A REVIEW OF THE PAVEMENT MANAGEMENT SYSTEM OF THE STATE OF LOUISIANA-PHASE I

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ABSTRACT
“Louisiana-Vision 2020” serves as a benchmark for improving highway pavements over a 20-year period. Cost-effective pavement preservation is emphasized in the current Louisiana state law and the federal law. The Louisiana Department of Transportation and Development (LADOTD) and the FHWA strategic plans also emphasize cost-effective pavement preservation. In an effort to improve the pavement management system (PMS), the Louisiana Transportation Research Center (LTRC) initiated a two Phase research study to evaluate the overall performance and effectiveness of the system. This paper focuses on the Phase I study and addresses the state-of-the-art practice of LADOTD’s PMS and the results of departmental survey to assess the needs of the various districts. Three location reference systems are being used by various units in the department which make it difficult to link different sets of database. Although many of the districts engineers do not have any concerns about all the referencing systems, most would prefer to have a unified reference location system. All the districts have access to the PMS data and the majority of them utilize it, however, the degree of use varies from one district to another. This paper also discusses the types of PMS output and reports, the degrees to which the outputs are analyzed, the accuracy of the information currently available, and the degrees to which the current PMS data tracks and differentiates between different preservation actions.

KEY WORDS: PMS, distress survey, distress index, deduct point, network reports, ARAN.

INTRODUCTION AND BACKGROUND
The Louisiana Department of Transportation and Development (LADOTD) pavement distress data collection system has evolved from windshield surveys in the early 1970s to videotaping using Pavedex Inc. in 1992 and to the ARAN (Automatic Road Analyzer) system in 1995. Currently, the pavement network is surveyed once every two years. The LADOTD collects roughness (IRI), rut, cracking, patching, and faulting data. All data are reported based on a reference location system that consists of control sections subdivided into log miles. The video images and distress data (VISIDATA) have been installed in each district, and the personnel have been trained to use the data.

The LADOTD uses dTIMS (Total Infrastructure Management System) software to analyze the pavement condition data and to model the pavement rate of deterioration. The condition data are analyzed based on an index scale from 0 to 100 (100 being perfect). Although the data are collected continuously, they are reported by 1/100th mile segments.

All districts in the State of Louisiana have access to all the PMS data; however, most are reluctant to use the data for various reasons, as shown below.

1. Complexity of the system.
2. Untimely posting of the data.
3. The types of the employed data aggregation systems (e.g., pavement types, composite index over a control section, pavement performance, etc.).
4. Lack of training and/or proper communications.
5. The types and complexity of the reports generated by the PMS, which may offer either too much or too little information to address their needs.
6. Lack of clarity about the benefits of learning and using the system.

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Pavement management is a business process that provides the needed information to the highway agencies personnel to make cost-effective decisions regarding the pavements under their jurisdiction. Numerous studies (1-14) have been conducted to design and effectively implement the PMS. The consensus is that the PMS should be customized to meet the individual agency’s needs. Two AASHTO documents provide a complete treatment of pavement management and PMS, including objectives, components, and benefits. The “Guidelines for Pavement Management Systems” (15), provides the basic information needed to develop a framework for PMS. The “2001 Pavement Management Guide” discusses in detail the technologies and processes used for selecting, collecting, reporting, managing, and analyzing the PMS at the state level (16). Valuable information about the development, implementation, and use of PMS by towns, cities, and counties can be found in National Highway Institute course 13426, “Road Surface Management for Local Governments” (11).

Although the PMS used by LADOTD is based on effective software, it is not perfectly tailored to the users’ needs. A well-customized PMS must provide its users with easy-to-use tools to assist them in making cost-effective decisions regarding pavement preservation (15). A successful PMS also provides a systematic process for collecting, managing, analyzing, and summarizing pavement information to support the selection and implementation of cost-effective pavement preservation programs (15, 16, 17).

Cost-effective pavement preservation is emphasized in the current Louisiana state law (i.e., Act 1028) and the Federal law (i.e., The Transportation Equity Act for the 21st Century); it is also emphasized in the LADOTD strategic plan and in the Federal Highway Administration’s (FHWA) national strategic plan (18). Further it is stated in the “Louisiana-Vision 2020”:

Poor highway pavements contribute to negative image of Louisiana as well as leading to increased vehicle repair cost, increased freight damage, and a general decrease in highway safety. A well-maintained highway system is critical to the state’s economy including tourism and the transport of products to market.

