

TRANSPORTATION MANAGEMENT CENTERS

MANAGEMENT AND OPERATIONS

Transportation management centers (TMCs), sometimes called traffic management centers and traffic operations centers (TOCs), coordinate ITS operations. TMCs can be owned or operated by a single agency or multiple transportation agencies and perform an array of functions including data acquisition, command and control, computing, and communications for many types of ITS applications.

TMCs are integral to a variety of management and operations strategies discussed throughout this report: traffic incident management, emergency management, electronic payment and congestion pricing, traveler information, and information management. While some of these strategies can be implemented in a stand-alone manner, others cannot, and each is enhanced through participation in a TMC. Careful planning is needed to gain the best performance through participation in a TMC. For example, TMCs provide an opportunity for centralized collection of data collected by ITS; however, TMC performance requirements are necessary during archived data management systems development for the successful development of such a system.

Coordination through a TMC can also improve the performance of the various strategies discussed earlier in this report. TMCs are often the venue for the instantaneous communication and coordination among various transportation organizations that enable improved system performance. For example, inclusion of road weather management personnel in TMC operations can facilitate the implementation of a variety of traffic management strategies, in addition to snow and ice control, to mitigate the impact of inclement weather.

TMCs can be operated under several different business models. TMCs operated by a single agency have the simplest business model. These TMCs are able to focus resources on specific agency goals, coordination requirements, and explicit performance measures. Joint TMCs, however, are more complex. Joint operation of TMCs by multiple agencies complicates the task of TMC stakeholders and decision-makers charged with developing realistic planning and performance measures needed to rationalize TMC investments.

To date, most evaluation efforts that discuss TMC operations focus on specific programs such as incident management, emergency management, or traffic control. Since evaluation data that explicitly quantifies the impacts of integrated systems is limited, evaluators charged with determining the potential impacts of these deployments typically rely on estimation, simulation, and surveying techniques to approximate system impacts.³⁰⁹ Reports also include lessons learned to help improve operational procedures, strategies, and policies.

THE CAPITAL COST OF
PHYSICAL TMC COMPONENTS
CAN RANGE FROM \$1.8 MILLION
TO \$11.0 MILLION PER FACILITY.

TRANSPORTATION MANAGEMENT CENTER CATEGORIES IN THE ITS KNOWLEDGE RESOURCES

Transportation Management Centers

TMC ANNUAL O&M COSTS CAN RANGE
FROM \$50,000 TO \$1.8 MILLION PER YEAR.

Findings

Benefits

A TMC integrates a variety of ITS applications to facilitate the coordination of information and services within the transportation system. Some of these applications perform more effectively because they are supported by other applications within a TMC. As such, while it is difficult to isolate the impacts of a TMC and evaluate them using explicit performance measures, experts agree that without the enhanced operational coordination that a TMC offers, the result would be increased congestion, reduced traffic safety, and noteworthy inconvenience to the traveling public.

A TMC can be implemented as either a virtual system accessible via remote device(s) or a physical system where single or multiple stakeholder operators are located in a permanent structure and have centralized access to multiple applications. Co-locating stakeholder operators can improve interagency coordination and communications resulting in improved efficiency and productivity throughout the transportation network. For example, if one operator's system experiences failures, other operators may be able to implement mitigation responses to ease the impacts on the traveling public.

Overall, the benefits of a TMC vary greatly depending on its purpose, configuration, service responsibilities, performance, and level of integration. Integrated transportation management systems have the potential to produce the following benefits:

- Improved traffic management, advisory strategies, and control actions
- Improved timeliness and accuracy of information provided to the traveling public
- Increased efficiency of maintenance operations
- More effective use of personnel and resources
- Enhanced institutional, procedural, and operational integration and coordination³¹⁰

Costs

The cost of TMCs can vary greatly. Primary cost drivers include the size of the facility, the number of agencies present, and the number of functions performed by the facility.³¹¹ Planners typically examine the following cost categories to help assure costs are accounted for early and budgets can be adequately funded.

