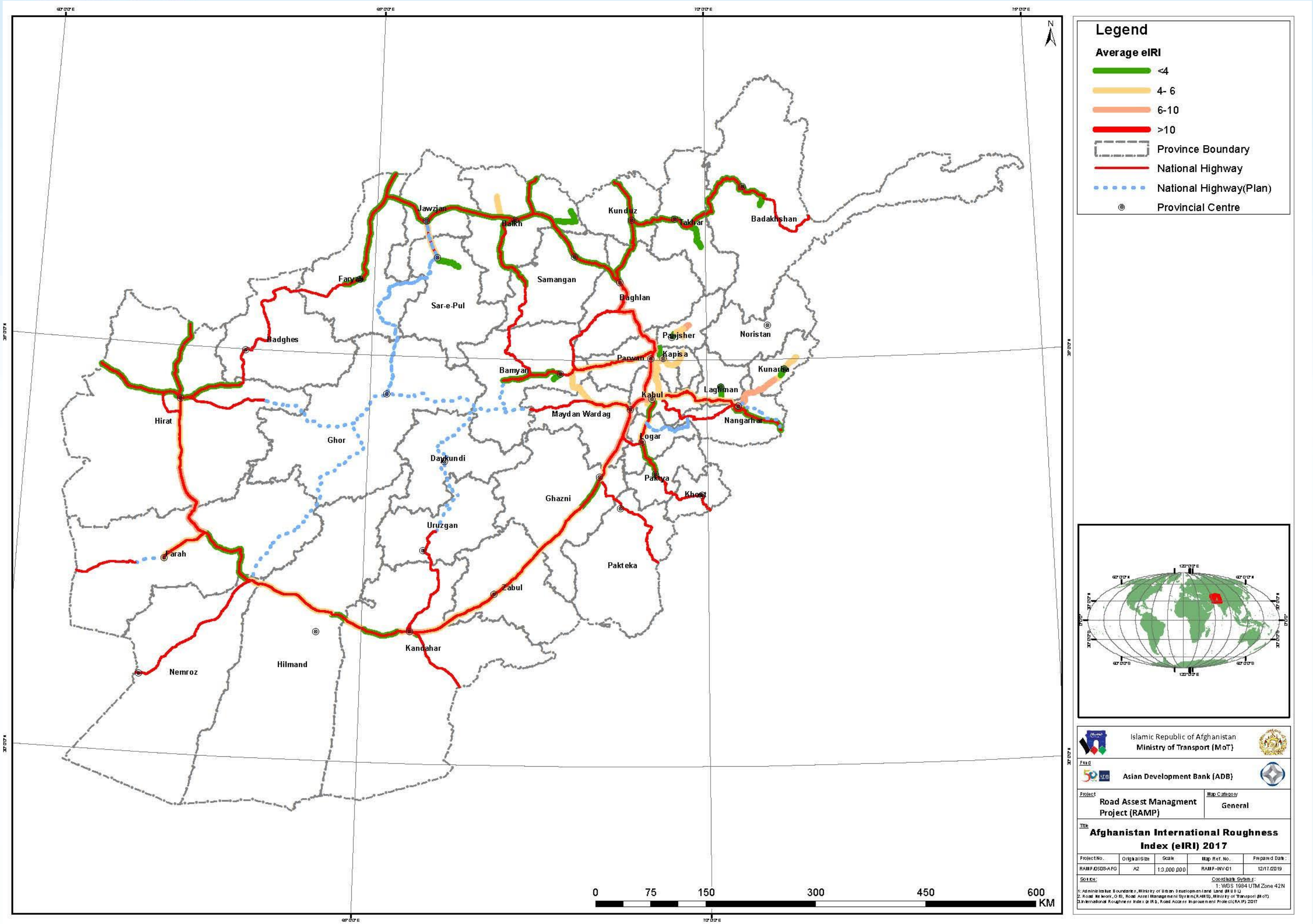
- Collection of IRI data (NRAP 2017, RAIP using RoadRoid)
- Collection of surface distress data through visual surveys
    - Pavement Surface Evaluation and Rating (PASER) – KAC 2016 and RAMP 2019/2020

Rating	Condition	Maintenance
10	Excellent	Routine
9	Excellent	Routine
8	Very good	Routine
7	Good	Routine (crack sealing)
6	Good	Seal
5	Fair	Thin overlay
4	Fair	Structural overlay
3	Poor	Milling/patching + major overlay
2	Very Poor	Reconstruction + base repair
1	Failed	Total reconstruction

