IMPROVING TRANSPORTATION SYSTEMS MANAGEMENT AND OPERATIONS (TSM&O)

Capability Maturity Model Workshop White Paper

Culture

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Background

Research done through the Second Strategic Highway Research Program (SHRP 2) determined that agencies with the most effective transportation systems management and operations (TSM&O) activities were differentiated not by budgets or technical skills alone, but by the existence of critical processes and institutional arrangements tailored to the unique features of TSM&O applications. The significance of this finding has been validated in 40 State and regional self-assessment workshops using the Capability Maturity Model (CMM) and its six dimensions of organizational capabilities. This white paper focuses on Culture as one of the central dimensions of capability needed to support effective TSM&O including understanding and internalization of the business case, leadership via in-reach and outreach, and development of supporting policy, program and authorities. It summarizes the TSM&O state-of-the-practice based on the workshops and subsequent implementation plans developed at 23 sites selected by FHWA and the American Association of State Highway and Transportation Officials (AASHTO) as part of the SHRP 2 Implementation Assistance Program.

Scope

Research done through the Second Strategic Highway Research Program (SHRP 2) determined that agencies with the most effective transportation systems management and operations (TSM&O) activities were differentiated not by budgets or technical skills alone, but by the existence of critical processes and institutional arrangements tailored to the unique features of TSM&O applications. The significance of this finding has been validated in 40 State and regional self-assessment workshops using the Capability Maturity Model (CMM) and its six dimensions of organizational capabilities. This white paper focuses on Culture as one of the central dimensions of capability needed to support effective TSM&O including understanding and internalization of the business case, leadership via in-reach and outreach, and development of supporting policy, program and authorities. It summarizes the TSM&O state-of-the-practice based on the workshops and subsequent implementation plans developed at 23 sites selected by FHWA and the American Association of State Highway and Transportation Officials (AASHTO) as part of the SHRP 2 Implementation Assistance Program.

State of the Practice Findings for TSM&O Culture

Key findings from the workshops included:

General

The legacy culture of State DOTs is civil engineering with a capital project orientation. While most agencies have accepted the notion that it is not possible to "build our way out of congestion," the business case for TSM&O is not widely understood, although a few agencies have begun to incorporate operational objectives into their formal policy. This same situation was reported at the metropolitan level. TSM&O is just beginning to be considered for formal

"program" status with its own line item budget and top level representation in executive leadership. Lack of this formal status appears to reduce the presence of TSM&O in the resource allocation process. Generally executive leadership exhibits only modest interest/visibility with respect to TSM&O – with a few notable examples that have spurred significant program improvement. However, new technology is raising the profile of operations as well as public expectations.

Technical Understanding and Business Case

- **Legacy culture.** The primary orientation of most State DOTs remains focused on the delivery of capital projects that dominates agency policy, program, and public communications. This is different in nature from the 24x7 real-time service orientation of TSM&O. While some individual TSM&O strategies are well understood, the concept of TSM&O as a multi activity coordinated "program" is just beginning to evolve in most agencies and TSM&O is rarely understood or packaged as a suite of capabilities and services. Some concern was expressed about the ability of State DOTs to play an appropriate role in new applications and systems.

- **Making the TSM&O business case.** With funding shortfalls and capacity constraints, it is increasingly recognized that is not possible to "build our way out of congestion." Agency TSM&O staff are realizing that they can capitalize on this recognition by highlighting the unique payoffs from highly cost-effective TSM&O solutions and new technology to make a formal business case and secure a clear role for TSM&O within a State DOT's program. Effective business-case-making is hampered by a lack of data and credible benefit-cost information, especially at the local level.

- **External reinforcement for the business case.** The value of improving TSM&O has often been demonstrated by agency response to shortcomings in the face of "unplanned events" (e.g., large-scale crashes or weather crises), by effectively managing large "planned special events" (sports, conventions), and by supporting specific freight, recreation, or border crossing strategies. National activities by FHWA, SHRP 2, and AASHTO have also increased the visibility of TSM&O.

Leadership/Champions

- **Top management and middle management champions.** By and large, TSM&O lacks formal State DOT "program" status. As a result, the momentum of TSM&O programs substantially depends on middle management "champions," who are committed to improving TSM&O and who exercise persuasion and "intra-preneurship" within their agencies to access resources and move projects forward. Reliance on these individuals, rather than on formal program structure and authority, renders progress vulnerable to staff turnover.

Outreach – Internal and External

- **Internal outreach.** Non-TSM&O State DOT staff with some level of involvement in specific TSM&O strategies (e.g., maintenance and safety staff who respond to incidents and weather outcomes) have a greater understanding of TSM&O. However, staff in non-operational units, such as design, planning and project development, are less likely to include TSM&O considerations in their activities. Some states/regions have incorporated consideration of TSM&O into their project development processes.

- **External outreach.** Promoting the TSM&O mobility mission among State DOT partners often takes special initiatives. With public safety entities (e.g., law enforcement, fire and emergency services), it is often promoting a priority mix that fully incorporates mobility objectives. With MPOs and local government leaders (who are largely focused on capital projects of interest to their constituencies), it is promoting the unique payoffs of traffic management investments. State DOT outreach efforts often use the visibility of major events or high priority development objectives to make the case for TSM&O.

Policy/Program Status/Authorities

- **TSM&O in agency policy.** Although some State DOTs now include "congestion reduction," "efficiency," and "mobility" as one of several objectives, and system performance is appearing on State DOT websites, TSM&O is typically not a formal State DOT program with clear embodiment in an agency's policy, mission or budget. TSM&O is rarely a separate first-level division equivalent to project development and maintenance. This policy status detracts from the ability for TSM&O to compete for management, staff, and financial resources. It also limits organizational accountability for operational performance.

- **Legal authorities**. The roles and activities of State DOTs and their public safety partners on public roads are defined by statute as well as conventional practice. Most States have obtained the necessary statutory authority for such measures as Quick Clearance, Move It, and emergency access use of shoulders. In most States, by law or formal agreement, public safety entities usually have incident command. In this context, State DOTs must indirectly exert their influence to promote the importance of mobility through MOUs and co-training with their partners.

- **Funding constraints.** TSM&O is rarely supported by a dedicated multiyear budget determined as part of a top-level resource allocation. Although many TSM&O expenditures are an eligible use of Federal aid, many States have legal constraints on the use of State capital and maintenance funding for TSM&O activities. Several States include TSM&O funding as a subcategory of "operations" or "maintenance", but information on rates of expenditure are rarely readily available or explicit.

- **Roles of public vs. private sector.** Staffing limitations and the need for special technical expertise associated with new technology have led to a substantial level of outsourcing to

consultant organizations or contracted staff, especially for activities such as TSM&O planning, systems engineering, performance data acquisition, TMC staffing, ITS device maintenance, and even safety service patrol. The reliance on outsourcing stimulated workshop discussion on the broader issue of what "core" functions and capabilities should be retained in-house to support assurance of best practice.

Synergism

TSM&O Culture is closely related to and synergistic with other dimensions of capability, especially Performance Measurement. Ideally an agency operates with senior management support for a "culture of performance" and recognition that a TSM&O Culture requires external Collaboration because its success is dependent on interagency cooperation. For the agency as a whole, changes in the dimension of Organization and Staffing also often are needed to support an operational culture.