TMC facilities, communications, and hardware

The cost of a TMC can depend on the size and complexity of building construction, number of agencies housed, and functionality supported. As illustrated in figure 10, the capital cost of physical components can range from \$1.8 million to \$11.0 million per facility,³¹² and have annual operations and maintenance (O&M) costs that range from \$50,000 to \$1.8 million per year.³¹³ The higher costs reflect the complexity of a large facility that supports multiple agencies and integrates multiple functions. The lower costs are for a smaller facility that supports a single agency or agency function.

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Central hardware costs can exceed \$200,000 if regional communications and system integration are required, and the O&M costs for central hardware can range from \$40,000 to \$55,000 per year.³¹⁴ These costs, however, can be much less for smaller TMCs that do not incur large initial costs for computer systems and work stations, and do not require complex or customized communication systems. Another significant budget item is the visual displays needed for control room operations. The cost of video walls and monitors can range between \$100,000 and \$345,000, and the O&M costs can range from \$35,000 to \$55,000 per year.³¹⁵

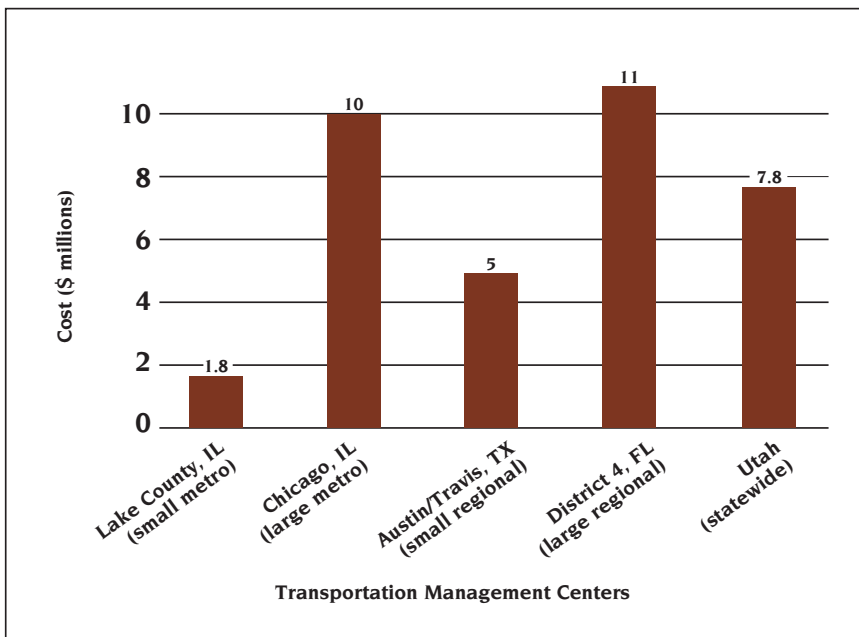


Figure 10 – TMC Initial Capital Costs

System integration and software

The cost of integration can vary depending on the current level of integration and specific operational needs of the transportation management system. Software integration costs vary significantly, ranging from \$250,000 to \$4.0 million. Annual O&M costs can range from \$50,000 to \$100,000.³¹⁶



Telecommunications

Establishing communications between TMCs and field devices can be the most expensive part of a transportation management system and require careful examination of life cycle costs with due consideration given to policy and technical issues. The Tennessee DOT evaluated the life cycle cost of leased service versus an owned service and concluded, based largely on the cost of maintaining a fiber optic communications plant, that leased services that included a favorable maintenance agreement would be more cost-effective.³¹⁷

The cost of installing fiber optic cable can vary greatly. Installation cost increases significantly in areas where new underground conduit is required. For Florida DOT District VI, the cost to install fiber optic cable in existing conduit was estimated at \$25,600 per mile.³¹⁸ However, in Broward County, where new conduit components were required, fiber optic communications cost between \$79,200 per mile and \$105,600 per mile.³¹⁹