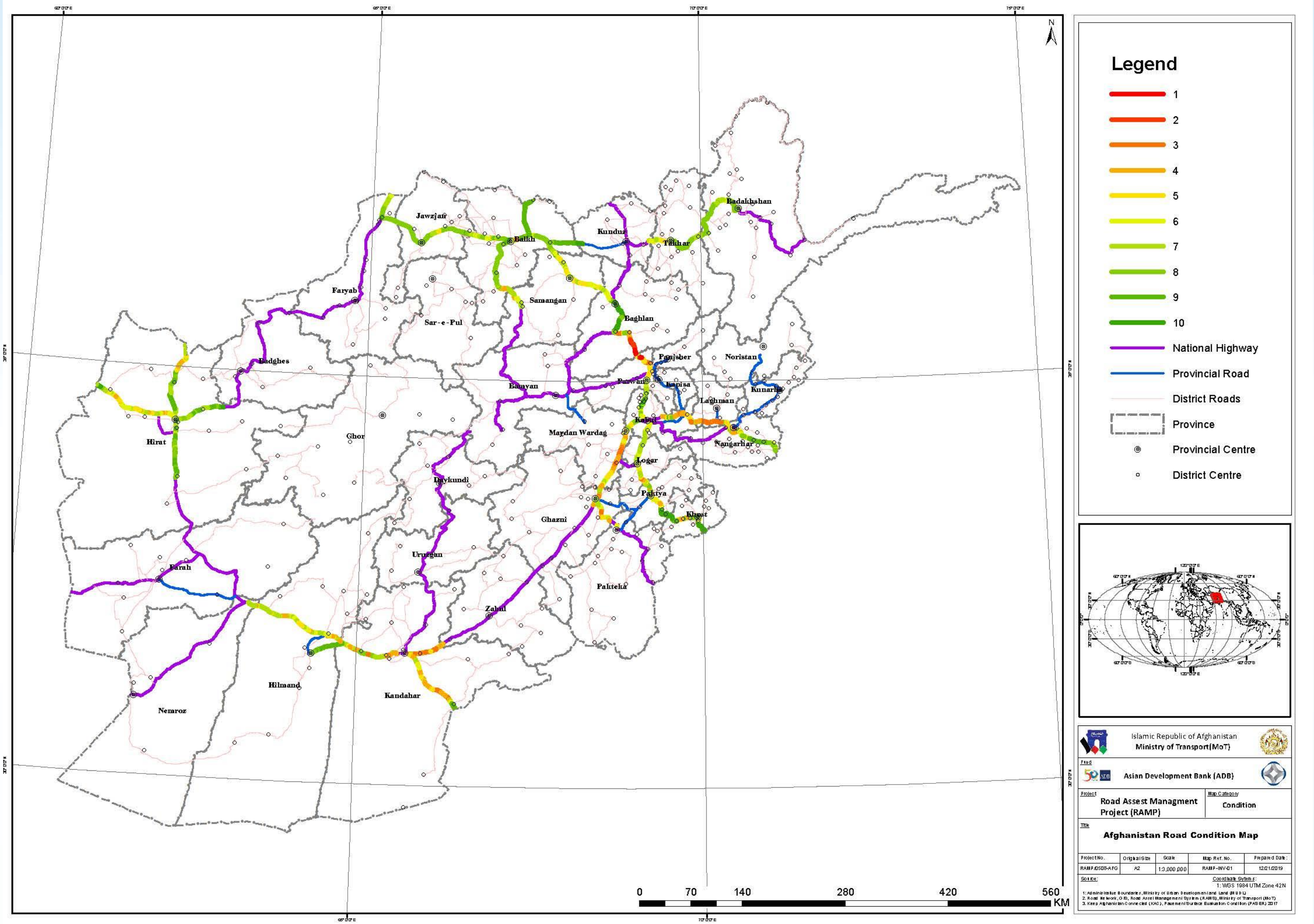
Example: Afghanistan

Rating	Distress	Condition
10	None.	New construction.
9	None.	Recent overlay. Like new
8	No longitudinal cracks except reflection of paving joints. Occasional transverse cracks, widely spaced (40’ or greater). All cracks sealed or tight (open less than 1⁄4”).	Recent sealcoat or new cold mix. Little or no maintenance required.
7	Very slight or no ravelling, surface shows some traffic wear. Longitudinal cracks (open 1⁄4”) due to reflection or paving joints. Transverse cracks (open 1⁄4”) spaced 10’ or more apart, little or slight crack ravelling. No patching or very few patches in excellent condition.	First signs of aging. Maintain 7 with routine crack filling.
6	Slight ravelling (loss of fines) and traffic wear. Longitudinal cracks (open 1⁄4”– 1⁄2”). Transverse cracks (open 1⁄4”– 1⁄2”), some spaced less than 10’. First sign of block cracking. Sight to moderate flushing or polishing. Occasional patching in good condition	Shows signs of aging. Sound structural condition. Could extend life with sealcoat.
5	Moderate to severe ravelling (loss of fine and coarse aggregate). Longitudinal and transverse cracks (open 1⁄ 2” or more) show first signs of slight ravelling and secondary cracks. First signs of longitudinal cracks near pavement edge. Block cracking up to 50% of surface. Extensive to severe flushing or polishing. Some patching or edge wedging in good condition.	Surface aging. Sound structural condition. Needs sealcoat or thin non-structural overlay (less than 2”)
4	Severe surface ravelling. Multiple longitudinal and transverse cracking with slight ravelling. Longitudinal cracking in wheel path. Block cracking (over 50% of surface). Patching in fair condition. Slight rutting or distortions (1⁄2” deep or less).	Significant aging and first signs of need for strengthening. Would benefit from a structural overlay (2” or more).
3	Closely spaced longitudinal and transverse cracks often showing ravelling and crack erosion. Severe block cracking. Some alligator cracking (less than 25% of surface). Patches in fair to poor condition. Moderate rutting or distortion (greater than 1⁄2” but less than 2" deep). Occasional potholes.	Needs patching and repair prior to major overlay. Milling and removal of deterioration extends the life of overlay.
2	Alligator cracking (over 25% of surface). Severe rutting or distortions (2” or more deep). Extensive patching in poor condition. Potholes	Severe deterioration. Needs reconstruction with extensive base repair. Pulverization of old pavement is effective.
1	Severe distress with extensive loss of surface integrity.	Failed. Needs total reconstruction.

