

Section F TRANSPORTATION MANAGEMENT SYSTEMS

The development of management systems is a requirement introduced by the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), with continued emphasis in the Transportation Equity Act for the 21st Century (TEA-21). The relationship between the management systems and development of metropolitan transportation plans is clearly expressed by two of the general policy statements in the regulations:¹

- “The primary purpose of the management system is to provide additional information needed to make effective decisions on the use of limited resources to improve the efficiency of, and protect the investment in, the nation's existing and future transportation infrastructure at all levels of jurisdictional control.”
- “The output of the individual management systems shall be integrated into the metropolitan and statewide transportation planning process . . . and shall be considered in the development of metropolitan and statewide transportation plans and improvement programs and in project selection decisions. . . .”

These policy statements express both the importance and linkage between the management systems and the metropolitan and statewide transportation planning processes.

OVERVIEW OF MDOT ACTIVITIES

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) required State Highway Agencies (SHA) to develop management systems in the following areas:

Pavement, Bridge, Safety, Congestion, Public Transportation, and Intermodal. The Michigan Department of Transportation (MDOT) collectively refers to the management systems as the Transportation Management System. This System will provide a source of information addressing both the condition and the performance of the existing and future transportation networks. This overview of MDOT management system activities presents a review of the development process and product.

The Transportation Management Systems (TMS) designed and implemented by MDOT serve as an integral decision support tool to feed a comprehensive project prioritization process and to provide a clear link showing how proposed projects use of funds support the State Long Range Plan and the Long Range Plans of the urban areas and other agencies within Michigan.

It is designed as a single management system with six subsystems. These systems include: Bridge, Congestion, Intermodal, Pavement, Public Transportation, and Safety.

This allows the TMS to include a common shared database, a common set of decision support tools and functionality, and the use of a robust and consistent user interface. Data collected, processed, and maintained at the working levels are stored using an enterprise database management system.

MDOT maintains a website on a web page dedicated to these management systems. It can be accessed at www.mdot.state.mi.us/planning/tms/index.cfm. For more detailed information and guidelines as to how to access this information and guidelines as to how to access this information, please contact the Michigan Department of Transportation.

¹ 23 CFR Section 500.105

Development of each system relies on a standardized procedure developed by MDOT and Cambridge Technology Partners (CTP). This procedure consists of the following steps for each management system:

1. Define the purpose.
2. Specify primary and secondary goals of implementing the management system.
3. Identify potential users of the system (e.g., transit agencies, county road commissions, local planning agencies, MPO's, and MDOT).
4. Specify the business functions as well as the type and source of data needed (e.g., project need for replacement buses, estimate cost and priority for repairing identified pavement deficiencies and/or assess alternatives to alleviate and/or prevent congestion problems).
5. Describe which other systems it supports and where it may require data from other systems (e.g., examination of alternative sites for a new intermodal rail-truck terminal may start with querying the Intermodal Management System, but require information from the Congestion Management System to determine which sites currently have congested roads).
6. Identify issues associated with its development (e.g., division of data collection responsibilities by management system, MDOT versus MPO's versus local road or transit agencies and frequency of data collection, in collecting and coordinating pavement condition data).

MDOT and CTP have developed prototypes to illustrate how the management systems will work. Prototypes allow for the construction of a realistic planning problem that will be solved using information derived from one or more of the management systems. This demonstrates how the management system will appear to the user.

In all cases, each management system includes the following:

- An inventory of existing conditions.
- A list of deficiencies based on uniform performance standards developed among affected transportation agencies.
- An assessment of solutions to alleviate deficiencies (a strategy).
- A proposed plan of action.

The management systems will be a support tool to provide information to make informed decisions.

The following narrative provides more detail of each management system as required under TEA-21.

PAVEMENT MANAGEMENT SYSTEM

The pavement management system provides for a systematic process that analyzes and summarizes pavement information for use in selecting and implementing cost-effective pavement construction, rehabilitation, and maintenance projects.

General Requirements: All federal-aid roadways are to be included in the pavement management system. Coverage of federally funded public roads will be determined cooperatively by FHWA and the local agency.