Staffing requirements

Proper staffing and scheduling are needed for effective operations. Payroll costs typically account for the greatest percentage of a TMC operating budget. The number of operators, supervisors, and technical staff (i.e., software support, communications support, and systems engineering support) can depend on the size and complexity of the transportation management system, functional role of the TMC, and the hours of operation.³²⁰

The annual staffing costs for a medium to large TMC that provides peak period service or 24/7 operational support can range from \$280,000 to more than \$1.20 million depending on the number of TMC operators, administrative staff requirements, and level of technical support needed.³²¹ The labor costs for a smaller TMC that can provide part-time operator and technical support for limited incident management or special event coverage can cost between \$54,000 and \$130,000 per year.³²² In addition, training during the first year of operations is estimated at \$20,000.³²³

Operations and maintenance

TMC maintenance plans typically include life cycle cost estimates for building facilities, power supplies, central hardware and software, control systems, commercial off-the-shelf (COTS) products, video displays, Web sites, and media connections.³²⁴

Deployment

Figure II shows the functional capabilities of TMCs operated by freeway and arterial management agencies. The results are based on a 2006 survey of 102 freeway management agencies and 170 arterial management agencies. Capabilities reported by a high percentage of both types of TMC include incident management, network surveillance and data collection, and dissemination of data to travelers and other agencies, as well as traffic management for special events and evacuation. In general, a higher percentage of freeway TMCs report individual capabilities, indicating that they perform multiple functions to a greater degree than do arterial TMCs. Functions for which freeway TMCs have a particularly clear advantage are: providing en route information to travelers, conducting environmental monitoring, and carrying out road weather management. On the other hand, arterial agencies much more often report a capability for corridor management and traffic signal coordination.

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The 2006 survey of freeway management and arterial management agencies in the country's 108 largest metropolitan areas is the source of deployment statistics presented later in this chapter.

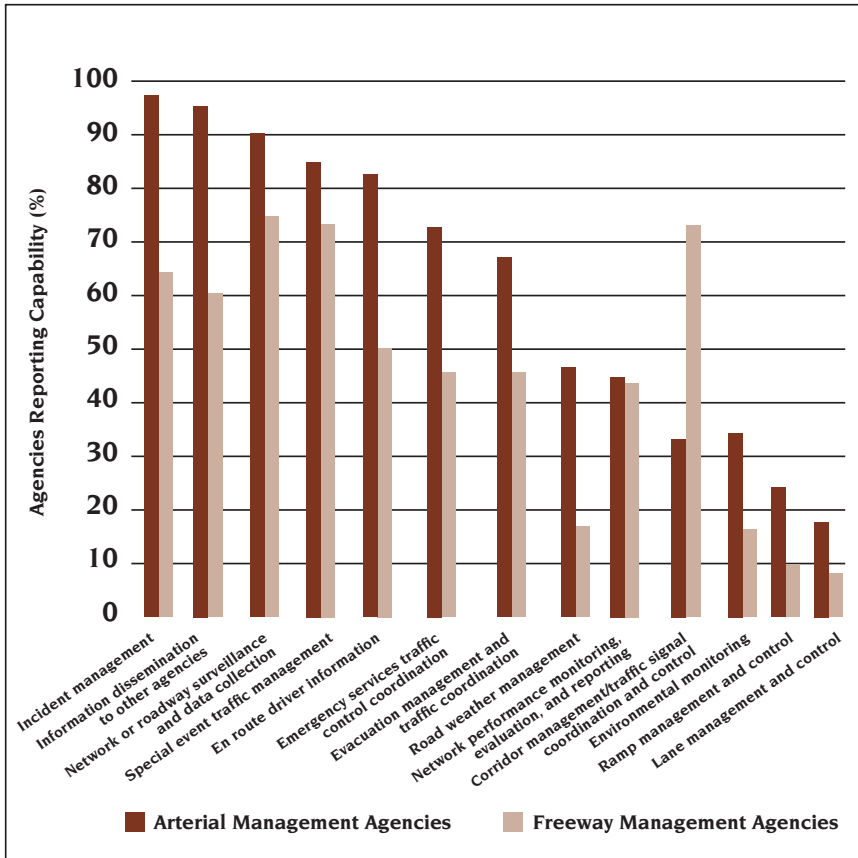


Figure 11 – Functional Capabilities of Transportation Management Centers



LESSONS LEARNED

Integrate emergency information into transportation management center (TMC) operations to improve performance and increase public mobility, safety, and security during regional emergencies.

