Report No. K-TRAN: KU-18-2 ▪ FINAL REPORT ▪ January 2021

Promoting the Transportation Systems Management and Operations Program in Kansas

Alexandra Kondyli, Ph.D.
Steven D. Schrock, Ph.D., P.E., F.ITE
Bradley W. Lane, Ph.D.
Mohamadamin Asgharzadeh, Ph.D.

The University of Kansas

Kansas Department of Transportation

1 Report No. K-TRAN: KU-18-2	2 Government Accession No.	3 Recipient Catalog No.
4 Title and Subtitle Promoting the Transportation Systems Management and Operations Program in Kansas		5 Report Date January 2021 6 Performing Organization Code
7 Author(s) Alexandra Kondyli, Ph.D. Steven D. Schrock, Ph.D., P.E., F.ITE Bradley W. Lane, Ph.D. Mohamadamin Asgharzadeh, Ph.D.		8 Performing Organization Report No.
9 Performing Organization Name and Address The University of Kansas Department of Civil, Environmental & Architectural Engineering 1530 West 15th St Lawrence, Kansas 66045-7609		10 Work Unit No. (TRAIS) 11 Contract or Grant No. C2113
12 Sponsoring Agency Name and Address Kansas Department of Transportation Bureau of Research 2300 SW Van Buren Topeka, Kansas 66611-1195		13 Type of Report and Period Covered Final Report July 2017–January 2020 14 Sponsoring Agency Code RE-0733-01
15 Supplementary Notes For more information write to address in block 9.		

16 Abstract

This research investigated the current level of Transportation Systems Management and Operations (TSMO) implementation and integration within the Kansas Department of Transportation (KDOT) at the headquarters and all areas and districts in Kansas. This investigation is of particular importance to KDOT because it will initiate implementation of a statewide TSMO plan and align Kansas with its peer states. The research team conducted a thorough review of how TSMO is defined and implemented in several states throughout the United States, and the team consulted with federal guidelines and applied the Capability Maturity Model (CMM) to identify the current state of TSMO development and implementation in Kansas. Survey questionnaires were sent to several state employees at the headquarters and within all areas and districts to investigate the capability level for five CMM dimensions: business process, systems and technology, performance measurement, collaboration, and organization and workforce. Based on the survey responses, the team concluded that most TSMO activities are performed ad-hoc and champion-driven, although efforts are made to better understand strategy applications. Based on the CMM, this research recommended moving each CMM dimension towards the next level of maturity and promoting a TSMO program throughout the region.

17 Key Words Intelligent Transportation Systems, Transportation Systems Management, Capability Maturity Model, Questionnaires		18 Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service www.ntis.gov.	
19 Security Classification (of this report) Unclassified	20 Security Classification (of this page) Unclassified	21 No. of pages 72	22 Price

Form DOT F 1700.7 (8-72)

This page intentionally left blank.

Promoting the Transportation Systems Management and Operations Program in Kansas

Final Report

Prepared by

Alexandra Kondyli, Ph.D.
Steven D. Schrock, Ph.D., P.E., F.ITE.
Bradley W. Lane, Ph.D.
Mohamadamin Asgharzadeh, Ph.D.

The University of Kansas

A Report on Research Sponsored by

THE KANSAS DEPARTMENT OF TRANSPORTATION
TOPEKA, KANSAS

and

THE UNIVERSITY OF KANSAS
LAWRENCE, KANSAS

January 2021

PREFACE

The Kansas Department of Transportation's (KDOT) Kansas Transportation Research and New-Developments (K-TRAN) Research Program funded this research project. It is an ongoing, cooperative and comprehensive research program addressing transportation needs of the state of Kansas utilizing academic and research resources from KDOT, Kansas State University and the University of Kansas. Transportation professionals in KDOT and the universities jointly develop the projects included in the research program.

NOTICE

The authors and the state of Kansas do not endorse products or manufacturers. Trade and manufacturers names appear herein solely because they are considered essential to the object of this report.

This information is available in alternative accessible formats. To obtain an alternative format, contact the Office of Public Affairs, Kansas Department of Transportation, 700 SW Harrison, 2nd Floor – West Wing, Topeka, Kansas 66603-3745 or phone (785) 296-3585 (Voice) (TDD).