“Louisiana-Vision 2020” serves as a benchmark for improving highway pavements over a 20-year period. In response, in January, 1999 the LADOTD created Task Force on Highway Project Identification and Prioritization. The task force published a draft report in April 1999 and a final report in January 2000 (18). The Task Force recommended improvements in the already established process employed by the LADOTD for identifying, prioritizing, and selecting cost-effective highway projects. The revised process relies on much of the same data and represents only a minor modification to the existing process. There are some significant differences however, such as that it largely decentralizes the decision-making process and relies on the team of experts to assist in setting priorities and selecting projects (18, 19).

In an effort to evaluate and improve the PMS, the LADOTD, in conjunction with FHWA, initiated a two year research study to evaluate the overall performance and effectiveness of PMS of LADOTD. In order to conduct a comprehensive review and assessment of operation and implementation of the current LADOTD’s PMS, the study was divided into two phases. The Phase I included: a) review and examine current PMS practices within the department, b) conduct departmental survey to identify the needs of the PMS users, c) identify the available source of pavement data, and d) PMS roadway identification system. The Phase II includes: a) review and update of both pavement performance and treatment selection models. This paper focuses on the Phase I study “the-state-of-the-art practice of LADOTD’s PMS” and on the results of the departmental survey to determine the needs of the districts. It is believed that the proposed research will enhance the PMS capabilities in managing pavements and facilitate better communication.
amongst various PMS data users and decision makers. The district engineers will have more confidence in using the data because the outputs and reports will be based on their needs.

**LOUISIANA HIGHWAY SYSTEMS**

Louisiana’s highway network is the 32nd largest in the nation, with the State highway system being the 11th largest. The highway network is comprised of over 60,000 center-lane miles and more than 13,000 bridges under the jurisdiction of federal, state and parish governments and entities.

**Network Classification**

The LADOTD classifies the pavement network to the following categories based on the road function (20):

1. Interstate (893 miles): All are state highways
2. Other Freeway/Expressway (45 miles): All are state highways
3. Other Principal Arterial (1,967 miles): 1,801 miles of state highways, and 64 and 102 miles of parish and city roads, respectively.
4. Minor Arterial (3,268 miles): 2,532 miles of state highways, and 218 and 518 miles of parish and city roads, respectively.
5. Collector (9,907 miles): 8,723 miles of state highways, and 326 and 858 miles of parish and city roads, respectively.
6. Local (44,832 miles): 2,706 miles of state highways, and 32,703 and 9,423 miles of parish and city roads, respectively.

As reported above, the majority of the total public highways are under parish jurisdiction.

**Highway System Categories**

The LADOTD Task Force on Highway Project Identification and Prioritization (18) developed the concept of improved highway project selection process and recommended three categories of highways, a) the National Highway System (NHS), b) the State Highway System (SHS), and c) the Regional Highway System (RHS).

The NHS includes the Interstate highways, some urban and rural arterial highways, and a few urban and rural collector highways. The SHS compliments the NHS and is comprised of those highways whose principal function is the intercity, interregional, interstate, and international movement of people and goods. The RHS is comprised of those highways whose principal function is the local movement of people and goods (18).

For convenience of budget and pavement condition analysis, the PMS office separates the Interstate Highways from the NHS system and calls for four categories as follows.

1. Interstate Highway System (IHS)
2. National Highway System (NHS)
3. State Highway System (SHS)
4. Regional Highway System (RHS)

The NHS comprises of 893 center-lane miles (5.4%) of Interstate and 1,550 (center-lane miles 9.3%) of other highways. The SHS and RHS consists of 7,043 (42.20%) and 7,148 (43.1%) center-lane miles of highways, respectively.

**LADOTD EXISTING LOCATION REFERENCE SYSTEMS**

The LADOTD is currently using three major location reference systems. These are:

1. Control Section Log Mile
2. Route Mile Post
3. Global Positioning System

In addition to the above, the construction projects are referenced to station numbers or chain-age.

**Control Sections Log-mile**
The control sections log-mile (CSL) is the most widely used system in the LADOTD. The CSL are arranged in route number sequence and trace the route from its beginning in a west to east or south to north manner to its point of termination within the State. The CSL is defined by the following components of the roadway.