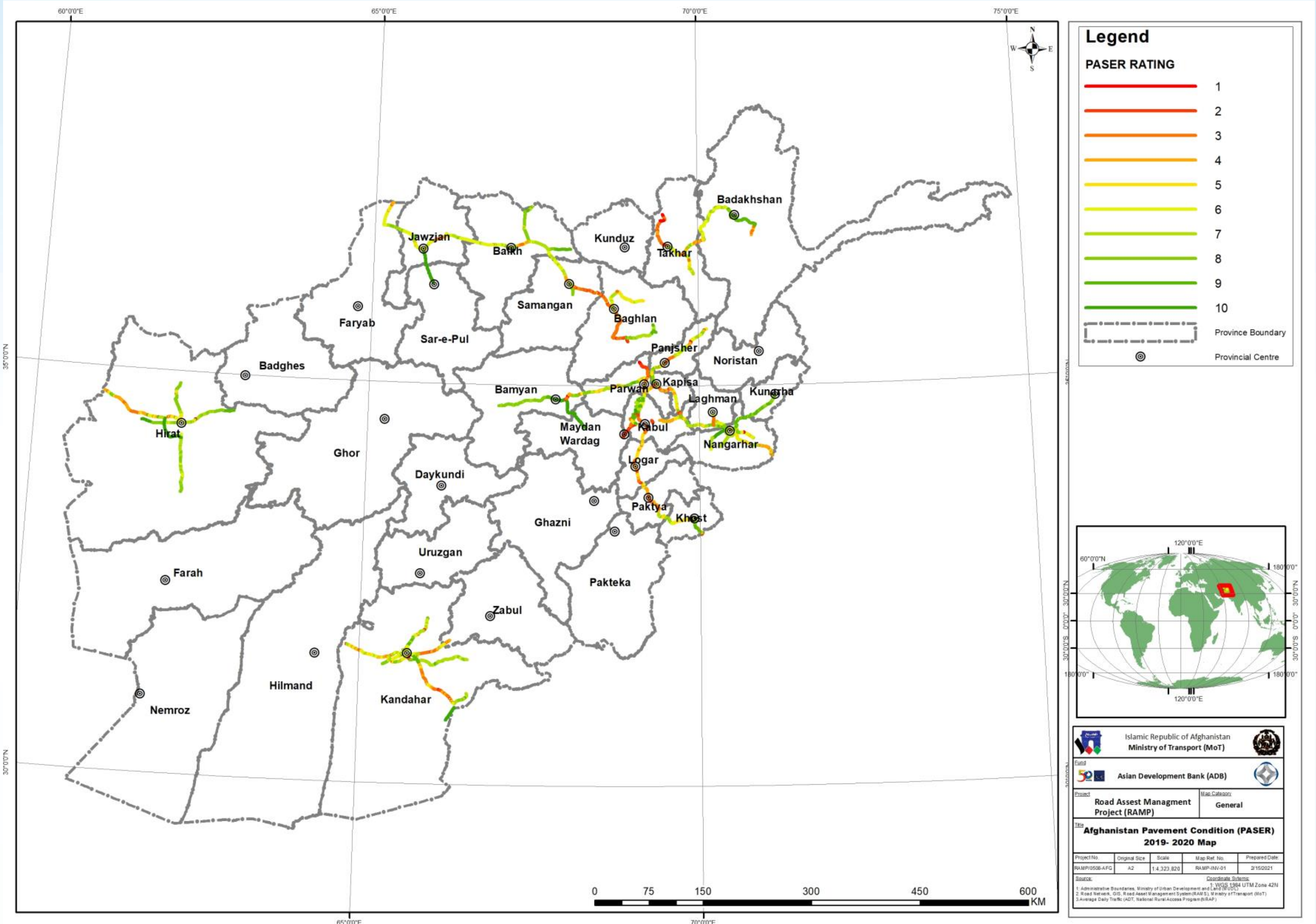
Afghanistan IRI survey 2017



Afghanistan PASER survey 2016



Afghanistan PASER survey 2019/20

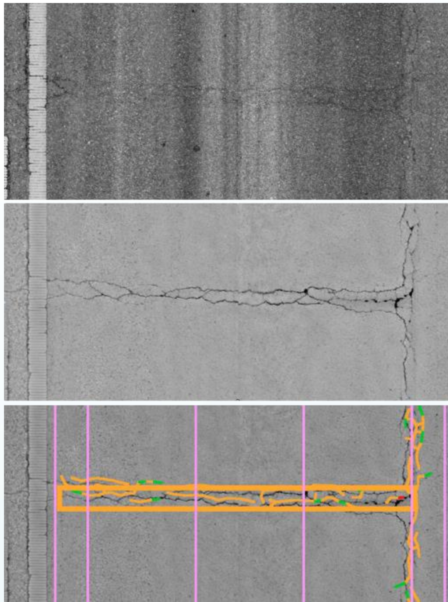


Data collection

- Different ways to collect the same or similar data
  - Depends on the required accuracy
  - Depends on how we will use the data – functions of the RAMS

- Example: potholes and cracking
  - Number and size of potholes or cracking
  - Degree of potholes or cracking (Low, Medium, High, Very High)

  - Manual survey in the field
    - Visual assessments from a vehicle
    - Measurements on the road itself - costly
  - Post-processing of video data
    - Visual assessment of categories based on forward-looking camera
    - Low accuracy measurements based on forward-looking camera
  - Automated data collection
    - High accuracy measurements based on downward-looking camera