State DOT and Regional Implementation Plan Priorities

A majority of workshop sites included one or more actions addressing Culture in their implementation plans. Among those actions, the highest priorities were:

- Development of a business case – conduct of a marketing plan or campaign that would increase the level of awareness, understanding, and most important, support for TSM&O

- Development of outreach or communication material to disseminate the purpose and successes of TSM&O

Best Practices and National Needs

This white paper describes example best practices and reference material related to the identified implementation plan priority needs. The paper also suggests supportive national actions to improve TSM&O Culture; developing resources to support effective TSM&O business cases; clarifying the TSM&O "brand" at the national and association level – including a focus on the National Operations Center of Excellence (NOCoE); and encouraging recognition that a TSM&O culture is essential to capitalizing on the range of emerging technologies related to automated and connected vehicles. Important roles are seen for FHWA, AASHTO, and the NOCoE in supporting these efforts.

1.0 TSM&O Capability Maturity Self-Assessment Program: General Background

Many State DOTs and regions have recognized the importance of more effective TSM&O to improving customer service and system performance. Best practice TSM&O is being developed as an integrated program to optimize the performance of existing multimodal infrastructure through implementation of systems, services, and projects to optimize capacity and improve the security, safety, and reliability of the transportation system.

1.1 TSM&O and the Capability Maturity Model

The Second Strategic Highway Research Program (SHRP 2) included a Reliability Focus Area that produced research and products on many important data, analytic, and design issues, as well as process and applications improvements. One project identified the institutional characteristics of the agencies with the more effective TSM&O activities.[1] This research determined that agencies with the most effective TSM&O activities were differentiated not by budgets or technical skills alone, but by the existence of critical processes and institutional arrangements tailored to the unique features of TSM&O applications. These processes and institutional arrangements are defined by six critical dimensions: business processes; systems and technology; performance measurement; agency culture; organization and staffing; and collaboration.

Using these critical dimensions, the research project adapted concepts from the Capability Maturity Model (CMM) – widely used in the Information Technology industry – to develop a self-assessment framework designed to help transportation agencies identify their current strengths and weaknesses and related actions needed to improve their capabilities for effective TSM&O – in effect, a roadmap for "getting better at getting better."

1.2 CMM Self-Assessment Workshops

The TSM&O CMM framework has been used as the basis for the development of a facilitated one-day self-assessment workshop process for State DOTs and regions. The CMM workshops are intended to improve the effectiveness of TSM&O applications and activities by assisting the unit managers and key technical staff with day-to-day oversight of TSM&O-related activities, as well as DOT partners, including public safety agencies, MPOs, local governments, and the private sector.

The workshop framework provides a structured focus on the six dimensions of capability, together with a facilitated self-assessment process in which participants evaluate their current activities and arrangements according to criteria from the CMM framework defining levels of

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[1] *Institutional Architectures to Improve Systems Operations and Management*, SHRP 2 L06, 2012.

capability. The current challenges and problems identified by workshop participants are used to identify actions needed to improve capability, which are subsequently embodied in an implementation plan to improve the effectiveness of TSM&O.

Senior agency leadership is involved in a pre-workshop briefing and their approval of the implementation plan is required as a precondition of Federal financial assistance for the SHRP2 Implementation Assistance program sites.

1.3   The Capability Maturity Self-Assessment Framework

The CMM self-assessment framework is structured in terms of six dimensions of capability. Three dimensions are process oriented:

- **Business Processes,** including planning, programming, and budgeting (resources);

- **Systems and Technology,** including use of systems engineering, systems architecture standards, interoperability, and standardization; and

- **Performance Measurement,** including measures definition, data acquisition, and utilization.

Three dimensions are institutional:

- **Culture,** including technical understanding, leadership, outreach, and program legal authority;

- **Organization and Staffing,** including programmatic status, organizational structure, staff development, and recruitment and retention; and

- **Collaboration,** including relationships with public safety agencies, local governments, MPOs, and the private sector.

For each of these six dimensions, the self-assessment utilizes four criteria-based "levels" of capability maturity that indicate the direction of managed changes required to improve TSM&O effectiveness:

- **Level 1 – "Performed."** Activities and relationships largely ad hoc, informal, and champion driven, substantially outside the mainstream of other DOT activities.

- **Level 2 – "Managed."** Basic strategy applications understood; key processes' support requirements identified and key technology and core capacities under development, but limited internal accountability and uneven alignment with external partners.

- **Level 3 – "Integrated."** Standardized strategy applications implemented in priority contexts and managed for performance; TSM&O technical and business processes developed, documented, and integrated into DOT; partnerships aligned.

- **Level 4 – "Optimizing."** TSM&O as full, sustainable core DOT program priority, established on the basis of continuous improvement with top-level management status and formal partnerships.

This structure of critical key dimensions of capabilities and their levels as self-assessed was used as the basis for the determination of the current state of the practice in the Culture dimension as discussed in the sections that follow.

1.4 CMM Self-Assessment Workshops Analyzed

This white paper synthesizes findings, as of December 2014, from 23 of 27 sites selected by FHWA and AASHTO in 2013 as part of the SHRP 2 Implementation Assistance Program. These 23, listed in Table 1.1, include 19 State DOTs (statewide or district focus) and four regional entities (including two MPOs).[2]

Table 1.1 Self-Assessment CMM Workshop Locations Analyzed in this White Paper

Arizona	NOACA (Cleveland, OH)
California	Ohio
Colorado	Oregon
Florida District 5 (Orlando)	Pennsylvania
Georgia	Rhode Island
Iowa	South Dakota
Kansas District 5 (Wichita)	Tennessee
Maryland	Utah
New Jersey	Washington, D.C.
Michigan	Washington State
Missouri	Whatcom (Whatcom County, Washington)
NITTEC (Buffalo, NY)	

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[2] For a detailed discussion of prior workshops and those selected for the SHRP 2 Implementation Assistance Program, see the Organizing for Reliability – Assessment and Implementation Plan Development Final Report.

2.0 Summary of all Capability Dimensions

As background to this discussion of the Culture dimension in this white paper, it is useful to understand all the CMM dimensions in terms of the comparative capability levels and related initiatives. Table 2.1 presents the range of self-assessment levels by CMM dimension and capability level for the 23 workshop locations analyzed in this white paper.

Table 2.1   Workshop Self-Assessment Levels Distribution by Dimension (23 Workshops)

Dimension	Capability Self-Assessment			
	Level 1 Performed	Level 2 Managed	Level 3 Integrated	Level 4 Optimizing
Business Processes	11	10	2	0
Systems and Technology	7	12	3	1
Performance Measurement	9	11	3	0
Culture	8	11	4	0
Organization and Staffing	8	9	6	0
Collaboration	4	12	6	1

Note: Workshop self-assessment scores were often augmented with a "plus" or "minus" or given as a fraction (e.g., 1.5). For the purpose of the exhibit, "pluses" and "minuses" were ignored and all fractions were rounded to a whole number (with one-halves rounded down).

Self-assessment "scoring" is subjective, is specific to each state/region, and represents the consensus of workshop participants. The scores cannot be used for cross-State comparison, as some states/regions were tougher self-graders than others were. Nevertheless, within a given state/region, the scores for each dimension appear to reflect the relative level of capability among the dimensions. However, certain general conclusions can be drawn:

• Most locations assessed themselves at the "performed" or "managed" level (often somewhere in between) for most dimensions.

• Only two locations rated themselves as Level 4 in specific dimensions.

• Only a few agencies indicated reaching the level of "integrated" on more than two dimensions.

• While the aggregate distributions among several dimensions were similar (see Figure 2.1), this result masks very different distributions within individual agencies; that is, strengths and weakness differed among agencies responding to varying conditions.