1. Annual Average Daily Traffic (AADT)
2. Pavement Type
3. Lane Width
4. Number of Lanes
5. Shoulder Type
6. Shoulder Width
7. Subsurface Material

Most of the CSL are determined by political or geographical divisions. Each control section is broken up by increments of one mile called as the log mile. All project names begin with the CSL that makes data retrieval an easy task. However, the different components that define the CSL make it difficult to locate specific points on the road in the field. In addition, the CSL linear referencing system does not identify the direction of traffic.

**Route Mile Posts (RMP)**
The route mile posts (RMP) is used by traffic engineers and is arranged in route number sequence and trace the route from its beginning in west to east or south to north to its point of termination within the State. The RMP is not dependent on the different components of the roadway. This is the only location reference system that can be seen on the actual roadway. One great advantage of this system is that it is easy to locate specific points on the road in the field. The disadvantage is that if the roadway is extended at either end of the route, all mile post must be adjusted.

**Global Positioning System (GPS)**
The global positioning system (GPS) has limited use in LADOTD. Some traffic sections and PMS utilize this technology. The distress data collected by ARAN are referenced using the GPS. The GPS easily locates specific points on the road in the field. Moreover, if the roadway is extended at either end of the route, there will be no mile posts that need to be moved. The disadvantage to this location system is that specific equipment must be installed on state vehicles. Further, sometimes, the signal from satellites cannot be detected by the receivers.

**Linkage of the Three Location Reference Systems**
Since various departments use different location reference systems, it becomes difficult to locate and link the data sets that are required for PMS. Sometimes, it is almost impossible to locate a section of the road that needs treatment. Therefore, it will be a great advantage to have a unified location reference system or a way to link all these different reference systems.

During the PMS review process, it was found that the computer section of the LADOTD has developed a user’s friendly software that links the three systems and can be seen in one visual map.
This is accomplished by a user friendly program. Once the program is executed, a window (see, Figure 1) will appear with the title “LADOTD – Convert Latitude/Longitude to Route/Milepost.” For example, if a control section 8002 and log mile 8.991 are entered in the “Cont-Sec:” and the “Logmile:” fields; and if the option “I-,US,LA” under the “Route Formats:” is selected and the “Submit” is activated; the software determines the latitude, longitude, route, mile post and the Universal Transverse Mercator (UTM) coordinates as shown in Figure 1.

The link between the latitude, longitude, route, mile post, control sections and log-mile are based on an access file labeled “latlong_2006_segs.mdb”. This file has a list of all the control section and the beginning and end of each log-mile. For each one of these points there is a corresponding latitude, longitude, route and mile post for each control section beginning and ending log-mile listed in the database. The UTM is a two dimensional reference system. UTM is very similar to the Lambert Conical Conformal except it slices north and south instead of east and west. The slicing begins at the North Pole and ends at the South Pole.

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**FIGURE 1 The LADOTD – Convert Latitude/Longitude to Route/Milepost software.**

After the route and mile post are determined from Figure 1, a visual map can be made for field and office personnel. The office personnel can see how the surrounding area looks like. For example, if detours are required for the project, this visual map can help to determine the temporary route. The way to get to the virtual map is to click on the “Virtual Earth” button located on the top right corner (Figure 1). A new window will open up as shown in Figure 2. There is a dot at the center of the figure, which represents the CSL as listed in Figure 1. The scale is shown on the lower right hand corner of the map. The map also has a tool box on the upper
left hand corner. The scale and the tool box are not shown in Figure 2. There are three buttons located at the bottom of the tool box: a) Road, b) Aerial, and c) Hybrid. The “Hybrid” button is automatically selected when the window first opens. This shows both the roads and aerial photos at the same time. When “Road” is selected only the roads and each road name or number will appear (Figure 2). When “Aerial” is selected, only the aerial photos will appear. On the tool box there is a slider bar that is used to zoom in closer. Sliding the bar between the first two tick marks, it will zoom into the map as close as possible. The scale will adjust automatically. Sliding the bar all the way to the bottom, it will show a map of the entire world.