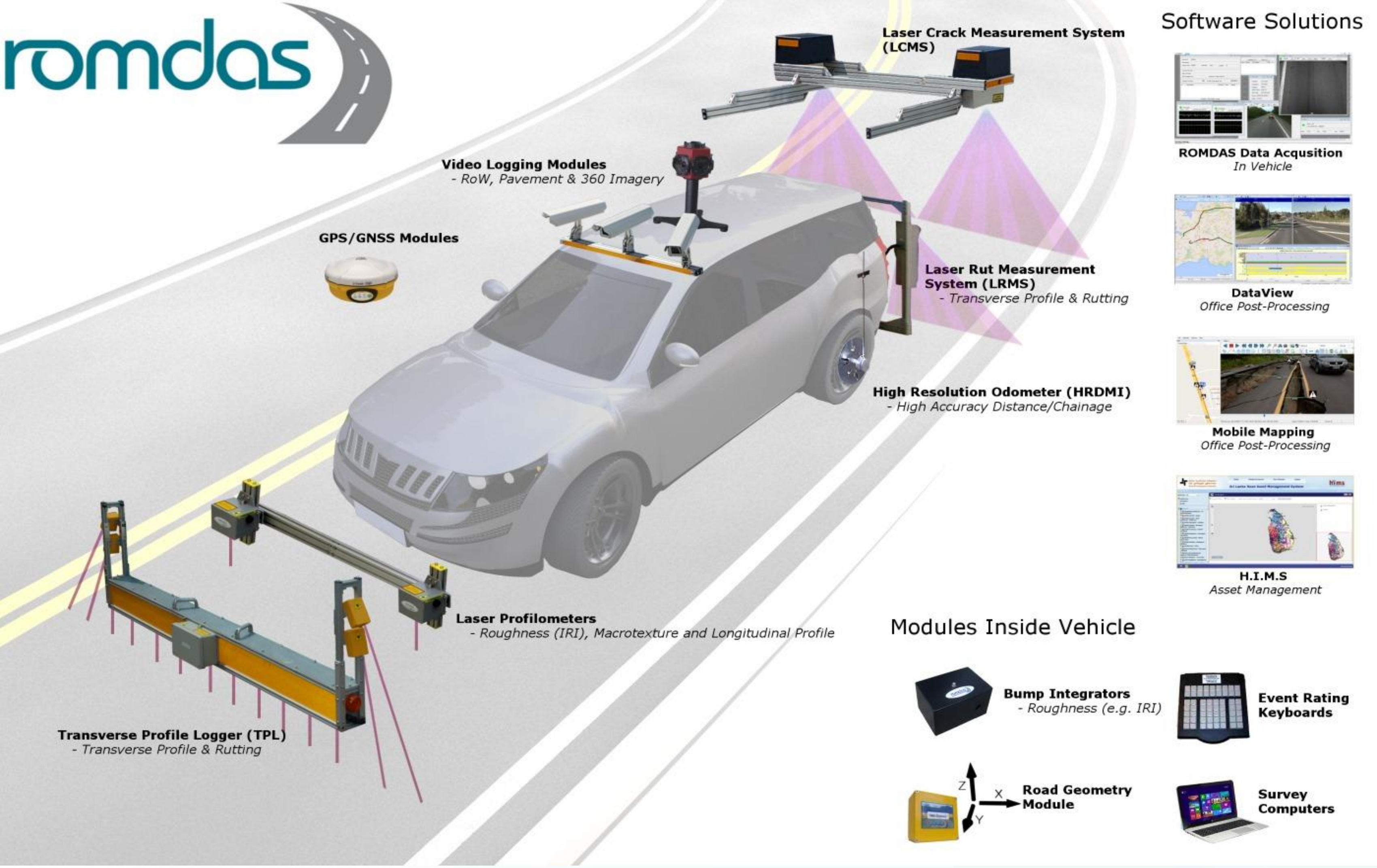
Combining data collection

- Different data types are often collected together
  - Using different equipment
  - During a single survey
  - This reduces data collection costs

- Not possible for all data
  - Some data can be collected in a drive-over survey
    - IRI data
    - Video
    - Road length (chainage, GPS)
  - Some data requires stopping (and measuring)