Components: Active pavement management systems allow the agencies to prioritize life-cycle based investments in pavement rehabilitation. Evolution of a pavement management system responsive to federal regulations and comprehensive transportation investment

planning will, at a minimum, need agreement among the area's transportation agencies. Issues to be addressed include:

- Coordination between MDOT and MPO's or local agencies to ensure that data collected by various types of pavement management systems can be integrated and utilized by the system.
- Division of responsibilities for collecting, maintaining, analyzing, and disseminating data among MDOT, Kalamazoo Area Transportation Study, and the local responsible road agencies.
- Securing funds, equipment, and other resources to expand collection of data beyond the existing systems to cover all federal-aid facilities within the metropolitan area boundary (MAB).
- Agreement on the frequency and format of data to be uniformly collected across jurisdictions. Data may include geometrics/pavement structure, current and future traffic volumes and classifications, structural capacity, ride quality, surface and base conditions, and skid resistance.
- Determination of uniform conventions for identifying existing deficiencies, computations for predicting future deterioration rates and deficiencies, and types of improvements.

BRIDGE MANAGEMENT SYSTEM

MDOT's Design Division has maintained a computerized bridge inventory in accordance with National Bridge Inventory Standards (NBIS) for over 25 years. This inventory covers all Michigan bridges over 20 feet in length, regardless of jurisdiction. MDOT

periodically conducts bridge condition surveys. Identical surveys are conducted by the responsible road agency for bridges in county and local jurisdictions and submitted to MDOT. Surveys of all bridges in the State are required as a condition for receipt of federal funding.

The bridge management system supplies an analysis and summary of data, uses mathematical models to make predictions and recommendations, and provides the means by which alternative policies and programs may be efficiently considered. This management system includes formal procedures for:

- collecting, processing, and updating data;
- predicting deterioration;
- identifying alternative actions;
- predicting costs;
- determining optimal policies;
- performing short term and long term budget forecasting; and
- recommending programs and schedules for implementation with policy and budget constraints.

General Requirements: All bridges are required to be inventoried and inspected, except for those that are federally owned. TEA-21 requires inventory of federally-owned bridges on public roads to be determined cooperatively by the FHWA and the local agency. The State is required to operate a bridge management system on non-federal-aid highways, excluding bridges on federally-owned public roads. Maintaining a centralized data base and implementing network analysis procedures is required for all bridges in the inventory, including inventories within any MPO. The bridge management system is a state-operated system with the capability to separately consider the needs of bridges within any local jurisdiction.

Components: The components of the bridge management system consist of data collection, maintenance, network level analysis, and optimization. MDOT is utilizing FHWA's PONTIS software as the basis for this management system.

HIGHWAY SAFETY MANAGEMENT SYSTEM

The highway safety management system addresses all modes of highway transportation safety. Specifically, it addresses safety on public roads, and similar to the other management systems, is integrated into the decision making process. The overall goal of this management system is the reduction of the number, and severity, of highway crashes.

Effective management and reduction of highway related injuries and fatalities is the intent of the highway safety system. This management system may recommend that responsible agencies direct their limited resources to safety projects to receive maximum return on their investment.

General Requirements: The highway safety management system emphasizes cooperation with local agencies. The federal agencies encourage states to provide appropriate opportunities for involvement of bicycle and pedestrian representatives when developing this management system. While there never seems to be sufficient resources for highway transportation, this management system will lead to more efficient and effective use of limited resources.

Requirements of the highway system include comprehensive roadway coverage on public roads. Private roads not meeting the definition of a public road found in 23 U.S.C. 101(a) are not required to be part of this management system.

Michigan is given flexibility in developing mechanisms consistent with local needs. Requirements linking non-related databases, such as emergency medical services to highway safety, would require extensive input from the private sector. The degree of detail and amount of information coordinated among local agencies will be determined by MDOT and local agencies.

Components: Data collection for the highway safety management system will include vehicle, pedestrian, and bicycle crash data. The need for pedestrian data beyond crash data will be determined by the agencies involved. Also required is information on highways necessary for problem identification and determination of improvement needs, safety problems (including operational practices and policy), and highway-rail crossing information. This management system will clearly identify strategies, time frames, and probable funding sources for each proposed project. The State and local agencies have flexibility in determining what data elements and sources are to be used in order to achieve the objectives and requirements of this management system.

KATS will work, in cooperation with MDOT, to incorporate and develop these key features of the Highway Safety Management System:

- Traffic Safety Goals and Policies;
- Data Collection and Maintenance;
- Assessment of Highway Safety Needs;
- Specialized Traffic Engineering and Safety Studies; and
- Public Information and Education.

CONGESTION MANAGEMENT SYSTEM

The TEA-21 requires that needs identified by the congestion management system be considered in developing metropolitan and statewide transportation plans and improvement programs. The congestion management system includes the identification of alternative strategies to alleviate congestion while enhancing the mobility of persons and goods.