- Collaboration and Systems and Technology are the strongest dimensions; for Collaboration, this reflects in part the impact of recent FHWA incident management training and other collaboration outreach; for Systems and Technology, this reflects an advancement in technology deployment over the past 10–15 years.
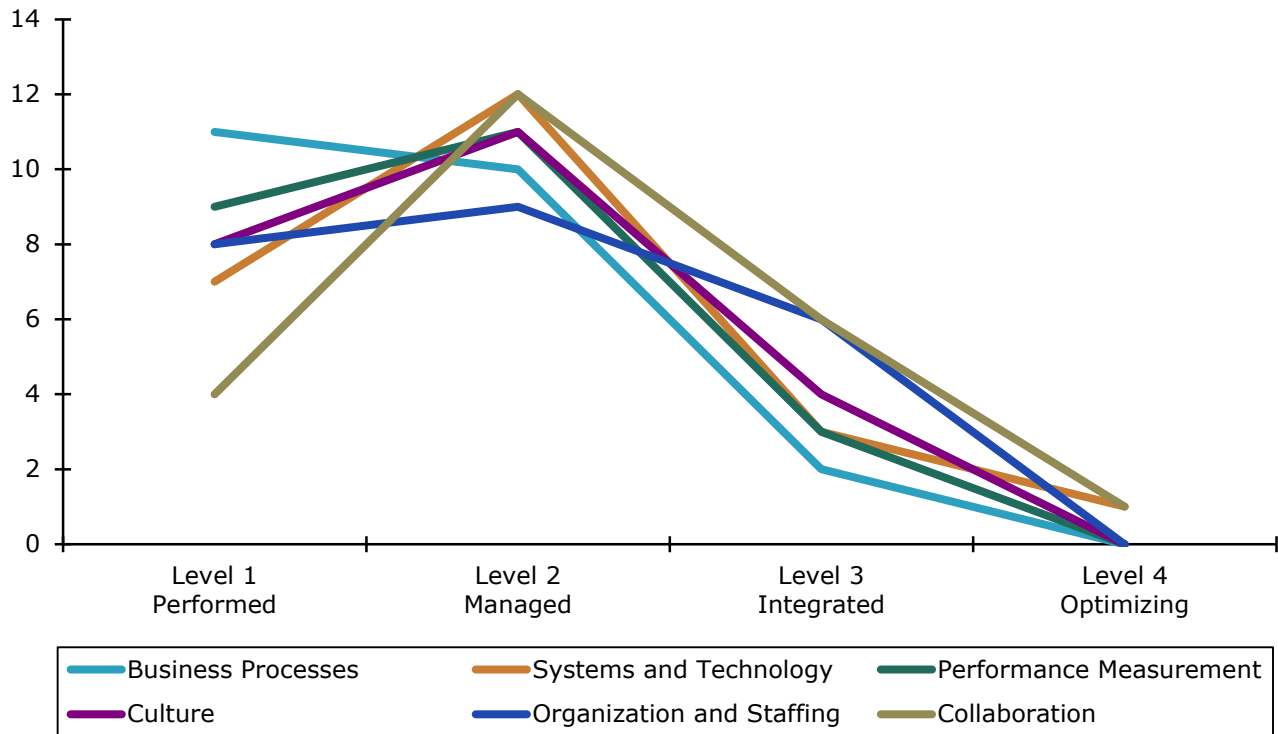
Figure 2.1 Graph. Distribution of Self-Assessments (23 Workshops)

(Source: Cambridge Systematics, Inc. and Parsons Brinckerhoff.)

Within a given dimension, there is often a significant gap between best practice and average practice among States. Even within individual States, progress in improving capabilities across the six dimensions is uneven. In many cases, however, there is visible change and strong staff leaders that are fully aware of what best practice is and are working within their institutions to develop essential capabilities.

2.1   Synergies among Dimensions of Capability

One of the most important findings of the SHRP 2 research, clearly validated in the workshops, was the apparent synergy among technical and institutional dimensions, as suggested in Figure 2.2. The dimensions of capability appear to be highly interdependent, such that it is difficult to improve a current level of capability in one dimension without simultaneously improving other dimensions that support it. This is reflected by the narrow spread in capabilities found among all workshops. As examples, workshop participants noted that

strategic planning is hampered by lack of performance data; business processes were hampered by lack of staff capabilities; and reorganization was impossible without top management buy-in (Culture).
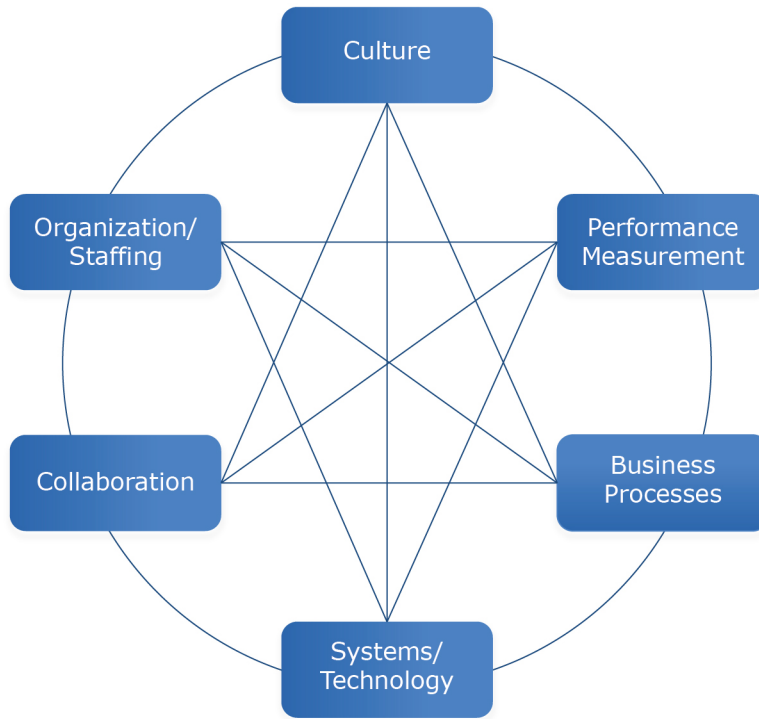
Figure 2.2 Graph. Synergy among Dimensions of Capability

(Source: Cambridge Systematics, Inc. and Parsons Brinckerhoff.)

2.2 General Implementation Plan Priorities for All Six Dimensions

Essential actions and products identified through the workshop and implementation plan process are presented below to establish some context regarding consideration of implementation plan recommendations for all six dimensions from the 23 workshops. A wide variety of actions are recommended across the six dimensions, including plans, processes, agreements, business cases, and organizational and staffing recommendations, each of which has a mutually reinforcing effect on overall capability.

Business Processes

- Develop a statewide/regional TSM&O program plan

- Integrate TSM&O into the conventional State and metropolitan planning process

Systems and Technology

- Update both regional and statewide system architectures for new/emerging TSM&O applications

- Improve ITS systems procurement process and/or relationships with agency IT unit

Performance Measurement

- Develop a plan for performance measures, data, and analytics

- Secure agreement from the public safety community on measures for incident management

Culture

- Develop a persuasive business case for TSM&O

- Develop a communications/outreach plan/branding for stakeholders

Organization and Staffing

- Define an appropriate organizational structure for the TSM&O program

- Identify core capabilities needed and develop related staffing and training plan

Collaboration

- Improve collaboration related to TIM including participating in TIM training and establishing a forum for building interagency relationships

- Align partners' TSM&O objectives and interact on a regular basis

3.0 State of the Practice for the Culture Dimension

3.1 The Culture Dimension

Culture is the most basic institutional dimension of transportation agencies. It embodies shared values, vision, and beliefs, including common technical perspectives. With regard to TSM&O in State DOTs, Culture is reflected in an accepted business case, policy and program status, legal authority, legal status, and communications messaging, both internally and exter-nally. Improvements in other capability dimensions are dependent on a high degree of shared culture.