    - Culvert data
    - Bridge abutment data
    - Falling Weight Deflectometer

Example of survey equipment

- Example from ROMDAS – this is only one of many possible suppliers



Survey equipment costs

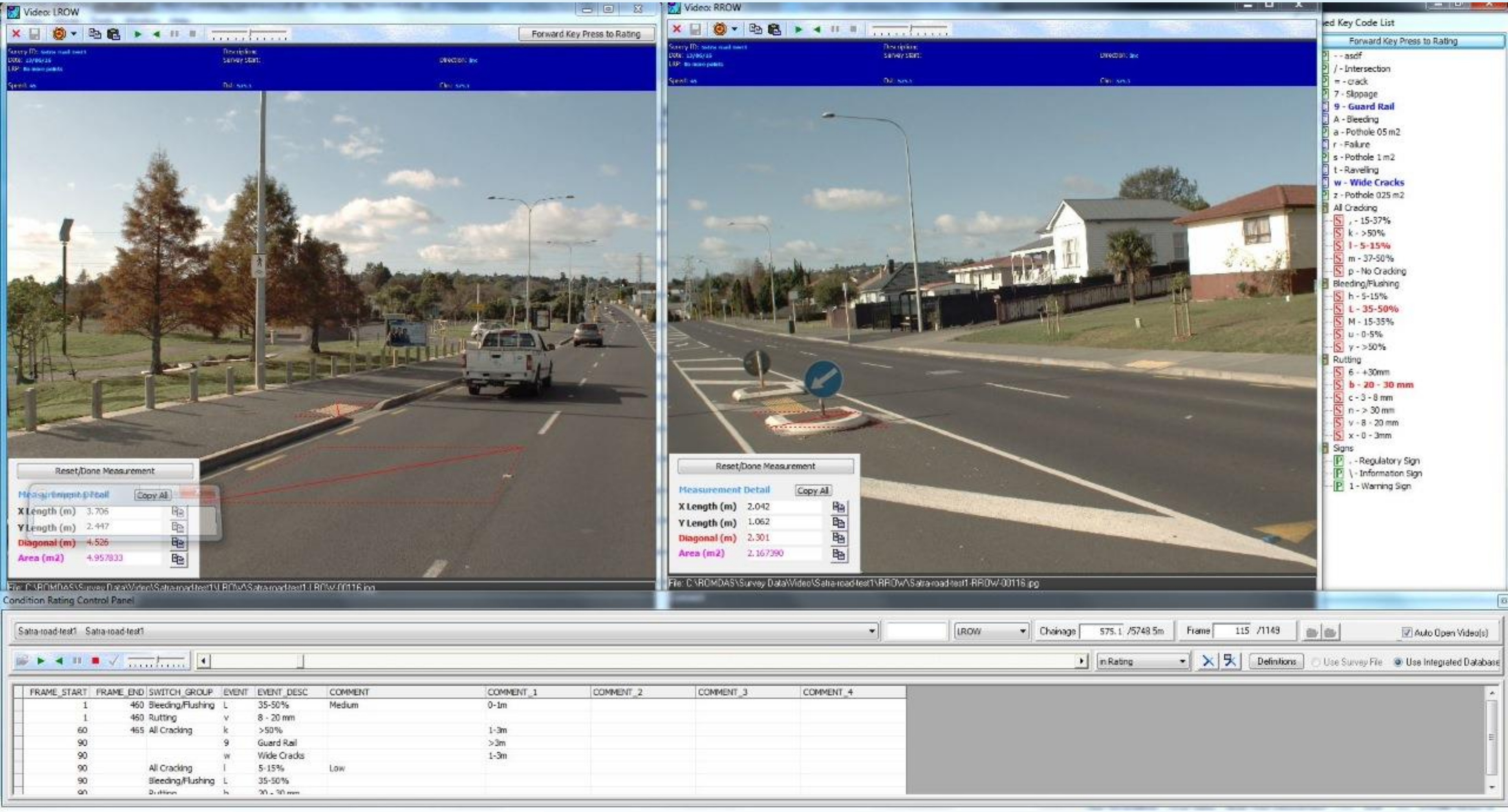
- Smartphone app: $500 (RoadLab) to $5,000 (RoadRoid)
  - eIRI measurements
  - GPS receiver
  - Low quality video