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the views or the policies of the state of Kansas. This report does not constitute a standard, specification or regulation.

Abstract

This research investigated the current level of Transportation Systems Management and Operations (TSMO) implementation and integration within the Kansas Department of Transportation (KDOT) at the headquarters and all areas and districts in Kansas. This investigation is of particular importance to KDOT because it will initiate implementation of a statewide TSMO plan and align Kansas with its peer states. The research team conducted a thorough review of how TSMO is defined and implemented in several states throughout the United States, and the team consulted with federal guidelines and applied the Capability Maturity Model (CMM) to identify the current state of TSMO development and implementation in Kansas. Survey questionnaires were sent to several state employees at the headquarters and within all areas and districts to investigate the capability level for five CMM dimensions: business process, systems and technology, performance measurement, collaboration, and organization and workforce. Based on the survey responses, the team concluded that most TSMO activities are performed ad-hoc and champion-driven, although efforts are made to better understand strategy applications. Based on the CMM, this research recommended moving each CMM dimension towards the next level of maturity and promoting a TSMO program throughout the region.

Acknowledgments

The authors of this report thank KDOT project monitors Tom Hein and Andy Mackley for their guidance and suggestions. The authors also thank previous project monitors Kristi Ericksen and Eric Kocher for assisting with the study.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

1.1 Background

Transportation Systems Management and Operations (TSMO) consists of a set of strategies that aim to improve operational and safety features of existing transportation systems. The ultimate goal of these strategies is to assess and improve existing transportation infrastructure systems (FHWA, 2013). Moving Ahead for Progress (MAP-21) defines TSMO as "*Integrated strategies to optimize the performance of existing infrastructure through the implementation of multimodal and intermodal, cross-jurisdictional systems, services, and projects designed to preserve capacity and improve security, safety, and reliability of the transportation system*" (FHWA, 2020b).

According to the Federal Highway Administration (FHWA), the overall benefits of TSMO include the following (FHWA, 2020b):

- More reliable and smoother traffic flow
- Congestion reduction
- Air quality improvement
- Fuel consumption reduction
- Better use of existing facilities
- Economic vitality improvement

However, since these improvements are general goals and similar to any other project, mission and vision must be specified in order to define the means and path to reach the desired goals. TSMO is not limited to Intelligent Transportation Systems (ITS) and technological improvement but rather considers the transportation network as a unified whole. TSMO includes a multidimensional approach to the entire system as the following integrational levels (AASHTO, n.d.):

1. **System Integration**: This level implants frameworks and strategies based on region requirements.
2. **Technical Integration**: This level requires use of the ITS features and data sharing within the region.
3. **Cultural Integration**: This level finds common ground when prioritizing various strategies and solutions within a region.

4. **Operational Integration**: This level integrates various entities within a region.
5. **Institutional Integration**: This level determines short, medium, and long-term goals for planning, program management, and design of transportation systems.

1.2 Objectives

The objective of this research was to recommend processes, tools, and resources required to implement a TSMO program in Kansas without disrupting the organizational structure of the Kansas Department of Transportation (KDOT). This effort promotes the mission of KDOT to serve major metropolitan areas while also executing that mission in challenging rural regions of the state.

Chapter 2: Review of Current Practice

This section includes a summary of the literature review related to TSMO definitions and applications throughout the United States, including a brief summary of the TSMO vision, mission, and goals in Iowa, Texas, Maryland, Florida, and Missouri.

2.1 Iowa

According to the Iowa TSMO strategic plan, the TSMO strategic direction is defined as follows (Iowa DOT, 2016):

- **TSMO Vision:** *"Iowa's transportation system is safe, efficient and reliable, supporting the state's environmental and economic health as a result of TSMO"* (Iowa DOT, 2016).
- **TSMO Mission:** *"To get you there safely and reliably by proactively managing the transportation system."*
- **TSMO Strategic Goals:**
  - **Safety:** Crash frequency and severity reduction
    1. Reduce the number of overall major crashes
    2. Reduce the number of secondary crashes caused by traffic incidents
    3. Reduce the number of work zone-related traffic incidents
  - **Reliability:** Reliable transportation and increased system resiliency to improve highway capacity in critical corridors
    1. Improve travel time reliability
    2. Increase the resilience of the transportation system to floods, winter weather, and other extreme weather events
  - **Efficiency:** Reduce delays and increase traffic efficiency
    1. Improve Level of Service (LOS) on major freight corridors
    2. Maximize use of existing roadway capacity
    3. Minimize environmental impacts of the transportation system
    4. Respond to and clear traffic incidents as quickly as possible