The capability-level criteria used in the self-assessments for this dimension are shown in Table 3.1.

Table 3.1   Self-Assessment Workshop Levels of Capability Maturity for Culture

	Culture Criteria for Level Achievement
Capability Level 1	Individual staff champions promote TSM&O
Capability Level 2	Jurisdictions' senior management understands TSM&O business case and educates decision makers/public
Capability Level 3	Jurisdictions' mission identifies TSM&O and benefits with formal program and achieves wide public visibility/understanding
Capability Level 4	Customer mobility service commitment accountability accepted as formal, top-level core program of all jurisdictions

Among the 23 workshops, the average self-assessed capability level for Culture is 1.92, with four sites at Level 3, eight sites at Level 1, and the remainder slightly above Level 2. Figure 3.1 depicts the scoring distribution relative to the other dimensions. Across all workshop locations, Culture was frequently cited for inclusion in implementation plans, behind Business Processes and Systems and Technology.
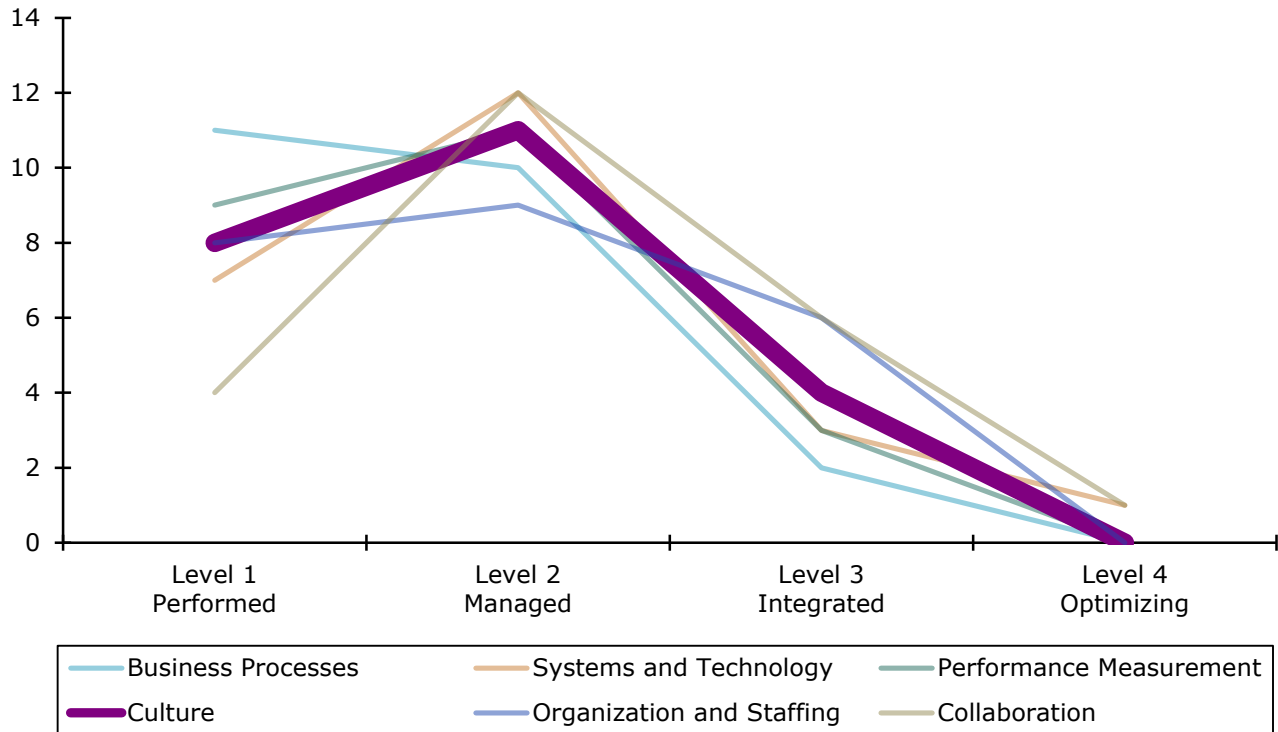
Figure 3.1 Graph. Culture Compared to Other Dimensions of Capability

(Source: Cambridge Systematics, Inc. and Parsons Brinckerhoff.)

The discussion of the state of the practice regarding the Culture dimension is divided into key elements based on the approach used in the *AASHTO Guide to Transportation Systems Management and Operations*:

- Technical Understanding and Business Case

- Leadership/Champions

- Outreach – Internal and External

- Policy/Program Status/Authorities

The following sections discuss key observations regarding the current state of play in each element.

3.2 Technical Understanding and Business Case

There were consistent themes in the discussion of the Culture dimension: participants lacked the material required to make an effective business case, and advancing the status and resource claims of TSM&O required persuasive examples and technical justification.

- **Legacy culture.** Culture, technical understanding, and the business case are closely related. The primary orientation of most State DOTs remains the delivery of capital projects, which dominates agency public outreach, web sites, and publications. However most senior managers recognize the constraints on capacity additions and largely understand the conventional components of TSM&O, such as incident and road weather management and traveler information. Nonetheless, the term "operations" as applied to TSM&O was a source of some confusion, since for many DOTs, "operations" refers to all of the day-to-day activities of the agency, including things like mowing and litter collection. Conventional TSM&O strategies have evolved independently of these types of day-to-day activities. Rarely is TSM&O understood or packaged as a suite of capabilities and services. Among headquarters TSM&O staff, the perspective regarding levels of payoff is often limited to the specific applications experience within their agency, which varies widely. In larger states, the understanding of TSM&O's role is often clearer since district engineers and their direct reports have more hands-on contact with operational matters. Finally, State DOTs often operate under a legacy 9-to-5 culture, whereas TSM&O demands a 24-7 focus on continuous, real-time strategy applications and response to irregular events such as incidents and weather.

- **Making the TSM&O business case.** Increasingly, TSM&O staff within agencies are realizing that a formal business case must be made to demonstrate the specific benefits and cost effectiveness of TSM&O activities in terms of agencies' stated customer service mission. In this manner, TSM&O can better compete for internal attention and resources. While most of the more urban states have taken the public position that it is not possible to "build our way out of congestion," few States have yet developed a formal business-case document to support focusing on TSM&O, although a few States and MPOs have produced considerable supporting material. Most participants noted both a lack of locally derived benefit-cost information, and in the case of some of the data available from national sources, high B/C ratios that were often not considered credible because they were so high. Most workshops concluded that a formal business case was needed to secure a clear formal role for TSM&O within a State DOT's program. Many considered development of a TSM&O business-case document as a top priority.

- **External reinforcement for the business case.** Participant discussions in the workshops indicated that several factors have promoted the value of TSM&O to both top management and external constituencies:

  - Funding shortfalls and agency cutbacks have drawn attention to the potential payoff of low-cost, highly cost-effective TSM&O activities. A few State DOTs – especially those with major urban areas – have taken the public position that it is not possible to "build our way out of congestion" and introduced an explicit program focus on TSM&O.

  - In a few cases, improved TSM&O is being linked to the support of specific economic activity such as freight movement, recreation area access, or border crossings.

 – Some of the more aggressive TSM&O activities were stimulated by experiences arising from "major events" – both *planned* (such as major athletic events or conventions) or, *unplanned* such as major crashes or weather events where incident management was clearly (and often publically) unsatisfactory. These events revealed the need for, or lack of, effective systems management in a publicly and politically visible fashion and increased attention accorded to TSM&O by State governments.