- ROMDAS basic equipment: $50,000 (excluding vehicle)
  - Laser profilometer and/or bump integrator (IRI)
  - Odometer (chainage, length)
  - GPS receiver
  - Forward looking video camera
  - Event rating keyboard and software

- Fully automated survey vehicle: $500,000 (including vehicle)

- Large portion of costs in operation of the vehicle for the survey (driver + operator, per diems, fuel, vehicle maintenance, etc.)

Example of Post-Processing



Measurement Detail

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Measurement Detail

X Length (m) 2.042
Y Length (m) 1.062
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Area (m2) 2.167390

File: C:\ROMDAS\Survey Data\Video\Satra-road-test1\RROW\Satra-road-test1-RROW-00116.jpg

- - - asdf
- / - Intersection
- = - crack
- 7 - Slippage
- **9 - Guard Rail**
- A - Bleeding
- a - Pothole 05 m2
- r - Failure
- s - Pothole 1 m2
- t - Ravelling
- **w - Wide Cracks**
- z - Pothole 025 m2
- All Cracking
  - , - 15-37%
  - k - >50%
  - **l - 5-15%**
  - m - 37-50%
  - p - No Cracking
- Bleeding/Flushing
  - h - 5-15%
  - **L - 35-50%**
  - M - 15-35%
  - u - 0-5%
  - y - >50%
- Rutting
  - 6 - +30mm
  - **b - 20 - 30 mm**
  - c - 3 - 8 mm
  - n - > 30 mm
  - v - 8 - 20 mm
  - x - 0 - 3mm
- Signs
  - . - Regulatory Sign
  - \ - Information Sign
  - 1 - Warning Sign

Satra-road-test1 Satra-road-test1

LROW

Chainage 575.1 /5748.5m

Frame 115 /1149

in Rating

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90			9	Guard Rail		>3m			
90			w	Wide Cracks		1-3m			
90		All Cracking	l	5-15%	Low				
90		Bleeding/Flushing	L	35-50%					
90		Rutting	b	20 - 30 mm					

Video post-processing

- Data collection through post processing of video
  - Video must be georeferenced (linked to GPS and chainage)
- Reviewing video data to identify characteristics
  - Link these to GPS coordinate and chainage
- Reduces need for staff to visit field – avoid security risks
  - Still requires vehicle survey to collect video data

Road	Bridge	Other
• Surface type • Carriageway width • Number of lanes • Surface distress class	• GPS Location • Chainage • Bridge length • Bridge width • Bridge type • Deck material • Bridge spans	• Terrain class • Damage location • Damage type

Example: Afghanistan

- Collection of visual assessment data (PASER)
  - Can this be done using video data?