- **Convenience:** Increase the convenience of choice for each mode of transportation
  1. Provide timely, accurate, and comprehensive information to customers
  2. No unplanned road closures or restrictions due to conditions within the control of Iowa's DOT
  3. Provide high quality, machine-ready information in open formats
  4. Accommodate bike, pedestrian, transit, and commercial vehicles in transportation management and operations
- **Coordination:** Improve the coordination between DOTs and external agencies
  1. Lead statewide and regional Traffic Incident Management Program activities
  2. Coordinate responses to large-scale traffic incidents with adjacent states
  3. Provide staff knowledge and management resources to enable adaptation to rapidly changing technology
- **Integration:** Incorporate TSMO strategies in planning, design, construction, maintenance, and operational activities
  1. Integrate TSMO into existing DOT policies, plans, and procedures
  2. Develop standards-based systems, rooted in geospatial technologies, to improve performance management and decision support systems
  3. Use integration and big data mining strategies to improve performance management and business intelligence
  4. Implement integrated corridor management strategies to manage traffic across multiple jurisdictions

2.2 Texas

According to the Texas TSMO strategic plan, the TSMO strategic direction is defined as follows (TxDOT, 2017):

- **TSMO Vision:** *"Improve safety and mobility for all modes of transportation by integrating planning, design, operations, and maintenance activities."*
- **TSMO Mission:** *"Through innovation, collaboration, and performance-based decision making, transportation facilities are developed, maintained, and operated cost-effectively, with the end user in mind"* (TxDOT, 2017).
- **TSMO Strategic Goals:**
    - **Safety:** Crash and fatality reduction by implementing traffic management systems and procedures
    - **Reliability:** Travel time reliability improvement
    - **Efficiency:** Alleviate congestion by implementing projects that optimize existing transportation system capacity and alleviate congestion
    - **Customer Service:** Provide updated and reliable traveler information system
    - **Collaboration:** Integrated corridor management through multi-jurisdictional coordination and cooperation between various transportation disciplines
    - **Integration:** TSMO prioritization as a core objective for various dimensions

2.3 Maryland

According to the Maryland TSMO strategic plan, the TSMO strategic direction is defined as follows (MDOT, 2016):

- **TSMO Vision:** *"Maximize mobility and reliable travel for people and goods within Maryland by efficient use of management and operations of transportation systems."*

- **TSMO Mission:** *"To establish and maintain a TSMO program and implement supporting projects within the Maryland Department of Transportation State Highway Administration, improving mobility and reliability for all people and goods through planned operations of transportation facilities."*
- **TSMO Strategic Goals:**
    - **Reliability:** Implement sustainable TSMO program and improve travel time reliability
    - **Customer Service:** Improve the traveling public's experience on Maryland highways by enabling customers with information and choices
    - **Integration:** Develop data- and performance-driven approaches to support TSMO planning, programming, implementation, and evaluation decisions

2.4 Florida

According to the Florida TSMO strategic plan, the TSMO strategic direction is defined as follows (FDOT, 2017):

- **TSMO Vision:** *"To deploy a customer-driven TSMO program focused on mobility outcomes through real-time and effective management of the existing transportation system toward its maximum efficiency."*
- **TSMO Mission:** *"To operate our transportation system at the highest level of cost-effective performance"* (FDOT, 2017).
- **TSMO Strategic Goals:**
    - Increase the use of transportation infrastructures
        1. Design, deliver, and implement TSMO strategies
        2. Develop and report performance measures in the dashboard on program and network levels
        3. Develop a plan for data collection on designated networks
        4. Establish data archive

- Provide funding for TSMO programs
  1. Develop a TSMO Needs Plan and Cost Feasible Plan
  2. Demonstrate, on a macro level, cost savings/efficiency with TSMO deployment instead of major capacity improvements
  3. In cooperation/coordination with Metropolitan Planning Organizations (MPOs) and planning offices, identify a plan to address gaps and incorporate plans into Work Program development process
  4. Establish TSMO projects as a viable alternative in Project Development and Environment (PD&E) studies
  5. Develop a benefit/cost process and adopt on all projects