FIGURE 2 The LADOTD – Virtual earth initial view and the road view.
Distress Survey
Currently, the LADOTD surveys the pavement network once every two years using the ARAN system, which continuously acquires continuous high definition digital images of the pavement surface. The LADOTD collects roughness (IRI), rut, cracking (longitudinal, transverse, random, alligator, and block), patching, and faulting data. Although the ARAN vehicle is equipped with GPS unit, all data are reported every 1/10th of a mile based on a reference location system that consists of control sections subdivided into log-miles. The earliest distress data available in the LADOTD database was recorded in 1995. The pavement surface condition data are collected in two directions. The primary direction (direction 1) in most cases travels from south to north and from west to east. The opposite direction, also referred as the secondary direction (direction 2), travels from north to south and east to west. The ARAN vehicle also uses a profiler that has three components that are collected and combined:

1. Reference to elevation
2. Height relative to the reference
3. Longitudinal distance
   
Presently, the department utilizes the quarter car model for profiling. The quarter car model is capable of profiling at high speed and compatible with monitoring roadway networks.

Inventory Data and Condition Data
Tables 1 and 2 provide lists of the LADOTD Pavement Management’s Inventory Data, Condition Data, & the frequency of data collections. The location referencing system used to identify section locations is based on distances measured from a reference point rather than mileposts, beginning of road, or GPS (Latitude/Longitude).

TABLE 1: Inventory Data for Pavement Design & Materials.

<table>
<thead>
<tr>
<th>No.</th>
<th>Data Category</th>
<th>Data Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>State PMS</td>
</tr>
<tr>
<td>1</td>
<td>Pavement type (e.g., HMA, JPCP, JRCP, CRCP, composite (HMA/PCC))</td>
<td>X Surface Type Log, NEEDS</td>
</tr>
<tr>
<td>2</td>
<td>Pavement width</td>
<td>Surface Type Log, NEEDS</td>
</tr>
<tr>
<td>3</td>
<td>Shoulder type (e.g., turf, granular, tied PCC non-tied PCC, HMA)</td>
<td>Surface Type Log, NEEDS</td>
</tr>
<tr>
<td>4</td>
<td>Shoulder width</td>
<td>Surface Type Log, NEEDS</td>
</tr>
<tr>
<td>5</td>
<td>Number of lanes in each direction</td>
<td>Surface Type Log, NEEDS</td>
</tr>
<tr>
<td>6</td>
<td>Layer thicknesses (i.e., all layers above the subgrade)</td>
<td>MATT FILE</td>
</tr>
<tr>
<td>7</td>
<td>Joint spacing (for jointed PCC pavements)</td>
<td>Surface Type Log, NEEDS</td>
</tr>
<tr>
<td>8</td>
<td>Transverse joint load transfer</td>
<td>MATT FILE</td>
</tr>
<tr>
<td>9</td>
<td>Subgrade type and material classification (i.e., AASHTO, UCS, or others)</td>
<td>MATT FILE</td>
</tr>
<tr>
<td>10</td>
<td>Layer material properties (e.g., strength, mix constituents, gradation, etc.)</td>
<td>MATT FILE</td>
</tr>
<tr>
<td>11</td>
<td>Drainage (e.g., presence of drainable or permeable layer, edge drains, etc.)</td>
<td>Surface Type Log, NEEDS</td>
</tr>
</tbody>
</table>
TABLE 2 Condition Data Collected for Network Level.

<table>
<thead>
<tr>
<th>Pavement Type</th>
<th>Distress/Condition Indices</th>
<th>Frequency</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yearly</td>
<td>Every 2 years</td>
</tr>
<tr>
<td>Flexible HMA</td>
<td>Rutting</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Fatigue/alligator cracking</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Longitudinal cracking in the wheel path*</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Transverse cracking</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>IRI</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>PSR***</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Surface friction (FN or skid number) #</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Other specify (Patching, Rutting)</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Rigid JPCP/JRCP</td>
<td>Transverse joint faulting</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Transverse cracking</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Longitudinal cracking</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Transverse joint spalling</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>IRI</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>PSR***</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Surface friction (FN or skid number) #</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Other specify (Patching)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Rigid CRCP</td>
<td>Punchouts</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Longitudinal cracking</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>IRI</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>PSR***</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Surface friction (FN or skid number) #</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Other specify (Patching)</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Composite (HMA/PCC)</td>
<td>Longitudinal cracking</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Transverse cracking</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>IRI</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>PSR***</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Surface friction (FN or skid number)#</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td></td>
<td>Other specify (Patching, Rutting)</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

* LADOTD collects longitudinal cracking outside of the wheel path as “longitudinal cracking” and longitudinal cracking in the wheel path as “alligator cracking”.
** LADOTD collects high severity joint spalling as “patching”
*** PSR calculated from IRI.

