Establishment of Management System for Maintenance Activities in Urban Road Network

Case study in Benghazi - Libya

Dr: Jamal A Beitelmal; BSc, MSc, PhD
Garyounis University Faculty of Engineering, Benghazi – Libya

Eng: Hamida A Orafy; BSc, MSc
Civil Engineer; Municipality of Benghazi – Libya
Pavement Maintenance Management system

- Planning tool
- Collects and monitors information on current pavement conditions
- Evaluates alternative repair strategies
- Prioritizes selected repairs
Traditionally, the core of engineering activity in the roads sector has consisted of the design and construction of new roads.

With a large network of highways in place, the need for preservation and efficient maintenance of existing highways is growing.

To keep roads in good or acceptable condition through their design life for the least expenditure, highway agencies are resorting to Pavement maintenance Management System (PMMS).
How PMMS Works

• Select the type of repair that is most cost-effective for the condition of pavement.

• Selection is based upon the current condition of the pavement.
Deterioration Curve

Pavement Condition

Very Good

Very Poor

New

Pavement Age

Old

Routine Maintenance

Preventive Maintenance

Rehabilitation

Reconstruction

Deterioration Curve

Without M

With M

www.irf2010.com
Study Objectives

- Presenting the existing situation and condition of pavement network at the city of Benghazi.

- Presenting the importance of pavement maintenance management system and its role in optimizing maintenance activities expenditure.

- Providing authorities related to road networks with developed system for pavement maintenance management appropriate to conditions prevails in the city of Benghazi.
The City of Benghazi Highway Network
The city of Benghazi pavements have the following current threats:

- Increase rate of deterioration (pavements deteriorate fast)
- Overloading of vehicles (no commitment to the legal loading)
- Rapid traffic growth (high increase of vehicle ownership)
- Poor maintenance (wrong implementation, etc)
- Limited resources (funds, equipment, materials, etc)
- Insufficient information for decision-making
Existing Road Condition in Benghazi

The roads can be classified into four existing conditions:

1. Roads in good condition
2. Roads in acceptable condition
3. Roads in bad condition
4. Roads in failed condition
Roads in good conditions
Roads in acceptable conditions
Roads in bad conditions
Roads in failed conditions
Therefore, establishing a PMMS computer programme that suits Conditions in Benghazi city is essential.
What a PMMS Computer Programme Can Do

The PMMS computer program can provide answers to questions related to each one of the following:

1. Pavement Condition
Which sections are with failed, poor, good conditions, etc?

2. Pavement Maintenance
Which sections require localized maintenance, global maintenance, overlaying or reconstruction?

3. Treatment Cost
What are the treatment cost of each section, each road or overall?

4. Priorities
Which roads should be repaired first?

www.irf2010.com
PMMS Software Components

3 Different Types of Data Go into the Program

1. Road Inventory
2. Pavement Condition Survey
3. Repair Strategies, Costs, etc.

Feed into 3 Basic Components of the Software

1. Database
2. Data Analysis
3. Reports

www.irf2010.com
Proposed Benghazi PMMS Computer Program Components

PMMS consists mainly of two major components:

1. An information system: to collect, store and manage data and information.

2. Decision support system: to process and analyze these data for decision making.
The proposed PMMS components based on the following two management software:

- **Microsoft Access**: used as a management tool to store the inventory information, distress data, treatment and cost data, and Pavement Condition Index (PCI) values.

- **Visual Basic.Net**: used as a modeling tool to help in evaluating the city pavements condition and to provide information and decisions about the city maintenance needs, costs, and priorities.
The data for each road section includes such information as:

- Section Identification
- Construction year (last surface).
- Street name, and number.
- Beginning and ending of the section.
- Functional classification.
- Number of lanes.
- Pavement type.
- Length, width and area of the section.
- Average Daily Traffic (ADT).
Pavement Condition Survey

- Determines the condition of each road section based on pavement distresses (using appropriate technology)

- An accurate condition survey is critical in helping determine appropriate maintenance/repair strategies to restore a deteriorated pavement to an acceptable level.