2.5 Missouri

According to the Missouri TSMO strategic plan, the TSMO strategic direction is defined as follows (MoDOT, 2017):

- **TSMO Mission:** *"MoDOT's TSMO program applies integrated strategies to optimize the performance of existing infrastructure through the implementation of systems, services, real-time information, and programs designed to preserve capacity and improve safety and reliability of transportation systems. MoDOT's TSMO program helps get people safely where they want to go."*
- **TSMO Strategic Goals:**
  - Improve the efficiency of existing systems to increase reliability
  - Improve the safety for all roadway users
  - Improve mobility and reliability
  - Provide low-cost effective solutions

Chapter 3: Capability Maturity Model

3.1 Overview

TSMO requires constant and progressive improvement of the transportation network for safety and mobility. Therefore, TSMO guidance should initially evaluate the current status of the network and then provide instructions for achieving network objectives, meaning network improvement must be monitored constantly. Application of TSMO strategies should monitor the stage of development and implementation of each strategy (AASHTO, n.d.). A progressive implementation plan for TSMO strategies is required to assess challenges associated with projected advancement of the strategy. Consequently, each proposed ongoing strategy must be assessed periodically to measure its advancement.

This strategy assessment process is applicable by implementing a Capability Maturity Model (CMM) to reduce the overall complexity of TSMO implementation. CMM, a management tool designed to monitor evolutionary improvement of TSMO effectiveness, derived from the *Strategic Highway Research Program 2* (SHRP2), which promotes a process-driven approach to improve TSMO (TRB, 2015). The FHWA designed SHRP2 to address three national transportation challenges: increasing highway safety, decreasing traffic fatalities, and improving roads and bridges. CMM has now spread to outcome-oriented products and service development in public and private sectors, especially in areas impacted by changing technology, such as customer service and manufacturing. CMM has several unique features that make it a practical tool for transportation programs:

- CMM presumes that evolutionary improvements in outcomes (such as reductions in delay from improved TSMO) can be managed.
- CMM identifies a high-level vision of capability as a target and provides a common language for discussion of how to achieve the desired outcome.
- CMM focuses on a small set of specific dimensions: business processes, organizational structure, and related capabilities.
- CMM recognizes that improvements must be installed in evolutionary, manageable levels, with each level clearly defined by criteria.
- Priorities are identified.

- Specific actions needed to reach the next level of capability synergize towards the objective of continuous improvement.

The TSMO CMM framework has been used to develop a facilitated one-day self-assessment process for state DOTs and regions. The self-assessment process intended to improve the effectiveness of TSMO applications and activities by assisting unit managers and key technical staff with day-to-day oversight of TSMO-related activities, as well as DOT partners such as public safety agencies, MPOs, and local governments.

3.2 Dimensions of Capability

The National Operations Center of Excellence (NOCoE) defined the following six levels of dimensions of capability (FHWA, 2015):

- **Business processes**: Business processes are specific, structured activities or tasks and related decision points required to efficiently produce TSMO systems and services, including formal planning, programming, scoping, budgeting, and project development.
- **Systems and technology**: The systems and technology dimension refers to systems engineering requirements of TSMO, including systems architecture, concepts of operation (ConOps) and interoperability, standardization, and documentation processes. However, this dimension focuses on key processes and aspects of technology procurement, integration, operations, and technology planning rather than the actual technology infrastructure.
- **Performance Measurement**: Performance measurement determines the effectiveness of organizational activity using tools such as definition measurement, data acquisition, and utilization measurement. Performance measurement is fundamental to all other capability dimensions because it identifies how well an organization delivers operations services and identifies areas that need improvement. Performance measurement for

operations encompasses several aspects of mobility, including congestion level and travel-time reliability.