 – FHWA, TRB, SHRP 2, and AASHTO activities have increased the visibility of TSM&O. The FHWA workshops, training and webinars, support of interstate coalitions, and the organization of the National Operations Center of Excellence have lent increased visibility, understanding, and credibility to TSM&O. These activities also have produced national visibility for key State DOT and MPO staff and supported their participation in national activities.

3.3 Leadership/Champions

Agency culture can be substantially affected by individuals who are formal or even informal leaders.

- **Middle management champions.** With few exceptions, TSM&O lacks formal DOT "program" status: statewide TSM&O activities are not accorded top-level division status, and no senior manager is exclusively responsible for it. As a result, the momentum of TSM&O programs substantially depends on middle management "champions," who are committed to improving TSM&O, who are aware of the state of the art, and who exercise persuasion and intrapreneurship within their agencies to access resources and move projects forward.

  These champions appear at several distinct levels in workshop sites. Among workshop participants, the strongest advocates for TSM&O in smaller states are DOT headquarters' middle managers, who possess the greatest technical knowledge of TSM&O potential and hands-on experience. In larger states with major metropolitan areas, these advocates may be TMC managers, key MPO staff, or even district engineers. While the role of these champions is critical in advancing several State DOT programs, the reliance on individuals, rather than on formal program structure and authority, renders progress vulnerable to staff turnover.

- **Top management.** With some exceptions, top managers in State DOTs and MPOs have focused their time on major capital project activities and have not exercised leadership visibility regarding TSM&O, either internally or externally. This situation is exacerbated by the high rate of CEO turnover and by the increasing number who come into transportation agency leadership from outside the highway or engineering arena. As indicated in senior leadership meetings, program priorities lie with the major capital programs, and TSM&O has secondary status as reflected in specific management actions and resource allocations. In some cases, major events have elevated the importance of certain TSM&O actions (emergency, weather, and special-event management) to a level of policy priority – not

just in State DOTs but even within State government administrations – leading to increased TSM&O focus and resources.

3.4 Outreach – Internal and External

Given the importance of collaboration for effective TSM&O, the culture of both internal and external "partners" is important to State DOT effectiveness.

- **Internal outreach.** Branch and district managers in State DOTs focus primarily on capital projects, maintenance, safety, and planning; the significance of congestion and history of major events and incidents notably influence the level of appreciation for the role of TSM&O. Staff with some level of involvement in specific strategies (e.g., maintenance and safety staff who respond to incidents and weather outcomes) have greater contact with TSM&O activities. Geography also is important: rural states focus on one or two TSM&O activities (particularly truck incidents and weather-related issues), whereas urban states tend to have a more programmatic approach that involves several activities, including freeway and arterial management, signalization, and special events. Staff in nonoperational units, such as design, planning and project development, are less likely to include TSM&O considerations in their activities, although a few states have incorporated consideration of TSM&O into their project development processes.

- **External outreach.** Public safety stakeholders (e.g., law enforcement, fire and emergency services, towing and recovery operators) increasingly understand the overlap between their own primary missions and traffic management. This perspective is stimulated by their own emergency management focus and is reinforced by transportation-related training initiatives. Traffic incident management team formation and co-training are increasingly common. While many local governments are system operators (arterials) in their own right and understand basic TSM&O concepts as they apply to their operating priorities, their focus is typically on their own jurisdictions' facilities. At the MPO level, significant traffic operational improvements (e.g., equipment upgrades, coordination, retiming initiatives) gain minimal support among elected and appointed board members who are typically focused on capital projects of interest to their constituencies. For other key external stakeholders with business interests related to capital investment (consultants, contractors, developers), TSM&O is of marginal interest. In terms of public education, State DOT outreach efforts and attempts to generate understanding and support from stakeholders have been modest, except in major problematic corridor contexts where, for example, weather or economic development impacts are highly visible and the relevance of TSM&O is most apparent. Regarding the general public and their elected officials, lack of robust business-case material is a major handicap, especially in the context of gaining public program understanding and support.

3.5 Policy/Program Status/Authorities

In transportation agencies, activities conceived as formal "programs" are accompanied by a set of long-standing formal institutional conventions and processes that are designed to provide

sustainability, resource sufficiency, capability improvement, and clear public- and private-sector roles.

- **TSM&O in agency policy.** Achievement of formal TSM&O program status is rare. Evidence of this would be clear embodiment in an agency's policy and mission, the individual agency's budget-line item, a separate first-level division, program leadership at an influential level within the agency, and formal resource allocation trade-offs between capacity and operations. This lack of policy status detracts from the ability of TSM&O to compete for management, staff, and financial resources. Similarly, it does not present itself as a promising career opportunity. At present, TSM&O exhibits a range of level of maturity among the workshop locations. Only one workshop site includes TSM&O in its formal DOT mission statement language that puts operating the system on par with system development and system preservation; however, several State DOTs now include "congestion reduction," "efficiency," and "mobility" as one of several objectives, and a few of these have standalone TSM&O strategies and multiyear program plans and budgets with full formal program apparatus including mission objectives, performance measures, and budget. Finally, national, State, and professional emphasis on accountability and performance management has stimulated an increasing number of publicly visible dashboards on agency websites, including measures of service and/or congestion (see the Performance Measurement dimension white paper).

- **Legal authorities.** The roles and activities of State DOTs and their public safety partners on public roads are defined both by statute as well as by conventional practice. Most states have obtained the necessary statutory authority for such measures as Quick Clearance, Move It, and agency use of shoulders for emergency access – although enforcement of these measures is reported to be uneven. In most states, by law or formal agreement, public safety entities usually have incident command, which varies by State between law enforcement and fire departments. In this case, State DOTs must exert their influence regarding the importance of mobility through MOUs and co-training with their partners.

- **Funding constraints**. TSM&O is rarely supported by a dedicated multiyear budget determined as part of the top-level resource allocations. Although most TSM&O expenditures are an eligible use of Federal aid, many states have legal constraints on the use of State capital and maintenance funding for TSM&O activities. In some cases, these constraints may actually reflect precedents regarding use of certain funds established over the years rather than actual legal prohibitions on how the funds can be used. Several states include TSM&O funding as a subcategory of "operations" or "maintenance", but information on rates of expenditure are rarely readily available or explicit. In almost all cases, capital and staff resources and authorities are subparts of other programs (typically maintenance) or are largely available on an ad hoc basis for occasional and specific initiatives.

- **Roles of public vs. private sector**. The prevailing legacy public works culture of transportation agencies is to manage "operations" with agency staff. However, staffing limitations and the need for special expertise have led to a substantial level of outsourcing

to consultant organizations or contracted staff, especially for intermittent activities such TSM&O planning, systems engineering, performance data acquisition, TMC staffing, ITS device maintenance, and even safety service patrol. Several State DOTs with higher self-assessment levels outsource many of these functions.

A variety of conventions are evolving regarding using outsourcing. One example is safety service patrols that have been set up under a series of regimes that vary with the use of agency staff versus contracted staff, agency versus private sponsorship, and uniformed personal and service emphasis. Another example is TMC staffing that also includes a range of approaches from outsourcing contract floor staff to outsourcing overall TMC management.

The use of outsourcing, however, stimulated workshop discussion on the broader issue of what "core" functions and capabilities should be retained in-house to support assurance of best practice. It was also noted that outsourcing has provided an effective way to introduce performance management on a contract basis. Several states build performance requirements into their operational contracting with private vendors/ suppliers.