- Visually looking for indications of distresses, including:
  - Cracking
  - Distortion
  - Disintegration
  - Drainage Problems
Figure 8 The middle part of the monitoring screen
Figure 11 The full scale machine ready for a trial run
Figure 12 The distance travelled device
Figure 13a Road category A (section in good condition)
Figure 13b Road category B (section need attention soon)
Figure 13c Road category C (section need attention now)
Current Pavement Condition

Potential Treatment

Estimate Repair Cost

Rank by Criteria

DATA ANALYSIS

Match Ranked List with Budget
PMMS Computer Program

Organization

1. Inventory Data entry (Basic Operations)

2. Work Information entry (Additional Field Data)

3. PCI Inspections entry (Basic Operations)

4. Maintenance & Repair needs and costs reports

5. Priorities report
Application of The Proposed Package in Some Real Life Cases

Arterial roads of the city network have been selected to be used as a case study for the following reasons:-

1. These roads have an economic and strategic importance because of the places they link.

2. Arterial roads are most liable to deteriorate rapidly because they carry out the heaviest traffic loads.

3. Sections of Arterial roads covered different condition categories from good to failed.
Inventory Screen (Basic Operations)
Field Inspection data screen
(Basic Operations)

Assessment result screen
Maintenance and Repair Needs and Costs Screen
5. Priority Screen

- Priorities Screen
- Priority Table
- Funds by Year
PMMS Computer Program Outputs

1. Current Condition Summary Report

![Condition Summary Graph]

<table>
<thead>
<tr>
<th>Condition</th>
<th>Number of sections</th>
<th>Length [m]</th>
<th>% Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>4</td>
<td>3197.6</td>
<td>11.61</td>
</tr>
<tr>
<td>Satisfactory</td>
<td>4</td>
<td>4700</td>
<td>17.07</td>
</tr>
<tr>
<td>Fair</td>
<td>10</td>
<td>8650</td>
<td>31.41</td>
</tr>
<tr>
<td>Poor</td>
<td>6</td>
<td>3970</td>
<td>14.42</td>
</tr>
<tr>
<td>Very poor</td>
<td>2</td>
<td>1600</td>
<td>5.81</td>
</tr>
<tr>
<td>Serious</td>
<td>2</td>
<td>2460</td>
<td>8.93</td>
</tr>
<tr>
<td>Failed</td>
<td>3</td>
<td>2960</td>
<td>10.75</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>27537.6</td>
<td>100%</td>
</tr>
</tbody>
</table>

Condition at last inspection: [Graph with bar chart indicating % length for each condition]
5. Total Funded Report

**Total Funds Table**

<table>
<thead>
<tr>
<th>Sum of Localized Maintenance Cost</th>
<th>Sum of Global Maintenance Cost</th>
<th>Sum of Structural Improvement Cost</th>
<th>Sum of Reconstruction Cost</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>14330.52</td>
<td>351908.5</td>
<td>1083696.50</td>
<td>419960</td>
<td>6409615.6</td>
</tr>
</tbody>
</table>

**Percentage Breakdown**

- **Localized Maintenance**
- **Global Maintenance**
- **Structural Improvement**
- **Reconstruction**
6. Maintenance Priority Report