The effects of both weather and emergency events on transportation operations can be significant and require an effective, coordinated response. Improvements in integrating emergency information into TMC operations result in improved public mobility, safety, and security. Lessons learned for enhancing operations during regional emergencies include:

- Co-locate operations of multiple agencies within the region.

The physical integration of operations leverages the resources of each agency to develop a center with more capabilities. The benefits of shared operations include reduced costs and increased awareness of the actions of other agencies.

- Create a restricted-access Web site for participating agencies.

A Web site with restricted access enables trained partner agencies with password accounts to share data, confident that the data have come from a trusted source, i.e., one of their TMC partners. Along the Pennsylvania Turnpike, TMCs and other authorized organizations access a Web site operated by the Pennsylvania Emergency Management Agency. The restricted-access Web site allows for a two-way flow of highly accurate incident information, with higher reliability than publicly-available Web sites.

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Selected Highlights from the ITS Knowledge Resources on Transportation Management Centers

Transportation Management Centers

TMCs are physical locations used to coordinate the activities of ITS operations. They can be owned or operated by a single agency or multiple transportation agencies and perform an array of functions including data acquisition, command and control, computing, and communications for many types of ITS applications.

Transportation Management Center
Costs
Unit Costs Data Examples (See Appendix A for more detail)
Transportation Management Center subsystem: <ul style="list-style-type: none"> • Basic Facilities and Communications for Large Area: \$4,314K-\$9,860K • Basic Facilities and Communications for Medium Area: \$4304K • Basic Facilities and Communications for Large Area: \$3766K • Video Monitors, Wall for Incident Detection: \$44K-\$80K • Software for Incident Detection: \$83K-\$101K • Labor for Incident Detection: \$751K-\$917K for multiple staff (annually) • Hardware, Software for Traffic Surveillance: \$131K-\$160K • Integration for Traffic Surveillance: \$219K-\$267K • Software for Traffic Information Dissemination: \$17K-\$21K • Integration for Traffic Information Dissemination: \$83K-\$101K
Sample Costs of ITS Deployments
TMC/Traffic Operations Center Facility <ul style="list-style-type: none"> • Illinois: Lake County TMC for advanced signal control cost \$1.8 million.³²⁵ • Texas: A shared regional transportation, emergency, and communications center in Austin and Travis Counties cost \$5 million.³²⁶ • Utah: The Utah DOT TOC that supports road weather management, traffic surveillance, incident management, ramp metering, signal control, and information dissemination cost \$7.8 million.³²⁷ • Illinois: The Chicago TMC that supports emergency management, signal control, and traveler information cost \$10 million.³²⁸ • Florida: Florida DOT District IV TMC shared by four agencies supports incident and emergency management, traffic surveillance, information dissemination, interactive traveler information services (511), and transit management at a cost of \$11 million.³²⁹

Transportation Management Center

Costs

Software and Integration

- **Virginia:** Integration of the Virginia State Police computer-aided dispatch system with the Richmond Smart Traffic Center for enhanced traveler information and incident location data cost **\$250,000**.³³⁰
- **Florida:** In Florida DOT Districts IV and VI, central software and integration costs varied between **\$250,000** for COTS products and **\$2 million** for custom designs requiring software development.³³¹
- **Illinois:** Software development and systems integration at the Chicago TMC cost **\$4 million**.³³²
- **Utah:** Software licensing and updates at the Utah DOT TOC cost **\$5 million**.³³³