4.0 Relationships to Other Capability Dimensions

The workshops illuminated interdependencies among the Culture dimension and other dimensions of capability.

4.1 Synergy

As noted in Section 3.1, the synergies among the six TSM&O CMM dimensions are key defining characteristics of their critically. Each dimension is directly dependent on other specific dimensions to support improving capabilities. The three process dimensions are interdependent, but they, in turn, are also dependent on supportive institutional dimensions.

TSM&O Culture – technical understanding and business case, leadership and champions, outreach and program status – is the most difficult dimension to evaluate because it denotes values and attitudes rather than evidence of a distinct process of organizational structure. However, workshop discussions indicated that Culture was closely related to and synergistic with several other dimensions of capability, both technical and institutional. The legacy culture of most State DOTs reflects a public service, civil engineering, project-oriented, 9-to-5 orientation. Real-time systems operational management, however, has a different orientation built on strong systems engineering, network-level and information management focus, and a 24x7 commitment.

Participants, therefore, noted the impact of culture on other dimensions, as illustrated in Figure 4.1. Examples include:

- The growing State DOT focus on performance supports development of measurement for systems management;

- The pace of senior management's understanding of the implications of TSM&O affects whether and how this is reflected in organizational change;

- The level of interagency collaboration critical to many TSM&O applications is impacted by the level of senior management peer outreach; and

- The adjustment of business processes to accommodate TSM&O requires agency-wide appreciation of the significance of systems operations.

As indicated by these examples, changes in culture involve an entire agency, and changes in many of the legacy arrangements and procedures, in turn, require aggressive top-down technical understanding and leadership.
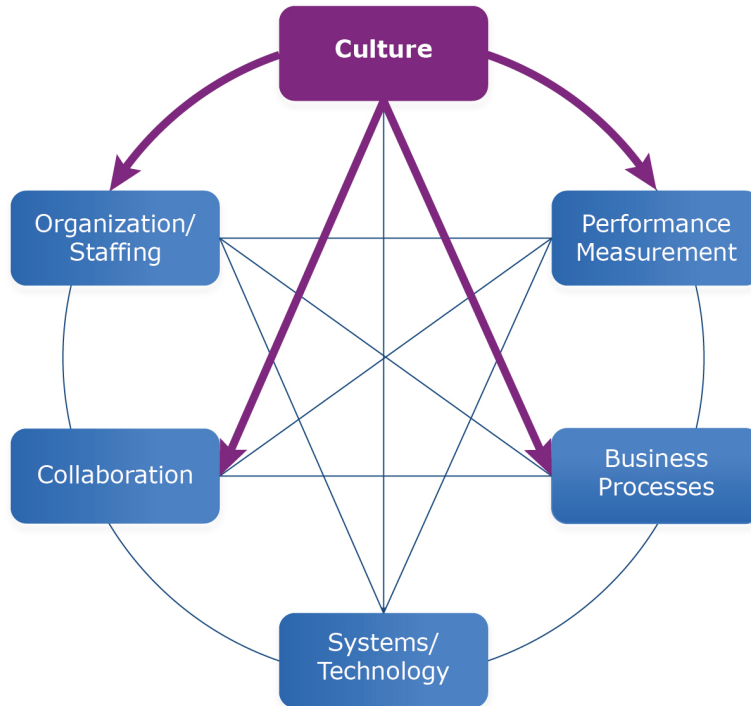
Figure 4.1 Graph. Key Synergisms between Culture and Other Dimensions

(Source: Cambridge Systematics, Inc. and Parsons Brinckerhoff.)

4.2   Span of Control

The workshops focused on middle management involved with TSM&O. This kind of staff is typically positioned at the third or fourth level within a State DOT central office, at the second or third level in DOT districts/regions, and is specialized staff in MPOs.. These individuals have direct responsibility for visible TSM&O functions, such as TMC operations, incident management, ITS device maintenance, or snow and ice control on a day-to-day basis in real time. The introduction or enhancement of TSM&O considerations in agency policy is largely outside their direct spans of control. They lack the authority for facilitating many of the key process and organizational changes associated with increasing TSM&O capabilities that rests with second or first-level managers.

Given their mid-level status in the agency, some of the more effective TSM&O managers appear to exert management-like influence through their personal initiatives, agency knowledge, and long-standing relationships, rather than through formal authority or control of resources. In workshop discussions, these "champions" explicitly acknowledged that their influence over culture is largely indirect. In some cases, these managers have been able to capitalize on major planned special events or unplanned incidents to draw focus to the need for TSM&O improvements. This has permitted them to access additional resources or effect organization changes. There have also been a few cases where, through exposure or outside

experience, top management has provided strong and visible leadership that has translated into organizational and process changes designed to support improved TSM&O.

5.0 Implementation Plan Capability Improvement Actions

A majority of workshop sites included one or more actions addressing Culture in their implementation plans. Among those actions, the highest priorities were development of a business case, marketing plan, or campaign that would increase the level of awareness, understanding, and most important, support for TSM&O; and development of outreach or communication material to disseminate the purpose and successes of TSM&O. Typical participant-suggested actions for advancement to the next level of capability are presented below in order of frequency of inclusion:

- Develop TSM&O outreach/communications material; document lessons learned/success stories

- Develop TSM&O business case

- Institute TSM&O knowledge sharing (e.g., though identified experts and peer exchanges)

- Develop proactive relationship with public service agencies

- Develop executive policy/directives in support of TSM&O/ITS/total system management

- Establish TSM&O executive steering committee to set vision and strategic priorities

- Recruit and select TSM&O advocates beyond headquarters to facilitate education

- Identify team of TSM&O champions at senior management and division head levels.

The appendix presents the key implementation plan steps commonly identified for these priorities. The highlights of these actions focus on two areas.

5.1 Develop TSM&O Business Case and Related Communications Strategy

The lack of a persuasive business case to justify TSM&O as a program (staffing, organization, and resource needs) was an issue that arose under Culture as well as the Business Processes and Collaboration dimensions. Development of a business case was typically conceived of as a distinct work effort, requiring collaboration among those involved and those who needed per-suasion. The common implementation plan work tasks typically had education, evidence, and persuasion components. Workshop participants recognized that custom-tailored cases had to be made for specific stakeholder audiences – in particular, senior management, policy makers, and key partners in TSM&O execution. There was concern that as a new program, TSM&O had to meet a higher standard of justification than a legacy program and that development of persuasive performance data, B/C data, payoffs, and anecdotal experience (nationally and

locally) was an important task yielding peer exchange and lessons learned. As a result, implementation plans related to business case development typically included an effort to identify and document cases where the payoffs could be described, especially in comparison to conventional improvements. Several workshops raised the need for compelling data on benefits.

5.2 Develop TSM&O Outreach/Communications Material

Closely related to the business case work tasks in implementation plans was development of a communication and outreach plan using arguments and examples tailored to both internal and external audiences. The plans focused on the identification of talking points for each type of audience, differentiating internal staff colleagues from external decision makers (commission/ board members, regional planning officials) and the general public. The plans also included the need to identify the communication strategies, media, and scale of material that would likely have the maximum impact. Implementation plans also included reference to materials that would be produced in TSM&O program plans and reflected in performance measures.

6.0 Best Practice Examples

Several best practice example illustrate how agencies have advanced a TSM&O culture.

