MEASURING PAVEMENT CONDITION IN DEVELOPING COUNTRIES: THE WORLD BANK'S EXPERIENCE

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Road Management Systems Require Data
What to Collect?

- Collect only what you need
- Collect to the lowest level of detail sufficient to make appropriate decisions
- Collect data only when they are required
To What Level of Detail?
IQL Concept

Large scale

Medium scale

Small scale

Portorož, Slovenia
Example – Cambodia IQL 3

Network

- Roughness (IRI)
  - Average IRI (100m interval)
  - 0, 1, 2, 3, 4, 5 (200m interval)

- Surface Integrity (SII)
  - FL, PA, RV, PH, CR, RT, EB, ER

- Major Surf Defect
  - Higher, Level, Lower

- Shoulder Height
  - Good, Fair, Failed

- Drainage Condition
  - None, Low, High, Extreme

- Wheelpath Rutting

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Example Timor Leste – IQL 4

TL National Road Condition

<table>
<thead>
<tr>
<th>Road</th>
<th>Length &amp; Condition (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td></td>
</tr>
<tr>
<td>Subtotals</td>
<td></td>
</tr>
<tr>
<td>A14 B-N</td>
<td></td>
</tr>
<tr>
<td>A13 S-Z</td>
<td></td>
</tr>
<tr>
<td>A12 Z-M</td>
<td></td>
</tr>
<tr>
<td>A05 A-B</td>
<td></td>
</tr>
<tr>
<td>A03 M-D</td>
<td></td>
</tr>
<tr>
<td>A02 A-Z</td>
<td></td>
</tr>
<tr>
<td>A02 D-A</td>
<td></td>
</tr>
</tbody>
</table>

Chainage (km)

Good
Fair
Poor

Portorož, Slovenia
With the Right Technology …

Designed for this

Not this …

Portorož, Slovenia
Technology Implications: Cambodia Roughness

Paved

Unpaved
The World Bank’s Experiences

- **Bank finances**
  - Procurement of equipment
  - Data collection services

- **Mixed results**
  - Some clients use equipment effectively
    - Many do not
  - Many data collection services are successful
    - Some are not
Equipment Procurement Problems

- Vendors convince agencies to procure unsuitable technology
- Data do not meet the agency’s needs
- Equipment not appropriate for local conditions
- Ongoing maintenance and calibration not sustainable
- Inadequate local support
- Inadequate training
## Consider Cost Against Performance

<table>
<thead>
<tr>
<th>Scale</th>
<th>Operational Performance</th>
<th>1 (Low performance)</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 (High performance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (High cost)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>3</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 (Low cost)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Equipment, Global Cost**
- **Operational Performance**

- **1 (Low performance)**
  - Skid Resistance
  - Dynamic - Vehicle
- **2**
  - Ground Penetrating Radar - Dynamic
  - FWD - Trailer
- **3**
  - Deflection Beams
  - FWD - Portable
  - Ground Penetrating Radar - Static
  - Skid Resistance - Dynamic Trailer
- **4**
  - Roughness - Class IV
  - Skid Resistance - Static
- **5 (High performance)**
  - Imaging for Surface Distress
  - Macrotexture - Dynamic High Speed
  - Precision INU for Geometry
  - Roughness - Class I (Laser)
  - GPS with INU
  - Macrotexture - Dynamic Low Speed
  - Rut Depth Profilers
  - Roughness - Class II
  - Video Logging
  - Roughness - Class III
  - GPS
  - Digital DMI
Specifications

- Prepared by agencies
- Often limited understanding of technologies
- Vendors may influence process
- Risk of omissions with agency
World Bank Generic Specifications
from www.road-management.info

Multifunction Vehicles

WIM and Volume

FWD

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Principles

- Validation
  - Calibrate to confirm measurements
  - Validate to show works locally
- 100 km sample survey
- Load data into agency’s road management system
- Issue acceptance certificate
Data Collection Services

- Most agencies had data collection problems
  - In-house and contracted data collection problematic
- Contracting data difficult
  - Requires good contract management
  - Data quality control checks
  - Liquidated damages for poor performance
Services: Comparative Costs

- **New Zealand**: 20,000 km - Surveys Only
- **Laos**: 8,000 km - Surveys and Mapping
- **Cambodia**: 11,000 km - Surveys, Mapping and Equipment
- **Philippines**: 25,000 km - Surveys and Mapping