General Requirements: The State may decide to address congestion management for all transportation modes and not focus solely on the movement of vehicles. The congestion management system must assure that the efficient movement of people and goods is

addressed and that consideration is given to other strategies and various modes, including parking management and bicycle and pedestrian facilities. The system will propose strategies which are critical to preserving the effectiveness and efficiency of the overall transportation system, in both metropolitan and non-metropolitan areas statewide.

The determination of congestion and potential congestion will be based on an area's definition of congestion and the results of forecasts. If population and land use changes are anticipated that could result in increased levels of travel, the evaluation of strategies to manage congestion will be warranted. Early recognition of the potential problem should lead to more effective solutions, including the timing, location, and design of proposed land use development and transportation facilities.

The congestion management system will be coordinated with the development and implementation of the other management systems. The congestion management system and public transit management system will identify and analyze transit performance measures and operation. The public transit management system will deal solely with transit capital assets. It will be the responsibility of MDOT, in cooperation with the MPOs, transit operators, and other affected agencies, to determine coverage and applicability of these three systems with regard to system performance.

Under the Congestion Management System regulations, general purpose road widening can only be considered after a careful evaluation of the congestion reduction impacts of low-cost improvements, such as traffic signal projects, local traffic engineering projects, and transit and/or ridesharing improvements. Capital improvements, when applied under a program that utilizes reasonable strategies to manage a facility, can be a solution under the congestion management system. However, before decisions can be made, non-capital strategies must be considered and appropriately analyzed.

Components: Performance measures should be established in order to evaluate the congestion management systems performance throughout local areas as well as statewide. A number of these performance measures may include:

- Delay per incident;
- Average travel time per trip;
- Persons per hour on the facility or in a corridor;
- Level of service;
- Lane miles over a specific level of service;
- Vehicle miles traveled over a specific level of service;
- Percent of vehicle miles traveled by functional classification;
- Vehicle miles traveled per lane mile;
- Delay per lane mile;
- Delay per vehicle miles traveled;
- Delay per trip; and
- Delay per vehicle.

In consideration to the movement of people and goods, numerous performance measures may include:

- Proportion of persons congested or delayed;
- Person hours of delay; and
- Vehicle occupancy.

Performance measures for transit facilities may include:

- Riders per vehicle mile;
- Riders per vehicle hour;
- Peak load factors;
- On-time performance;
- Cost per rider;
- Vehicle hours per employee;
- Vehicle miles per employee; and
- Riders per employee.

The congestion management system will require a continuous program of data collection and system monitoring. The extent of this program will be determined by MDOT in cooperation with MPOs, local officials, transit operators, and other transportation officials. Consequently, the driving force will be a function of the magnitude of congestion and the area's performance measures. If existing sources are not adequate, new sources will need to be developed to implement an effective congestion management system.

Emerging Issues: Some of the issues to be addressed as the congestion management system is further developed include:

- Evolution toward uniform performance measures across modes and jurisdictions for the use and analysis of traffic volume and congestion data among all major users (responsible road agencies, MDOT, the MPOs and others); and
- Development of explicit ties between the final methodologies for ranking deficient congestion locations and programming decisions.

PUBLIC TRANSIT MANAGEMENT SYSTEM

The intent of the public transit management system is to evaluate strategies and project alternatives for inclusion into appropriate transportation plans and improvement programs.

General Requirements: The cooperative development and implementation of a public transit management system allows each state to determine roles and responsibilities of affected agencies in the inventory of assets, collection of data, identification of condition measures, and monitoring of systems. This management system encompasses recipients and sub-recipients of Federal Transit Act Sections 5307, 5309, and 5311 funds, as well

as others to be identified by MDOT and the MPOs, thus ensuring the most comprehensive system possible.

The public transit management system is being developed in coordination with the development of the congestion management system and intermodal management system. This ensures that transit system performance is addressed as part of the overall transportation network.

Components: MDOT has led the effort to develop the public transit management system consistent with TEA-21. Data and administrative issues raised with the public transit management system include:

- Dividing responsibilities among MDOT, Kalamazoo Area Transportation Study, and transit operators for collecting, maintaining, analyzing, and distributing data.
- Assembling staff and securing funds, equipment, and other resources to expand collection of required data.
- Agreeing on the type, frequency, and format of data to be uniformly collected by MDOT, KATS, and the transit operators. Data may include characteristics and conditions of transit facilities for maintenance, reconstruction, replacement parts, parking and servicing; inventory of buses available, daily schedules, condition and maintenance costs; age, location and condition of terminals and stations; and inventory of other equipment.
- Determining uniform conventions for identifying existing deficiencies, computations for predicting equipment and facility replacement cycles and types of improvements.