Performance Culture: The Gray Notebook – Washington State DOT. "Moving Washington" is Washington State DOT's (WSDOT) overall transportation policy, intended to be embodied in its planning and programming. It includes principles for integrated investments in cost-effective solutions based on three strategies, tiered in order of priority to ensure cost effectiveness: "Operate Efficiently"; "Manage Demand"; and "Add Capacity Strategically." The "Operate Efficiently" strategy is designed to:

> "…get the most out of existing highways by using traffic-management tools to optimize the flow of traffic and maximize available capacity. Strategies include utilizing traffic technologies such as ramp meters and other control strategies to improve traffic flow and reduce collisions, deploying incident response to quickly clear collisions, optimizing traffic signal timing to reduce delay, and implementing low-cost/high-value enhancements to address immediate needs."[3]

WSDOT's focus on cost effectiveness is supported by its long-standing emphasis on performance measurement and reporting marked by the quarterly publication of *The Gray Notebook* series that provides performance tracking for asset and operational management. The origin of the notebook was an effort to increase public confidence in WSDOT by making the business case for transportation improvement through comprehensive performance reporting. *The Gray Notebook* includes information on the performance of various systems in general, some even on a corridor basis, and those where TSM&O strategies have been implemented and can be tracked. The publication is used for both internal and external purposes and includes time-series information about the cost and effectiveness of TSM&O investments and activities, as well as for capacity and maintenance improvements.

http://www.wsdot.wa.gov/Accountability/GrayNotebook/

District-Level Programs – Florida DOT District 4. At the executive level, the Florida (FDOT) leadership has endorsed TSM&O in the form of both a strategic plan and business plan. In addition to major interregional facility improvements, strong programs are developed at the individual district level. Covering Broward, Indian River, Martin, Palm Beach, and St. Lucie Counties (including Ft. Lauderdale and Palm Beach), District 4 has the most mature and comprehensive TSM&O programs in terms of applications, planning, and performance measurement at the district level. Due to long-standing leadership and staff technical expertise, the district has been a leader in the State in several areas. One is the application of incentive-based incident response (Rapid Incident Scene Clearance), first to freeways and more recently to arterials. The district also has defined a TSM&O network and developed both

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[3] http://www.wsdot.wa.gov/movingwashington/.

a long-range and short-term plan and program for an advanced traffic management system. In addition, benefit-cost outcomes are tracked, and the district publishes an annual report outlining its progress and accomplishments. The district also has sponsored its own transportation management academy.

http://www.dot.state.fl.us/trafficoperations/Newsletters/2014/2014-Dec.pdf#page=8

Public Relations: The $1,000 Doug MacDonald Challenge – Washington State DOT. The former WSDOT secretary established a contest soliciting ideas for the best way to explain the unique challenges facing TSM&O to a skeptical public. The contest was won by a contestant who submitted a demonstration of rice flowing through a funnel. The contest achieved considerable local and national press coverage.

http://www.wsdot.wa.gov/NR/rdonlyres/93FF7D3A-A543-4C51-A173-AFBA312CF6C3/0/TRB_Doug_Challenge_Handout.pdf

Major Statewide Public-Private TSM&O Performance Contract – Virginia DOT. Under a single performance-based contract, VDOT has both consolidated and outsourced much of its TSM&O activities under a single contract. This includes the operations of its five transportation operations centers, including floor operations for managing highway incident and emergency response, management, dispatching, and staffing of the highway safety service patrols, dispatching maintenance crews and conduct of field maintenance, managing high-occupancy vehicle reversible lanes and coordinating signal systems, and developing advanced traffic management systems. Key features of this arrangement are the emphasis on using outsourcing as a means of managing for consistency on a statewide basis, employing performance incentives for innovation and efficiency, and capitalizing on contractor flexibility and responsiveness – all while still retaining agency overall management control.

http://www.itscalifornia.org/Content/AnnualMeetings/2013/PRESENTATIONS/Tue%20Tech%20Session%205%20-%202013%20ITSCA%20VDOT%20Statewide%20TOC%20Gustafson_1.pdf.

7.0 Addressing Needs on the National Level

The weakness and related implementation plan actions identified in common by many State DOTs and their partners suggests an agenda of needs for research, guidance, and training. Consistent with the capability dimensions, this agenda is focused on process and institutional improvements that are not substantially addressed by existing support materials developed among peers or by AASHTO, FHWA, or other entities. There is very little support material targeting culture-related issues (see Best Practices above and References below). Suggestions are presented in Table 7.1.

Table 7.1 Suggested National Activities to Support Improvements in Culture

Activity	Culture Element	Sponsor(s)	Comments
Develop resources and collect examples of TSM&O business cases	Technical Understanding and Business Case Outreach – Internal and External	FHWA, AASHTO, NOCoE	Build on material already included in the NOCoE web site and incorporate case studies and B/C material from ITS Joint Program Office and FHWA web sites
Support appropriate level of national consistency in "branding" TSM&O as key transportation agency function	Technical Understanding and Business Case Outreach – Internal and External	FHWA, AASHTO, NOCoE	Ensure that external communications from both to the public use common language and most effective examples
Establish regular forum for State DOT leadership (chief engineers, district engineers) to discuss TSM&O-related issues and provide a group of peers for potential peer exchanges	Leadership/Champions	FHWA, AASHTO, NOCoE	No TSM&O forum for agency leadership exists (top manage-ment is not often involved in any peer-to-peer discussion in AASHTO, Regional Operations Forums, etc.)
Identify and communi-cate payoffs from new forms of public-private partnerships, including towing and recovery incentives and travel data	Policy/Program Status/Authorities	FHWA, AASHTO, NOCoE	Many DOTs remain unaware of the dramatic payoffs from these types of arrangements

Activity	Culture Element	Sponsor(s)	Comments
Identify and communicate the impact of operations and technology focus continuity across TSM&O and connected vehicles (CV)	Technical Understanding and Business Case Outreach – Internal and External	FHWA, AASHTO, NOCoE, TRB, transportation associations	Public interest in CV can be used as a "hook" to support TSM&O by noting the baseline TSM&O functions that support various CV applications

NOCoE   National Operations Center of Excellence

TRB   Transportation Research Board

8.0 References

AASHTO TSM&O Guidance: Culture Dimension. AASHTO's web-based TSM&O Guidance follows the six dimensions of TSM&O capability described in this white paper, including Culture. It is designed for transportation agency managers whose span of control relates to the operations and management of the roadway system, including policy makers and program managers for ITS and TSM&O at both the State and regional levels. It incorporates insights from a review of the state of the practice in TSM&O among transportation agencies into a well-accepted change management framework that identifies doable steps toward mainstreaming TSM&O on a continuously improving basis. Specific guidance for culture is cited here for advancing an agency currently at Level 1 to Level 2 within the CMM framework. Other level changes within the framework can be found on the [AASHTO TSM&O Guidance web site](.).

http://www.aashtotsmoguidance.org/guides/Cul_L2.pdf

Business Case Primer: Communicating the Value of Transportation Systems Management and Operations, SHRP 2 L17. This guide focuses on communicating the value of TSM&O to a full range of stakeholders. It provides the "who, what, when, and how" to communicate the business case for TSM&O. It is intended to help practitioners communicate messages about the value and benefits of TSM&O so that important decision makers and peers will actively support TSM&O implementation and integration within their agencies. Basic steps addressed include the following:

- Identify target audiences and reasons to implement TSM&O that resonate with each

- Learn about opportunities for communication, both informal and formal

- Prepare to deliver the message whenever the opportunity is available.

In addition, specific messages are included, organized by audience type (decision makers, implementers, travelers) and problem/issue with summaries of communication messages, facts, and sound bites by audience and sub-audiences.

http://www.tsmoinfo.org/pdf/SHRP_2_L17_Business_Case_Primer_Final.pdf

FHWA Benefit/Cost Resources. FHWA offers a number of resources that help estimate the benefits and costs of TSM&O strategies, an important capability to help make the case for supporting their application.