- Video data can be collected through a simple drive-over survey
  - Linked to GPS data (and possibly chainage data)

- Video can be analysed from the office
  - PASER categories identified and directly linked to GPS/chainage data
  - Basic data collected (surface type, pavement width, bridge location, bridge type, etc.)
  - Basic measurements can be carried out using video post-processing software

- Is the PASER data sufficient for analysis and planning?
  - Does not measure actual distress levels – difficult to input into HDM4
  - Instead use may be made of laser profilometer or bump integrator – higher accuracy
  - Requires similar drive-over survey

Data collection timing

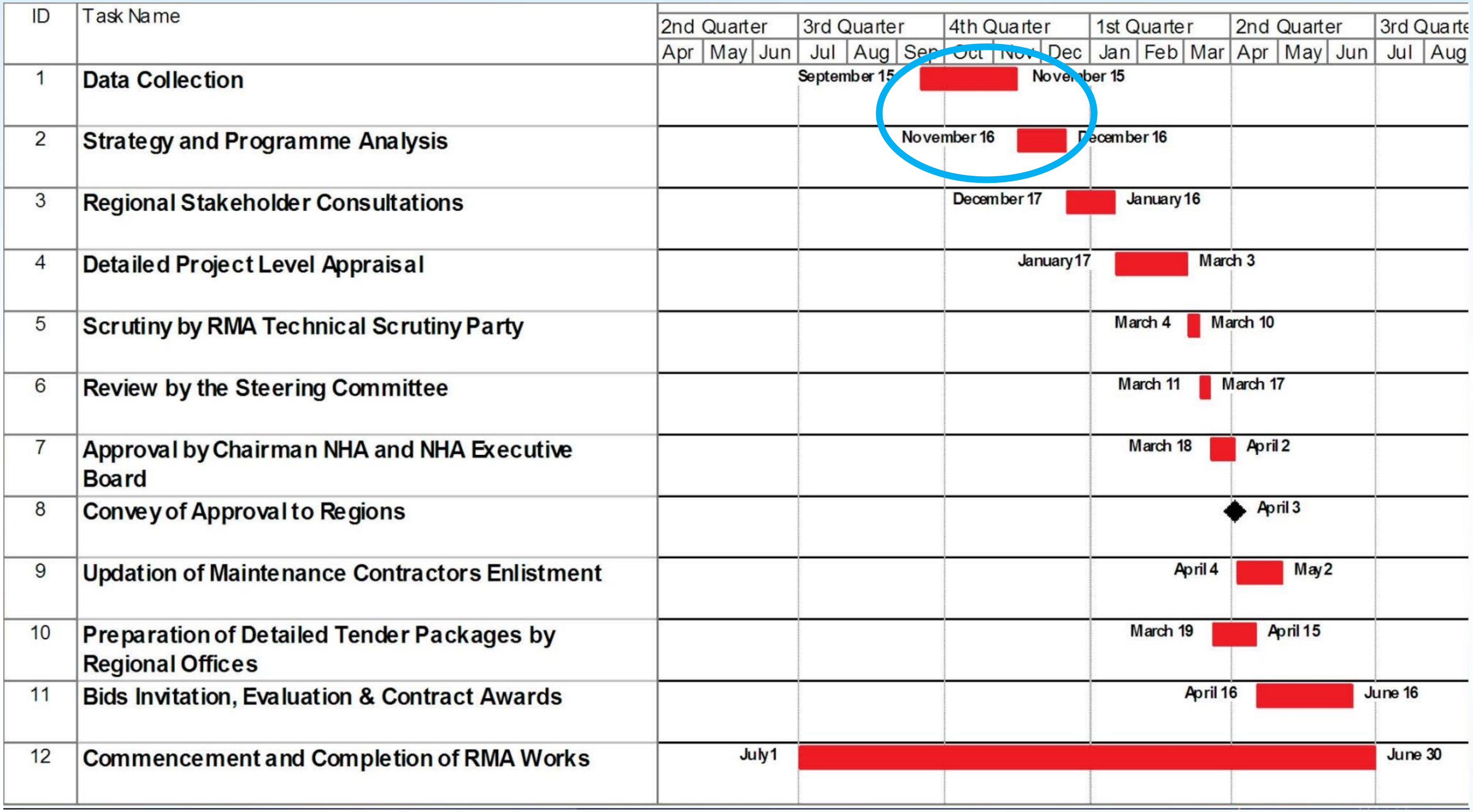
- Data generally collected after winter or rainy season
  - Most damage occurs during that season
  - Data considered up-to-date until next winter/rainy season

- Post-processing can be carried out throughout the year

- Data to be used for planning and budgeting
  - Needs to be aligned with budget submission / fiscal year
  - Take account of time required for data processing and analysis

- Generally a peak period for data collection
  - Few months each year
  - Depends on network size and portion to be surveyed each year
  - Depends on frequency of surveys