#Surface friction (Skid number) is updated every 5 years and yearly for sections where accident occur frequently.

The LADOTD uses the AASHTO Provisional Standards to measure IRI, rutting, faulting, and cracking. The PMS collects data for the following four types of pavements.

1. Flexible Pavement (Hot Mix Asphalt(HMA))
2. Composite Pavements
3. Continuously Reinforced Pavement (CRCP)
4. Jointed Plan and Reinforced Concrete Pavements (JPCP, JRCP)

All of the inventory data are organized by project number and stored in the mainframe computer. The project number is composed of nine digits. The first five are the control section and the last four represent the number of projects done on that control section. The material type
and thickness information of the base, subbase, asphalt or concrete surfaces is located in Material Testing System (MATT). The surface type, roadway geometry and traffic data are located in both the MATT and Highway NEEDS sections. In addition, some of the material testing data is stored in hard and soft files of each district’s material testing laboratory.

All the condition data including the raw distress data measured by ARAN and all distress indices calculated by the PMS office are stored in PMS database. It should be noted that the PMS database does not contain material stiffness and falling weight deflectometer (FWD) data.

Traffic & Load Data (Network Level)
Traffic data is collected to calculate annual ESALs, annual number of heavy trucks (FHWA Class 4 through 13), and traffic forecasts (e.g. growth rate) for all types of vehicles. Currently, the ESAL factor is calculated on a three-year cycle with weight-in-motion data collected at 100 sites. In the near future, the weight in motion data will be increased to 300 sites collected on a three-year cycle. The traffic volume data can be located in the traffic section of the department.

Historical Data
For majority of the pavement, PMS records and stores historical data such as construction date, construction type (e.g., original or reconstruction), rehabilitation date, rehabilitation type (e.g., thick overlays, grinding, etc), preventative maintenance date, and preventative maintenance type (e.g., thin overlay, seals, etc.)

It is clear that the LDOTD contains various sets of database for all kind of pavements. During the review it was noticed that it was not convenient to download all the related data for a given section of the road. This is because the data sets are not linked to each other and contains different reference location systems.

DATA ANALYSIS AND REPORTING
Distress Index
The LADOTD uses Total Infrastructure Management System (dTIMS) software to analyze the pavement condition data and to model the pavement rate of deterioration. The condition data are analyzed based on an index scale from 0 to 100 (100 being perfect pavement). Indices for roughness, rut, patching, alligator cracking, transverse cracking, longitudinal cracking, and random cracking (transverse and longitudinal cracking in flexible pavements) are calculated. Along the distress index scale, several threshold values are established by the LADOTD. Each threshold value triggers certain type or types of maintenance or rehabilitation actions that need to be taken. Although the data are collected continuously, they are reported by 1/10th mile segments.

It should be noted that, for flexible pavements, the longitudinal and transverse cracking are added together and called as random cracking. The index calculated from such system does not accurately represent the condition of the pavement. Since the cause of failure for both the cracking types is completely different from each other, such a system may lead to selecting inadequate treatment that is not based on the cause of failure.

Deduct Points
The distress indices are calculated using the deduct points for each distress in a pavement. The deduct points used by LADOTD are based on the type of distress, extent of the distress, and severity level. For most distresses, three severity levels are used; low, medium, and high. During
the review it was found that there were multiple deduct point threshold values to trigger various actions. However, a deduct value of 60 or higher was common for major rehabilitation action. As reported by PMS personnel the deduct point policy was established in 1992 or earlier. Since then no study has been conducted to calibrate and modify the deduct points. Said calibration is being done in this study.

**Pavement Performance and Treatment Selection Models**

The review of the pavement performance and treatment selection models is a part of Phase II study. The Phase II has just started and the discussions and meetings are being conducted to improve the existing system.