<table>
<thead>
<tr>
<th>Road</th>
<th>Section</th>
<th>Section Area</th>
<th>Cost</th>
<th>Maintenance Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sudan Street</td>
<td>1012AR/001</td>
<td>9600</td>
<td>413,266</td>
<td>Localized Maintenance</td>
</tr>
<tr>
<td>Khaliji Al Arabi Street</td>
<td>1011AR/007</td>
<td>10350</td>
<td>1312</td>
<td>Localized Maintenance</td>
</tr>
<tr>
<td>Syria Street</td>
<td>1006AR/005</td>
<td>7440</td>
<td>2413,746</td>
<td>Localized Maintenance</td>
</tr>
<tr>
<td>Hejaz Street</td>
<td>1010AR/003</td>
<td>15870</td>
<td>4149,045</td>
<td>Localized Maintenance</td>
</tr>
<tr>
<td>Al Wahda Alarabia Street</td>
<td>1009AR/003</td>
<td>26600</td>
<td>6042,451</td>
<td>Localized Maintenance</td>
</tr>
<tr>
<td>Hejaz Street</td>
<td>1010AR/004</td>
<td>4715</td>
<td>15229,45</td>
<td>Global Maintenance</td>
</tr>
<tr>
<td>September Street</td>
<td>1012AR/004</td>
<td>6300</td>
<td>20349</td>
<td>Global Maintenance</td>
</tr>
<tr>
<td>Syria Street</td>
<td>1006AR/001</td>
<td>6600</td>
<td>21318</td>
<td>Global Maintenance</td>
</tr>
<tr>
<td>Khaliji Al Arabi</td>
<td>1011AR/003</td>
<td>8970</td>
<td>28973,1</td>
<td>Global Maintenance</td>
</tr>
<tr>
<td>Sudan Street</td>
<td>1012AR/002</td>
<td>16200</td>
<td>32946</td>
<td>Global Maintenance</td>
</tr>
<tr>
<td>September Street</td>
<td>1010AR/005</td>
<td>13800</td>
<td>44574</td>
<td>Global Maintenance</td>
</tr>
<tr>
<td>Hejaz Street</td>
<td>1013AR/003</td>
<td>14000</td>
<td>45220</td>
<td>Global Maintenance</td>
</tr>
<tr>
<td>September Street</td>
<td>1013AR/004</td>
<td>15525</td>
<td>50145,75</td>
<td>Global Maintenance</td>
</tr>
<tr>
<td>September Street</td>
<td>1013AR/005</td>
<td>16100</td>
<td>52003</td>
<td>Global Maintenance</td>
</tr>
<tr>
<td>Khaliji Al Arabi</td>
<td>1011AR/002</td>
<td>5635</td>
<td>202296,51</td>
<td>Structural Improvement</td>
</tr>
<tr>
<td>7 October Street</td>
<td>81AR/002</td>
<td>6400</td>
<td>229760,01</td>
<td>Structural Improvement</td>
</tr>
<tr>
<td>Syria Street</td>
<td>1006AR/004</td>
<td>7440</td>
<td>267096,01</td>
<td>Structural Improvement</td>
</tr>
<tr>
<td>Hejaz Street</td>
<td>1010AR/001</td>
<td>7590</td>
<td>272481,01</td>
<td>Structural Improvement</td>
</tr>
<tr>
<td>Khaliji Al Arabi</td>
<td>1011AR/001</td>
<td>10810</td>
<td>388079,02</td>
<td>Structural Improvement</td>
</tr>
<tr>
<td>7 October Street</td>
<td>81AR/001</td>
<td>13760</td>
<td>493984,02</td>
<td>Structural Improvement</td>
</tr>
<tr>
<td>Hejaz Street</td>
<td>1010AR/006</td>
<td>4140</td>
<td>190440</td>
<td>Reconstruction</td>
</tr>
<tr>
<td>Syria Street</td>
<td>1006AR/003</td>
<td>6400</td>
<td>386400</td>
<td>Reconstruction</td>
</tr>
<tr>
<td>Sudan Street</td>
<td>1012AR/003</td>
<td>10800</td>
<td>496800</td>
<td>Reconstruction</td>
</tr>
<tr>
<td>Syria Street</td>
<td>1006AR/006</td>
<td>14400</td>
<td>662400</td>
<td>Reconstruction</td>
</tr>
<tr>
<td>Syria Street</td>
<td>1006AR/002</td>
<td>16800</td>
<td>772800</td>
<td>Reconstruction</td>
</tr>
<tr>
<td>7 October Street</td>
<td>81AR/003</td>
<td>16500</td>
<td>772800</td>
<td>Reconstruction</td>
</tr>
<tr>
<td>Al Wahda Alarabia Street</td>
<td>1009AR/001</td>
<td>19740</td>
<td>908040</td>
<td>Reconstruction</td>
</tr>
</tbody>
</table>

**Total**: 6409615.588
The comprehensive highway maintenance management system must be established to protect the network from rapid deterioration.

The budget required for maintenance activities should be sufficient to cover all works.
Recommendations (continued)

- Keep historical maintenance records up to date.

- The continuous monitoring for road network condition by sophisticated equipment are needed to make effective maintenance decision.
Recommendations (continued)

- There is a great need of long-term commitment of officials, pavement managers, public and road users towards the conservation and protection of pavement assets.

- Future developments including a simple performance model to predict pavement condition for road network should be considered.