INTERMODAL MANAGEMENT SYSTEM

According to TEA-21, the purpose of this management system is to improve integration and coordination in planning and implementing air, water, and ground transportation systems. This management system includes all facilities, both public and private, necessary to establish an efficient intermodal transportation system. An effective intermodal system will consider private sector issues, and many capital decisions affecting transportation facilities and systems made by the private sector. However, government policies and programs have an impact on private sector operations and decision making.

General Requirements: The State is required to develop, establish, and implement an intermodal management system that meets the federal legislation requirements. The data requirements of the intermodal system mandates coordination and integration with metropolitan and statewide transportation planning, the private sector, and other management systems. Because of the complexities of quantifying the intermodal management system, a task force has been formed at the state level to provide for local input into developing this system.

Components: The Kalamazoo Area Transportation Study and its agency participants will work with MDOT in developing and collecting the data necessary to implement this management system.

Development of the intermodal management system raises several issues:

- Access to data is required for each mode and system. Railroads, truck companies, shipping, and aviation companies are privately owned and may be hesitant to release data to public agencies.
- Private industry needs to be involved in the public planning process so that plans for major facilities or intermodal terminals can be considered and their impacts incorporated into transportation planning.
- MDOT and KATS must divide responsibilities for data collection, maintenance, analysis, and dissemination.

FUTURE DIRECTIONS

Developing the Management Systems: The proposed management system regulations addresses three directions for developing future policies and procedures which may reflect a departure from past practice:

- First, costing of projects and programs under all management systems must be based on life-cycle costing. In the past, the project and program costs may have been based only on the initial project cost.
- Second, while many agencies already develop transportation projects based on congestion and safety considerations using carefully developed quantitative evaluation and ranking procedures, these procedures are not uniform across the area. The management system regulations imply that a uniform set of performance standards, measures, and project evaluation procedures must be developed and applied. These uniform procedures will be cooperatively worked out and agreed upon among the Kalamazoo Area Transportation Study, the area's transportation operating agencies, and MDOT, and will be developed to cover all management systems. The ties between each project's priority for improvement and annual programming decisions will be made more explicit across the area. Again, these ties will be established through procedures cooperatively developed among area transportation agencies, KATS, and MDOT.
- Third, as stated before, general purpose road widening can only be considered after a careful evaluation of the congestion reduction impacts of low-cost improvements.

Implementing the Management Systems: TEA-21 required implementation of each management system by 1995, with MDOT annually certifying progress on implementation of each management system to FHWA.

Revising the Long Range Plan: Recommendations from each of the 6 fully-developed management sub-systems will be incorporated into future updates of the statewide Long Range Plan and the metropolitan areas Long Range Plans.

OVERVIEW OF KALAMAZOO AREA TRANSPORTATION STUDY ACTIVITIES

The primary purpose of the management systems is to provide the information and data needed to make effective decisions on the use of limited resources to improve system efficiency and protect existing and future infrastructure investments. The states have been assigned the lead role in developing and implementing the management systems. In metropolitan areas, state-MPO cooperation is emphasized. Recognizing that decision making on over 90% of the system miles is vested in local officials at various levels, this cooperative or joint effort is important to the successful implementation and application of the management systems.

Within the Kalamazoo metropolitan area, the local transportation agencies have advanced their management system activities, acting in coordination with and cooperatively through the MPO. Coordination with the system development efforts by MDOT has focused on that same approach. The Kalamazoo Area Transportation Study has been both a direct and indirect participant in the development of the management systems.²

² The chair of the KATS Safety Management System Committee (Jon Start) directly participated in the Safety Management System development.

A summary of the management system activities as follows:

Pavement Management System

The initial development and implementation of a pavement management system (PMS) by the major road agencies in the Kalamazoo metropolitan area predates the requirements of ISTEA and TEA-21. The City of Kalamazoo was the first agency within the metropolitan area to initiate the implementation and use of a PMS system. They were soon followed by the Kalamazoo County Road Commission, with the City of Portage achieving full system implementation in 1994.

The basis for pavement management system implementation focused on two direct applications or needs:

- Each individual agency recognized a need to develop or adopt a sound engineering process to comparatively evaluate their roadway conditions, produce estimates of achieving and maintaining pavement conditions that were acceptable and safe for the traveling public, and prioritize the expenditure of limited resources in a cost-effective and system-efficient manner. Clearly, developing local rehabilitation and maintenance programs for their jurisdiction was the first priority.
- Interagency coordination, acting through KATS, resulted in the second system application intent. That intent was simply to assure a uniform system (within the metropolitan area boundary) that could eventually be used to select rehabilitation projects that would be federally funded with STP targeted funds in the Kalamazoo metropolitan area.