The LADOTD’s PMS monitors and predicts performance using Empirical (Regression) models. Performance curves are used to plot graphs with the Performance Index vs. Age for each pavement family. The pavement families are based on pavement types (composite, asphalt, jointed concrete, and continuously reinforced concrete pavements) and highway classification of IHS, NHS, SHS and RHS.

The distress index models currently used by LADOTD are based on at least six years of data collected at two-year intervals. The models are a function of the “Age” of the pavement that follows the various transformation functions as listed below.

- Roughness Index: Polynomial function
- All indices for CRCP: Power function
- Rutting Index: Exponential function
- All other: Linear function

For example, the LADOTD performance model for longitudinal distress index for CRCP is a power function with the following form:

\[
\text{Longitudinal Distress Index} = 100 - a \times (\text{Age})^b \\
\text{Where, } a = 0.0173 \text{ and } b = 2.6
\]

Changing the values of “a” and “b” affects the slope and the degree of curvature of the resulting curve, respectively. Regardless of the type of performance model used within LADOTD PMS, the models themselves should be periodically reviewed and refined. Performance models directly impact the year a pavement section is selected for repair.

Final selection of the appropriate treatment for the section of the pavement depends on the type, cause and level of distress, and the expected return from the treatment. Currently, the LADOTD has a distress manual that addresses some of the above issues.

**Network and Project Level Reports**

A network level report is sent out to all districts. The following four files are delivered to each district.

1. Microsoft (MS) Excel File
2. Microsoft Access File
3. Two Acrobat Reader Files

The MS Excel file “DISTRICT 03 MAY 2006.xls” is an Excel file with five sheets labeled:

1. Resets
2. Current Condition Resets
3. Priority List
4. Poor and Very Poor
5. Lower Fair
In the sheet labeled “Resets”, there is a list of projects that have been reset to an index value of 100% since the last data was collected. The “Priority List” sheet is a list of all the sections of roads that are in vital need of repair. The recommended treatment and cost of the treatment is also presented. The “Poor and Very Poor” sheet has a list of the roads that are in bad condition. The “Lower Fair” sheet has a list of the roads that are in the lower portion of the fair category. An example of “Current Condition Resets” is shown in Table 3.

One of the two Acrobat Reader’s files is titled “Summary_2005_District_03_Treatment Type.pdf.” This file shows a map of the districts roads and the corresponding treatment that is recommended. The treatment types are color coded as shown in Figure 3. The map shows the CSL for each road with colored dots representing the 1/10th mile for the treatment. The second acrobat reader file shows a map of the districts roads and the treatment year that is recommended. The treatment years are each color coded. The map shows the control section for each road with colored dots representing the 1/10th mile for the treatment year.

Also, the project level report is sent out to each district upon request of the district. The report will consist of detailed distress information including the distress indices as tables and visual maps for 1/10th mile section for every parish in the district. The maps will be color coded for each 1/10th mile section.

**LADOTD DISTRICT SURVEY**

The research team, in collaboration with LTRC researchers and engineers, and the PMS office conducted an extensive survey of the PMS group and engineers at the nine districts who are potential users of the PMS output. The survey questionnaire consisted of 23 questions with multiple sub questions. The main objective of the survey was to identify the needs of districts including the following:

- The types of output and reports accessible and available to the various users.
- The types of information and reports needed or desired by the users in order to make cost-effective decisions.
- The degrees to which the current PMS outputs are analyzed and utilized.
- The adequacy and the accuracy of the information currently available.
- The various issues and concerns regarding the PMS data and output.
- The degrees to which the potential PMS users fully understand the benefits and the potential cost savings that can be precipitated by using the PMS data.
- The ease at which a pavement section can be located by using the location reference system.
- The degrees with which the current PMS tracks the performance of pavement preservation actions.
- The degrees to which the current PMS data differentiate between pavement projects that have received different preservation actions.