Telecommunications

- **Illinois:** Life cycle cost estimates for four different communication network options designed to connect the Illinois DOT District 8 TOC to ITS field devices on 105 centerline miles of roadway range from **\$43 million** to **\$52.5 million**.³³⁴
- **Utah:** The fiber optic network installed through the Salt Lake Valley to connect the CommuterLink system with its field devices cost approximately **\$51.2 million**.³³⁵
- **Florida:** In District VI, the cost to install fiber optic cable in existing conduit over a distance of 21.3 miles was estimated to cost **\$25,600 per mile**. Annual cost estimates to lease telephone lines with T1 and T3 capability ranged from **\$5,600 to \$10,000** and **\$25,000 to \$132,000**, respectively.³³⁶
- **Florida:** In Broward County, the cost to install fiber optic cable in new conduit (with junction boxes, splicing, and terminators) was estimated to range from **\$79,200 to \$105,600 per mile**.³³⁷

Labor

- **Utah:** The costs of personnel working at the CommuterLink system are estimated at **\$400,000 per year**.³³⁸
- **Florida:** The labor costs to operate the TMCs in three DOT Districts ranged from **\$300,000 to \$1.2 million per year**.³³⁹
- **United States:** Estimated personnel operations cost (system operators, administration, and technical support)³⁴⁰
 - Regional TMC (27 staff, continuous 24/7 operations): **\$1.3 million per year**
 - Large TMC (seven staff, weekday 12/5 operations): **\$476,500 per year**
 - Medium TMC (four staff, weekday peak period 8/5 operations): **\$277,900 per year**
 - Small TMC (one staff equivalent, special event or incident response only): **\$53,600 per year**
- **Arizona:** Labor costs for the Arizona TMC are estimated at **\$920,000 per year**. Staffing includes four supervisors, nine operators, and three part-time interns that support 24/7 statewide incident management, traffic management, and traveler information functions.³⁴¹

LESSONS LEARNED

Prioritize constraints when designing a transportation management center (TMC) work schedule to help alleviate the complexity of scheduling problems.

TMC staffing and scheduling depends on a number of factors. Policies establish the work rules that are applied in the context of employee availability and preferences, work demands, and budgetary limitations, all of which create scheduling constraints. Conflicting constraints often cause problems that must be resolved by the schedule administrator to generate the most desirable schedule.

- Recognize that equipment availability and the size of a TMC are constraints because they limit the number of employees who can work during a shift.

The number of operators who can work during a shift is constrained by the number of workstations available, which in turn may be limited by space or funds. The consideration of equipment must also include contingencies if a piece of equipment should need to be repaired or replaced.

- Prioritize constraints when designing a work schedule.

The complexity of generating a staffing schedule increases as the number of constraints increase. One method to help alleviate the complexity of scheduling problems is to prioritize the constraints. A common method used to prioritize constraints using software is to classify each constraint as a hard constraint that must be satisfied or a soft constraint that may be violated to resolve scheduling conflicts.



Transportation Management Center

Costs

Operations and Maintenance

- **United States:** Estimated TMC operations cost (building O&M, utilities, communications equipment and services, computers and software licenses, and miscellaneous).³⁴²
 - Regional/Statewide TMC (continuous 24/7 operations): **\$1.8 million per year**
 - Large TMC (weekday 12/5 operations): **\$180,700 per year**
 - Medium TMC (weekday peak period 8/5 coverage): **\$109,400 per year**
 - Small TMC (special event or incident response only): **\$46,900 per year**
- **Arizona:** The Maricopa Association of Governments estimated it would cost **\$660,000 per year** to maintain regional communications between the TMC, local facilities, and public safety centers.³⁴³
- **Arizona:** Operating costs for the Arizona TMC are estimated at **\$1.08 million per year** with a breakout as follows:³⁴⁴
 - Equipment and supplies: **\$320,000**
 - Operations support: **\$300,000**
 - Utilities: **\$200,000**
 - Building maintenance: **\$120,000**
 - Software licenses: **\$100,000**
 - Training: **\$40,000**
- **Florida:** Florida District IV TMC maintenance costs range from approximately **\$294,000 (2005) to \$320,000 (2006) per year**.³⁴⁵

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