Survey Cost ($/km)

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Costs Affected By

- Challenging network to drive
- No pre-defined network
- No previous data on inventory or condition
- Missing links / broken bridges
- Mines and unexploded ordinance (UXOs) within the right way
- Equipment breakdowns and difficulties getting spares
- Wildlife
- Banditry
- Weather
Challenges to Contracting Data Collection

- **Surveys result in a large amount of data**
- **Unless processing is done during survey significant delays**
  - Contracts should require data submission within 30 days of survey
- **Quality assurance is challenging but essential**
  - Philippines: some data returned 4 times to contractor for correction
- **ALL projects have underestimated difficulties in data processing**
The need for Quality Control

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Generic TOR for Data Collection Services
www.road-management.info

- Designed to guide agencies through procurement
- Address key issues to ensure success
- Minimum specifications for data appropriateness
- Quality assurance requirements

Generic Terms of Reference
Pavement Data Collection Services

Version 1.0 – April 23, 2007

East Asia Pacific Transport Unit
The World Bank
Washington, D.C.
Key Principles

- **Output based contract**
  - Paid only for data delivered and accepted
  - All equipment procured by contractor
  - Payments based on pro-rata basis
  - Not a consulting time-writing contract
  - Contract: two years with option for extending

- **Example of payment schedule**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Payment Type</th>
<th>Basis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceptance for survey certificate</td>
<td>lump-sum</td>
<td>10%</td>
</tr>
<tr>
<td>Data collection</td>
<td>pro rata</td>
<td>per km or number</td>
</tr>
<tr>
<td>Data processing</td>
<td>pro rata</td>
<td>per km or number</td>
</tr>
<tr>
<td>Acceptance of final report</td>
<td>lump-sum</td>
<td>15%</td>
</tr>
</tbody>
</table>
## Data Expectations

<table>
<thead>
<tr>
<th>Data Item</th>
<th>Units</th>
<th>Reporting Interval</th>
<th>Min Accuracy Level</th>
<th>Paved</th>
<th>Unpaved</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Location Referencing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location referencing (linear)</td>
<td>-</td>
<td>0.1%</td>
<td>M/O/NR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GPS Centreline coordinates</td>
<td>-</td>
<td>5/10/20m</td>
<td>5/10m - horizontal</td>
<td>M/O/NR</td>
<td>M/O/NR</td>
</tr>
<tr>
<td><strong>Inventory</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Inventory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>● Road Type</td>
<td>-</td>
<td>at change</td>
<td>IQL 2/3/4</td>
<td>M/O/NR</td>
<td>M/O/NR</td>
</tr>
<tr>
<td>● Pavement Surface Type</td>
<td>-</td>
<td>at change</td>
<td>IQL 2/3/4</td>
<td>M/O/NR</td>
<td>M/O/NR</td>
</tr>
<tr>
<td>● Pavement Width</td>
<td>m</td>
<td>at change</td>
<td>IQL 2/3/4</td>
<td>M/O/NR</td>
<td>M/O/NR</td>
</tr>
<tr>
<td>● Shoulder Width</td>
<td>m</td>
<td>at change</td>
<td>IQL 2/3/4</td>
<td>M/O/NR</td>
<td>M/O/NR</td>
</tr>
<tr>
<td>● Shoulder Type</td>
<td>-</td>
<td>at change</td>
<td>IQL 2/3/4</td>
<td>M/O/NR</td>
<td>M/O/NR</td>
</tr>
<tr>
<td>● Shoulder Elevation</td>
<td>cm</td>
<td>at change</td>
<td>IQL 2/3/4</td>
<td>M/O/NR</td>
<td>M/O/NR</td>
</tr>
<tr>
<td>● Median Width</td>
<td>m</td>
<td>at change</td>
<td>IQL 2/3/4</td>
<td>M/O/NR</td>
<td>M/O/NR</td>
</tr>
</tbody>
</table>
Quality Assurance

- Vital for contractor and agency to have QA plan
- Proper adherence will improve results
  - Continuous checks
  - Repeat surveys
  - Revalidation
- Need sufficient staff and resources to implement
The Final Word: Success Depends on Convergence of People, Processes and Technology

Successful projects properly address all three factors.