- **Collaboration**: The collaboration dimension, which includes relationships with public safety agencies, local governments, MPOs, and private sectors, refers to cooperative arrangements between two or more entities to achieve a shared goal. Examples of collaboration include public-public cooperation with other sectors of government (e.g., municipalities) and/or safety offices (e.g., police department, fire department, and emergency medical services [EMS]) and public-private partnership. Collaboration primarily involves an agency's external communication with other public or private offices. (Internal agency collaboration is addressed in the organization and staffing dimension.)
- **Organization and staffing**: The organization and staffing dimension, which includes technical understanding, staff capabilities, training/development, and recruitment and retention, develops an appropriate TSMO-related organizational structure within and between state DOT headquarters and districts. This dimension also includes the identification, development, and maintenance of essential staff capabilities.
- **Culture**: Culture includes technical understanding and business case, leadership, outreach, and program legal authority.

3.3 Capability Levels

This research assessed each capability dimension using a criteria-based level of capability maturity that indicates the direction of managed changes required to improve TSMO effectiveness (FHWA, 2015). The purpose of the evaluation was to provide the motivation and appropriate action items to the user (agency) to improve TSMO to the next level of capability. Table 3.1 describes the four capability levels for each dimension, starting with a level that reflects a start-up situation with ad-hoc, inconsistent, fragmented, and informal approaches, as well as minimal management and overreliance on committed champions. Each level adds a new level of capability that increases efficiency, improves outcomes, establishes the foundation, and provides instructions for reaching a higher level. The definitions of levels are summarized as follows:

1. Performed (ad hoc): Activities and relationships are largely ad hoc, informal, and champion-driven and are substantially outside the mainstream of other transportation activities.
2. Managed: Basic strategy applications are understood, key processes' support requirements are identified, and key technology and core capacities are under development, but there is limited internal accountability and uneven alignment with external partners.
3. Integrated: Standardized strategy applications are implemented in priority contexts and managed for performance. TSMO technical processes are developed, documented, and integrated into the regional transportation agencies, and partnerships are aligned.
4. Optimized: TSMO is a full and sustainable regionwide program established on the basis of continuous improvement with all partners.

Table 3.1: Levels of Agency Capability

Source: AASHTO (n.d.)

	Capability Levels			
Dimensions	**Level 1 (Performed)**	**Level 2 (Managed)**	**Level 3 (Integrated)**	**Level 4 (Optimized)**
Business Processes	Each jurisdiction operates uniquely according to individual priorities and capabilities.	Multiyear statewide TSMO plan and program exist with deficiencies, evaluation, and strategies.	Programming, budgeting, and project development processes for TSMO are standardized and documented.	TSMO is integrated into jurisdictions' multisectoral plans and programs based on formal, continuous planning processes.
Systems and Technology	Ad hoc approaches are used for system implementation without considering systems engineering and appropriate procurement processes.	Regional or statewide ConOps and architectures are developed and documented with costs included; appropriate procurement process are employed.	Systems and technology are standardized, documented and trained statewide, and new technology is incorporated.	Systems and technology are routinely upgraded and utilized to improve efficiency of performance systems; integration and interoperability are maintained continually.
Performance Measurement	Some output-level performance is measured and reported by some jurisdictions.	Output-level performance measures are used directly for after-action debriefings and improvements; data are easily available and dashboarded.	Outcome-level measures are identified (networks, modes, impacts) and routinely utilized for objective-based program improvements.	Output and outcome performance measures are reported internally for utilization and externally for accountability and program justification.
Collaboration	Relationships are informal, infrequent, and personal.	Regular collaboration occurs at the regional level; objectives, strategies, and performance measures align among organized central players (transportation and public safety agencies) with after-action debriefing.	Formal interagency agreements are used for collaborative interagency adjustment of roles and responsibilities.	A high level of operations coordination is institutionalized among key players (public and private).
Organization and Staffing	Fragmented roles are based on legacy organization and available skills.	The relationship among roles and units are rationalized, and core staff capacities are identified.	Top-level management positions and core staff for TSMO are established in the central office and districts.	Operations core capacity positions include professionalization, certification, and performance incentives.
Culture	The value of TSMO is not widely understood beyond champions.	The value and role of TSMO is appreciated throughout the agency.	TSMO is accepted as a formal core program.	The agency is explicitly committed to TSMO as a key strategy to achieve a full range of mobility, safety, and livability/sustainability objectives.