**Results of Survey**

Louisiana has nine districts and in each district four groups were concentrated including the Maintenance Engineers, Construction Engineers, Traffic Engineers, Design Engineers, Water, and Res. & Development Engineers. In general, each group consists of District and Assistant District engineers. A total of 63 survey questionnaires were sent and 30 survey responses were received and analyzed. It was assumed that the District and Assistant District engineers returned one response for the survey. The summary of results is reported below.
FIGURE 3 Network level report of priority list by treatment type.
TABLE 3 Current Condition/Treatment with Resets for District 03, May 2006.

| DIST | ROUTE | CONTROL | BEG_LOG | PAVE-TYPE | TREATMENT | SHS | RUFF | AVEG_IRI | RUT | R_AVG | ALCR | LONG | TRAN | RNDM | PTCH | FSECTION | PERF_INDEX | RSL | RESET |
|------|-------|---------|---------|-----------|-----------|-----|------|----------|------|--------|------|------|------|------|------|------|--------|------------|-----|-------|
| 03   | LA0014| 055-07  | 1       | 8.95      | Jointed Concrete | Minor Rehabilitation | SHS | 74 % | 169 | N/A % | -1 | N/A % | 99 % | N/A % | 99 % | 055-07-1-08.95 | 84 % | 12 |
| 03   | LA0014| 055-07  | 1       | 9.81      | Jointed Concrete | Minor Rehabilitation | SHS | 72 % | 181 | N/A % | -1 | N/A % | 83 % | N/A % | 99 % | 055-07-1-09.81 | 78 % | 11 |
| 03   | LA0014| 055-07  | 2       | 6.17      | Composite     | Minor Rehabilitation | SHS | 98 % | 160 | 100 % | -1 | 100 % | N/A % | N/A % | 99 % | 055-07-2-06.17 | 99 % | 14 | reset |
| 03   | LA0014-B| 055-30 | 1       | 0         | Jointed Concrete | Minor Rehabilitation | SHS | 80 % | 140 | N/A % | -1 | N/A % | 99 % | N/A % | 99 % | 055-30-1-00.00 | 87 % | 17 |
| 03   | LA0014-B| 055-30 | 1       | 0.37      | Jointed Concrete | Minor Rehabilitation | SHS | 62 % | 229 | N/A % | -1 | N/A % | 87 % | N/A % | 96 % | 055-30-1-00.37 | 73 % | 4 |
| 03   | LA0014-B| 055-30 | 1       | 0.99      | Jointed Concrete | Minor Rehabilitation | SHS | 67 % | 206 | N/A % | -1 | N/A % | 86 % | N/A % | 99 % | 055-30-1-00.99 | 76 % | 7 |
| 03   | LA0014-B| 055-30 | 1       | 1.72      | Jointed Concrete | Minor Rehabilitation | SHS | 68 % | 198 | N/A % | -1 | N/A % | 95 % | N/A % | 97 % | 055-30-1-01.72 | 79 % | 8 |
| 03   | LA0014| 055-31  | 1       | 0.03      | Jointed Concrete | SHS | 91 % | 85 | N/A % | -1 | N/A % | 99 % | N/A % | 99 % | 055-31-1-00.00 | 94 % | 25 |
| 03   | LA0031| 056-01  | 1       | 0         | Composite | Medium Overlay | SHS | 67 % | 205 | 89 % | 0.24 | 82 % | N/A % | N/A % | 92 % | 056-01-1-00.00 | 76 % | 4 |

NOTE:
DIST: District number, ROUTE: Route number, BEG_LOG: Beginning Log mile, PAVE-TYPE: Pavement Type, SHS: State Highway System, RUFF: Roughness Index based on IRI, AVEG_IRI: Average IRI value, RUT: Rut Index, R_AVG: Rut Value, ALCR: Alligator cracking Index, LONG: Longitudinal Cracking Index, TRAN: Transverse cracking Index, RNDM: Random Cracking Index, PTCH: Patching Index, PERF_INDEX: Performance Index, RSL: Remaining Service Life based on IRI, RESET: Index Rests to 100% due to treatment.
All districts have access to the PMS data and more than 10 people in each district have access to the data. Of those, who have access to the PMS data, 86% actually use it.

On the average, 72% of the engineers use the PMS data to obtain the present distress conditions of pavement projects, selection and prioritization of projects. Most view the IRI index followed by condition and individual distress indices. Only a few cared about the remaining service life (RSL) of the pavements.

A majority (70%) of the engineers stated that they do not use the data to track the performance of applied treatments. In addition, 65% do not report the reconstruction, rehabilitation, preservation, and routine maintenance activities to the PMS office (e.g., using the mainframe data entry or others).