Example: Pakistan



ID	Task Name		
1	**Data Collection**	September 15	November 15
2	**Strategy and Programme Analysis**	November 16	December 16
3	**Regional Stakeholder Consultations**	December 17	January 16
4	**Detailed Project Level Appraisal**	January 17	March 3
5	**Scrutiny by RMA Technical Scrutiny Party**	March 4	March 10
6	**Review by the Steering Committee**	March 11	March 17
7	**Approval by Chairman NHA and NHA Executive Board**	March 18	April 2
8	**Convey of Approval to Regions**		April 3
9	**Updation of Maintenance Contractors Enlistment**	April 4	May 2
10	**Preparation of Detailed Tender Packages by Regional Offices**	March 19	April 15
11	**Bids Invitation, Evaluation & Contract Awards**	April 16	June 16
12	**Commencement and Completion of RMA Works**	July 1	June 30

Data collection frequency

- Inventory data
  - Only changes if road is damaged or improvements are made
  - Recording damages/improvements in RAMS will keep it up-to-date
  - Still need to update inventory data every 5-10 years
    - Entire network or only portion
    - Can be simple check of existing data – correct/add only where incorrect/missing
- Condition data
  - Changes rapidly – old data not useful
  - New data needs to be collected through surveys
  - Generally every 1-2 years for planning
    - May be longer period for low level roads (monitoring)
    - Less frequently for structures
- Traffic data
  - Can be adjusted based on general traffic growth
  - Still need to update traffic data every 5 years

Data collection frequency

- Lower frequency = Lower reliability (data is outdated)
- Higher frequency = Higher cost

- Again the question is what is required

- Programme analysis
  - Higher accuracy required to determine treatment for each road link
- Strategy analysis
  - Lower accuracy required to determine mix of treatments for entire network

In-house or contracted out

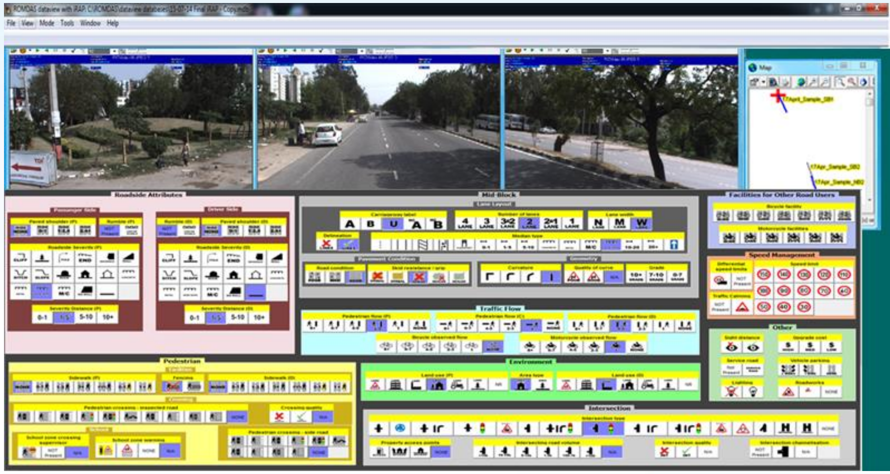
- Condition data collection has peak each year
- Inventory/traffic data collection has peak every few years

- Data collection by in-house staff has benefits
  - Develop specific skills particular to your system
  - Avoid procurement delays and other issues
- It also has drawbacks
  - What will in-house staff do between peaks? Can they be involved in other aspects of the RAMS and planning?
  - How to ensure budget for operation (fuel, per diems) and equipment repairs?

- Can certain data collection tasks be outsourced?
  - Does the capacity/equipment exist in-country?
  - How can quality be ensured?

Example: Georgia

- Data collection is done in-house
  - ROMDAS survey vehicle
    - GPS, odometer, 3 video cameras, laser profilometer
  - 2 mobile traffic counting stations
  - Operated by RAMS unit – 3 staff



- Data needs expected to increase
  - Detailed inventory (passportization)
  - Bridge Management System
  - iRAP assessments using video data

- Some data collection likely to be outsourced
  - Maintenance contractors already required to collect traffic data
  - Just data collection or also post-processing

Example: Timor-Leste

- No data collection carried out yet
    - ROMDAS survey vehicle used for contract performance monitoring
        - GPS, odometer, laser profilometer, bump integrator, (1 video camera, DataView software)

- Currently a RAMS is being developed
    - Requires data to operate

- WB to support data collection for national and municipal roads
    - Using the existing ROMDAS vehicle
        - Basic inventory and condition data
        - Post-processing of video data using DataView software (e.g. bridges, surface distress)
    - Providing fixed/mobile traffic counters to roads department for traffic counts
    - On-the-job training to government staff
    - Government staff to replicate in future years (RAMS unit, Maintenance Department)

Group Work

- What data do we want/need to collect?
  - List at least 10 data items
- What will we use that data for?
- How will we collect the data?
- How often do we need to collect that data?
- What resources are needed?
- Can we reduce the required data collection?