- **Operations Benefit/Cost Analysis Desk Reference.** This Desk Reference provides practitioners with guidance on how to effectively and reliably estimate the benefits and costs of operations strategies. It includes background information on benefit/cost analysis including basic terminology and concepts. It is intended to support the needs of practitioners just getting started with B/C analysis and unfamiliar with the general process. It also describes some of the more complex analytical concepts and latest research in order to support more advanced analysts. This Desk Reference is supported by an Operations

B/C decision support spreadsheet tool, called the Tool for Operations Benefit/Cost (TOPS-BC).

http://www.ops.fhwa.dot.gov/publications/fhwahop12028/index.htm

- **Transportation Systems Management and Operations Benefit Cost Analysis Compendium.** This TSM&O Compendium is a collection of cases from across the country where benefit/cost analyses (BCAs) have been applied to one or more TSM&O technologies/strategies.

  Posting to FHWA Office of Operations web site is forthcoming.

- **The Road Weather Management (RWM) Benefit Cost Analysis Compendium.** This Compendium is similar to the one above and provides information about BCAs conducted around the country for specific RWM technologies or operational strategies. The actual project evaluations involve the use of custom spreadsheets developed by the agency or its contractors, or the application of available software tools to the BCA. The Compendium also includes hypothetical cases designed to demonstrate how BCA can be used for a specific RWM technology or operational strategy. The *Operations Benefit/Cost Analysis Desk Reference* (see above) should be used in conjunction with the RWM Compendium.

  http://www.ops.fhwa.dot.gov/publications/fhwahop14033/

ITS Joint Program Office Knowledge Resources. This database provides standardized summaries by application area providing costs and benefits information that can be used in the development of business plans and outreach.

http://www.itsknowledgeresources.its.dot.gov/

Making the Case for Funding Using Performance Management: The Washington State DOT Experience. This paper discusses issues associated with communicating the business case for TSM&O to gain public confidence. The paper demonstrates how support for the program can be achieved using performance management and measurement and effective, ethical communication.

http://www.wsdot.wa.gov/NR/rdonlyres/E5D34B36-6662-4464-B4BA-1E858BBD710D/0/Making_Case_for_Funding_PM_TRBprintedvsn.pdf

An Overview for Improving Traffic Operations within North Carolina, NCDOT. This is a rare example of a business plan-like document that defines and describes the value of TSM&O; relates it to agency goals; and identifies stakeholders, current capabilities, and strategies to overcome program weaknesses, including those related to staffing, performance reporting, and outsourcing.

http://www.tsmoinfo.org/pdf/06%20ROF_prestudy_NC_Traffic_Plan-Operations_Focused_Recommendation.pdf

SHRP 2 L31 Outreach Materials. SHRP 2 has developed outreach materials tailored for State DOT and MPO leadership that can help gain support for TSM&O efforts. These materials include an adaptable PowerPoint presentation and an accompanying presentation guide focused on educating chief executive officers (CEOs) and senior managers of State DOTs about the value of mainstreaming TSM&O as a core mission, business practice, and investment priority. A similar presentation and accompanying presentation guide are tailored for CEOs and senior managers of MPOs and to the MPO's board members about the value of mainstreaming TSM&O as a core component and investment priority in the regional transportation planning process.

State DOT PowerPoint presentation:
http://www.fhwa.dot.gov/goshrp2/Exit?url=http!3a!2f!2fshrp2.transportation.org!2fDocuments!2fReliability!2fOperations%2BCEO%2BPresentation_DOT_Version%2B1_April%2B2014.pptx

State DOT presentation guide:
http://www.fhwa.dot.gov/goshrp2/Exit?url=http!3a!2f!2fshrp2.transportation.org!2fDocuments!2fReliability!2fOperations%2BCEO%2BPresentation_DOT_Version%2B1_April%2B2014combined.pdf

State DOT PowerPoint presentation:
http://www.fhwa.dot.gov/goshrp2/Exit?url=http!3a!2f!2fshrp2.transportation.org!2fDocuments!2fReliability!2fOperations%2BCEO%2BPresentation_MPO_Long_Version%2B1_April%2B2014.pptx

State DOT presentation guide:
http://www.fhwa.dot.gov/goshrp2/Exit?url=http!3a!2f!2fshrp2.transportation.org!2fDocuments!2fReliability!2fOperations%2BCEO%2BPresentation_MPO_Long_Version%2B1_April%2B2014combined.pdf

Appendix: Steps to Implement Common Implementation Plan Priority Actions for Culture Dimension

The steps listed below implement the most common priority actions identified by workshop participants when developing their implementation plans. Although the actions themselves are not stated, they generally address improvement in each of the culture elements. The steps for each action were developed by the workshop site core team, assisted by a template of facilitator-supplied suggested steps based on workshop outputs, and structured consistent with the basic CMM guidance presented in the AASHTO TSM&O Guidance.

Technical Understanding and Business Case

1. Establish cross-discipline interagency working group to develop consensus business case based on performance data and define purpose, scope, and audience (internal and external) for business case

2. Identify key audiences and "hot button" issues and promising media formats and communication strategies

3. Review peer experience with business case development and FHWA/AASHTO/SHRP 2 materials regarding approach to identification and presentation of costs, benefits, payoffs, and expected outcomes; assess relative B/C compared to non-TSM&O alternatives

4. Identify and select data and analytics, identify project-type targets, and identify full range of cost and benefit categories of interest (including monetary and nonmonetary) for TSM&O alternatives

5. Develop both internal and external visions or "stories" of TSM&O benefits, leveraging past successes (specific strategy applications, projects, major events) and/or national best practice and research findings

6. Look for opportunities to present materials at special events that attract TSM&O stakeholders

Leadership/Champions

1. Designate traffic engineers in DOT regions to serve as champions and advocates for TSM&O during the planning process; cultivate and involve these champions in TSM&O strategic planning and performance strategy

2. Leverage current efforts (TIM Training and traffic incident management plans) to engage stakeholders

Outreach – Internal and External

1. Develop a communications strategy to promote TSM&O program activities and achievements and to conduct internal and external TSM&O outreach by identifying and evaluating media outlets and dissemination opportunities, including marketing, branding, and terminology:

   – Develop materials to address different audiences such as engineering staffs, the public and political leaders

   – Develop guidance regarding the use of the materials so that they are focused on a local context when they are distributed

   – Include examples of the impacts it would have on the lives of the people in the area of the proposed TSM&O improvements

   – Discuss the impacts and implications of not making the improvements as well

2. Identify and select case study opportunities to document success stories and support outreach materials

3. Align agency public relations strategies with the TSM&O program and highlight the program's importance, purpose, and successes

4. Develop consistent talking points that support the program objectives and goals and provide a consistent level of traceability to specific TSM&O strategies and activities; incorporate performance outcomes to support the talking points and business case

5. Identify opportunities to promote a TSM&O program, activities, and success stories via commission/board presentations, regional planning meetings, and other avenues; utilize consistent talking points to emphasize the TSM&O business case and message

6. Bring additional stakeholders into TSM&O discussions to help promote the TSM&O program and objectives; emphasize collective benefits of TSM&O collaboration

Policy/Program Status/Authorities

1. Using business case materials, present the notion of establishing TSM&O as a separate formal top-level agency program with its own mission, goals, top-level leadership, performance measures, and capital and operational budget

2. Develop and present background materials designed to obtain legislative authorization for a greater range of TSM&O strategies (active traffic management, managed lanes) and increased State DOT authorities (incident management)