Several systems were reviewed with the MPO actively participating in the review process. The system selected was PMS, Limited (now Stantec). The Stantec system is an engineered system with the ability to locally define “decision trees” that are used for the

project ranking and selection process. Both the City of Kalamazoo and Road Commission have been through multiple pavement evaluation updates.

Not coincidental to this joint process, each agency has recognized the benefits of economies of scale in system purchase, system updates, and pavement re-evaluation cycles.

The system used is based on the concepts described in the AASHTO Guidelines for Pavement Management Systems. Clearly, the system selected is designed to fit the local agency's goals, policies, criteria, and resources. The system, as implemented, is a reasonably complex system, however, is felt to provide value for its intended purposes.

Current application of the system addresses the required essential components or basic framework:

- Inventory (System inventory is kept current on a continuing basis and entered into the database prior to each update, but not less than annually).
- History (The PMS database has a history module available. Projects and maintenance information is kept by record and is available for system entry).
- Condition Survey (The surface distress, rutting, and surface friction are scheduled to be updated on a 3-year cycle).
- Database (The database and reporting system is kept updated and has annual applications. All three agencies have used the system to develop their Capital Improvement Programs (CIP), and it is an integral part of project solution for both the Long Range Plan and Transportation Improvement Program). The City of Portage had briefly suspended use of the system but will begin using it again for their federal aid system roads.

Over 95% of the federal-aid system within the metropolitan area boundary has been evaluated under PMS. Detail review of the “decision trees” developed for the metropolitan area indicate that they reliably prioritize projects that have the best benefit/cost ratios.

The system is used by two of the three major road agencies in project selection for their Capital Improvement Programs and was directly used in the first years’ “preserve” project selection process for development of the 2025 Transportation Plan.

The Stantec system, selected and developed for the Kalamazoo metropolitan area, is somewhat unique insofar as the system can reflect local goals and programs. Since the system is based on the framework of the AASHTO Guidelines for Pavement Management Systems, integration and transfer of data to the State can be accomplished.

In summary, the Pavement Management System (PMS) has been near totally implemented in the Kalamazoo metropolitan area and is being fully utilized. System refinements, such as scheduling of measurements, are a matter of continuing review.

Safety Management System

The KATS activity on the Safety Management System (SMS) has focused on:

- Development of an accident database;
- Preliminary development of an analysis system to use with the accident database for system analysis; and
- Increased staff emphasis on traffic engineering and safety.

KATS initiated database development, starting with the new UD-10 crash reporting form, in January, 1992. Local enforcement agencies within the metropolitan area boundary provide KATS the traffic crash accident forms for manual data entry and data scanning.³ This internal process was initiated based on early unknowns regarding data availability and has continued based on timing, completeness of accident incident coverage, and extent of data elements coded. With the system at Michigan Tech University being extended to include cities and improvements to Roadsoft in the near future, this process will be continually reviewed for value.

Time and budget constraints has delayed the development of the analysis system. With the increased emphasis on safety at the Federal, State, and MPO level, development of better analysis tools will be a priority for KATS in the upcoming years.

Public Transportation Management System

The public transportation management system focus is on physical inventory and condition evaluation of the capital elements of the transit systems. In working with the local transit providers, the initial steps of comprehensive inventory and condition reports have been completed (October, 1994). The inventory has been limited to identification of all transit assets items with procurement cost in excess of \$1,000. These data, including life cycle replacement schedules, were used to develop the public transportation capital needs component of the Long Range Plan.

Congestion Management

The local KATS program is in the beginning phases of this management system. Initial efforts have been limited to collecting data that will provide the ability to measure locations, duration, and extent of congestion. Work outlines and procedures have been developed and are subject to continuing internal review.

At this time only limited effort has been directed to the remaining two systems, Bridge and Intermodal. The Bridge Management System (BMS) Committee has met and initially defined its role as monitoring to ensure that timely and accurate data is being provided to MDOT for system input. The local road agencies actively inspect their bridges as required and update the database for the new bridge conditions. The results of these inspections drive the programming of most bridge projects in the county. Detail work outlines have been developed for the Intermodal Management System (IMS), but priorities and schedules have not permitted advancing this activity at this time.

There has been an expressed interest in the Maintenance Management System (MMS). At this time, the committee will only monitor its development to evaluate future local applicability.

³ The data scanning is performed by Western Michigan University (WMU) under an agreement with KATS. This has been a cost effective and time effective process, with scanning turn around of 1 - 2 hours.