Chapter 4: Dimensions Description

4.1 Business Process Dimension

The business process dimension highlights the opportunities and/or deficiencies of implementation of TSMO activities. This dimension also identifies strategies to improve systems and technologies and introduces a process for allocating resources to various activities based on their payoffs. According to the AASHTO guide for TSMO (AASHTO, n.d.), the business processes dimension contains four subdimensions.

4.1.1 TSMO Planning Process and Efforts

The TSMO planning process and efforts subdimension aims to substitute the conventional (short-term) planning procedure with mid-term or long-term planning for TSMO projects (e.g., incident and freeway management). The TSMO planning process also provides action items for projects that have potentially reached a plateau. TSMO-related planning includes ITS proposal, freeway/arterial operation, and incident management efforts.

4.1.2 Programming and Budgeting

TSMO's lack of program status and resources limits appropriate programming and budgeting. In addition, TSMO staff is not typically represented at an organizational level in budget discussions, and TSMO is not typically included in top-level agency-wide resource allocation processes. TSMO-related programming and budgeting includes determination of operational and capital costs for TSMO projects and long-range programming for capital investments.

4.1.3 Project Development/Procurement

Similar to other project development processes, TSMO projects have particular development requirements, including systems engineering, ConOps, procurement, systems integration and deployment needs, and special contracting requirements. However, TSMO may not require an exclusive implementation process since it benefits from integration with other capital or maintenance projects.

4.1.4 Metropolitan Planning Organizations, Regional Entities, and TSMO Planning

The TSMO planning process, which requires the involvement of MPOs and other local public agencies, includes practical joint regional planning, programming, and performance measurements according to each local government's involvement in arterial and transit operations.

4.2 Systems and Technology Dimension

The systems and technology dimension can be divided into the following three key elements based on the approach in the AASHTO guide for TSMO (AASHTO, n.d.).

4.2.1 Regional Architecture

Continuous improvement of TSMO requires a systematic systems-engineering approach. ITS systems architecture provides a common framework for planning, defining, and integrating ITS deployments.

4.2.2 Project System Engineering/Testing and Validation

The discussion of issues that emerge from the implementation of new technologies, insufficient staff training, outsourcing issues (technical responsibilities with the private sector), and other challenges learned from previously tested best practices of systems engineering in peer states is beneficial. Challenges regarding purchasing and operating new ITS equipment must also be considered, including long processing times for substituting and implementing new equipment while controlling the quality. Procurement of the most advanced equipment may be a concern when new projects are underway and contractors are searching for the most cost-effective, acceptable product to meet project requirements. To overcome this concern, the IT department should be deeply involved with procurement processes related to TSMO.

Outsourcing also should be perpetually considered because it could address staffing and budget restrictions by eliminating hiring and technological limitations. Outsourced units can be flexible and adjust their own staffing levels autonomously without the DOT. In addition, keeping pace with technology can be readily maintained because outsourcing reduces internal training and beneficially supports the implementation of new equipment, the deployment of new software, and improved maintenance capabilities.

4.2.3 Standards/Interoperability

System interoperability vitally facilitates the operation of various equipment and software by implementing standards to ensure interoperability. Implementation of these standards on legacy equipment may be subject to limitations and consequently limit expansion options due to incompatibility with new equipment. System interoperability is essential for data and voice communication among agencies. However, system interoperability requires the development of ITS industry standards to facilitate data exchange, communications, and informative displays, as well as to identify common objectives. Therefore, standards must be updated and relevant to evolving technologies.

4.3 Performance Measurement Dimension

The performance measurement dimension's state of practice can be categorized as key elements (AASHTO, n.d.).

4.3.1 Measures Definition

The MAP-21 has specified national performance measures such as congestion mitigation, increased air quality, improved freight movement, increased highway performance quality, efficient incident management, and improved traffic safety (FHWA, 2013). These performance measures can be categorized as output or outcome performance measures. Output measures refer to tabulation, calculation, or recording as a result of an activity, effort, or process (e.g., annual count of rear-end crashes). Outcome measures, however, measure the result of a system relative to the aim. In other words, an outcome measure measures the success of a system. Most outcome performance measures include system reliability based on output measures (e.g., improving intersection safety). Because each performance measure requires specific data sources for calculation, states are required to obtain the necessary data through the other dimensions.