Approximately, 70% and 63% of the engineers would like to receive both project-level reports and network-level reports, respectively, from the PMS office. In addition, 64% would like to receive these reports once a year, as opposed to 20% wanting them twice a year.

About, 71% of the engineers stated that they do not receive visual aids such as maps presenting suggested highway treatments, treatment years, and roughness information from the PMS office. Of the remaining (29%) who do receive the visual aids, a majority of them do use it. These visual aids were rated between very good and fair quality.

Approximately, 67% of the districts stated that the information presented in the reports for their work was just right. The visual maps (43%) and tables (23%) were both stated as the preferred format of the PMS data in reports.

A majority of engineers (70%) stated that 25% to 50% of the annual pavement projects selected by the district were the same as those recommended by the PMS office.

Less than half of the district engineers do have concerns or issues regarding the following:
- Existing location reference system (37%)
- Accuracy of the data (40%)
- Value of the indices (33%),
- Recommended treatments (42%)
- Remaining service life (40%).

The construction engineers showed no concerns for all of the above.

The survey indicated that the primary reference location used in the districts is Control Section Log mile (100%) followed by the Route Milepost (59%). Most of the districts stated that Route Point mile (67%) and GPS (81%) are not used.

Seventy six percent of the districts stated that they would like to have a Unified Reference Location System.

Based on the 2003–2004 FHWA and LADOTD surveys, several recommendations were made and forwarded to the PMS office for implementation. In regard to the implementation status of such recommendations, 75% stated that they were not aware of the implementation status of at least half of the recommendations. In addition, 80% did not know that the PMS data of the 2007 survey will have the following capabilities: a) Fore slopes and cross slopes data, b) Bridge clearance and ramps, c) Object heights and distances using the surveyor tools, d) High definition (HD) quality sharp images, e) Degree of curvatures based on AASHTO classification, and f) Electronic data in smaller intervals than a tenth of a mile.

A majority of the districts (88%) stated that they would like to receive the training on the PMS data once a year including: VISIDATA, VISIWEB, surveyor tools and distress data.
CONCLUSIONS AND RECOMMENDATIONS

The Phase I of the research study related to the review of PMS of LADOTD has been completed. The findings of the study will provide guidelines for the future research work and the implementation of improvements to the Department’s PMS. Based on the review of the PMS and the survey conducted within all the districts, the following conclusions and recommendations were made.

- All the districts have access to the PMS data and majority of those who have access to the data actually use it.

- It is evident that the use of the PMS data as reported by the districts varies substantially. Although the majority views the overall IRI, one needs to determine the steps that must be taken to increase the use of the PMS data and reports. One step, for example, is to review the values of the distress indices and determine whether or not they reflect the conditions of the pavements.

- The deduct point policy has not been modified since its establishment. Therefore, it is highly recommended that the deduct points should be calibrated and modified. In addition, the PMS must adopt uniform trigger (threshold values) for all pavement types and for all types of distress in the pavements. This will help in determining the accurate condition of the pavements and enhance communication with the districts.

- There is no consensus amongst the districts as to the type of reports they like to view. New forms of reports probably should be developed. The PMS unit should streamline the audience for their reports. For example, the network level report is prepared for the management only whereas the project level report should be mailed to engineers and technicians.

- The survey responses imply that the PMS unit cannot track actions (rehabilitation or maintenance) that have been taken on various pavement sections. A meeting between the PMS unit and the various districts should be held to address this issue. Alternatively, most districts have electronic records of their maintenance and rehabilitation activities. The implication of the two responses is that the electronic records are:
  - either not accessible to the PMS unit, or
  - not compatible with the PMS data software, or
  - the PMS data bank is not designed to store such data.

- The majority of the districts engineers would like to convert to a unified referencing system although more than half have no concern about the current system. This issue would probably be best addressed as a Departmental decision and may even require state legislation. Linking CSL and RMP to GPS will allow LADOTD to continue using the different systems. This can easily be accomplished by utilizing the already existing software developed by the computer section of the department.

- The majority were unaware of the implementation status of the previous recommendation made by FHWA and future capabilities of the new data collection and PMS database. This suggests a lack of good communication between the PMS unit and the districts. The PMS office should conduct yearly training sessions and biannual meeting with the district to train and update them about the recent developments and capabilities of the PMS. This will also enhance communication between PMS and the districts, thereby, accessing the needs of end users.

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