4.3.2 Measures Utilization and Development

Performance measures have internal and external applications. Internal utilization includes performance measure application in the decision-making process and the establishment of policies. External application of performance measures includes providing public periodic reports. Development of a performance measurement plan includes setting measures (outputs and outcomes), identifying targets (including variations across districts or regions), controlling data availability (by identifying collaborating internal/external partners), determining available analytical methods, setting standards according to MAP-21 requirements, identifying reporting partners/party (public or other entities), and evaluating legacy performance measures.

4.4 Collaboration Dimension

TSMO requires collaboration between entities instead of singular control by DOTs. Key elements based on the approach in AASHTO (n.d.) for the collaboration dimension are summarized below.

4.4.1 Public Safety Agency Collaboration

Providing real-time collaboration between public safety agencies is necessary for effective implementation of incident, emergency, and special event management, as well as metropolitan planning and jurisdictional operations. These agencies have unique priorities that typically do not align with other agencies. For example, because mobility is not a priority for public safety agencies, collaboration with DOTs may be necessary. The DOTs must be raising awareness among these entities, including initiating involvement with public safety agencies for mobility aspects of incident response and engaging in cooperative activities such as co-training and after-incident debriefings. Safety officers must be involved in major sporting events and recurring major weather challenges to ensure the effectiveness of traffic management, traveler information, and the improvement of mobility and safety. In addition, state DOTs must coordinate with local police departments, each of which is responsible for incident response at facilities within their jurisdictional boundaries, even when the incident occurs on an interstate road.

4.4.2 Metropolitan Planning Organization, Regional Transportation Planning Agency, and Local Government Collaboration

In addition to safety and law enforcement agencies, collaboration between MPOs, the Regional Transportation Planning Agency (RTPA), and the local government should also be considered in TSMO activities. The effectiveness of TSMO strategies relies on constructive collaboration among state DOTs and local governments (MPOs), including the establishment of appropriate roles, relationships, procedures, and protocols while mobilizing staffing, operating, and maintenance resources.

4.4.3 Outsourcing/Public-Private Partnership

Cooperation between private partnership and outsourcing companies is essential for successful TSMO application. Public-private partnerships commonly provide access to specialized private-sector expertise. These arrangements highlight private-sector resources, capabilities, and specialized technical expertise.

4.5 Organization and Staffing Dimension

The organization and staffing dimension can be divided into key elements based on the approach in the *AASHTO Guide to Systems Operations and Management* (AASHTO, n.d.).

4.5.1 Organizational Structure

TSMO should be recognized as a formal program in KDOT's organizational structure at the headquarters and district/regional levels, including within TSMO senior management responsibilities and TSMO hierarchy between headquarters and districts. Responsibilities related to TSMO should be distributed among agency headquarters and the districts. Managers responsible for TSMO-related statewide activities are distributed at three to four levels down.

TSMO activities include planning and programming, as well as real-time tasks such as traffic engineering, traffic management centers (TMCs), safety, and other real-time activities with public safety and local government partners. Real-time tasks typically occur at the district level, while planning and programming tasks take place at headquarters. However, in rural districts (usually without TMCs) TSMO functions are likely the responsibility of a traffic or maintenance group. TSMO duties are typically divided between operations/management units and engineering/project development units, each of which have separate upward reporting relationships. The reporting should be reorganized among headquarters and district levels.

4.5.2 Staff Development

Since TSMO is not yet a formal program with a distinct educational and training focus, TSMO staff typically come from various backgrounds within DOTs, such as planning, maintenance, and traffic engineering. The effectiveness of TSMO often relies as much on informal connections as formal organizational charts. However, TSMO requires specialized technical/managerial capacities to maintain program effectiveness, as reflected in job specifications for TSMO positions, including TSMO-specific knowledge, skills, and abilities.

The emergence of new technologies has highlighted the challenging lack of staff development, especially in areas that require special technical expertise (e.g., systems engineering, communication, data management, and automation), as well as the lack of development in general knowledge of TSMO. In addition, the lack of specialized staff and staff slot limitations encourage outsourcing of expert technical services such as planning, systems engineering, and data management to private entities. Formal training with a TSMO focus is recommended to overcome these challenges.

4.5.3 Recruitment and Retention

Due to declining staff levels among state DOTs and limited recruitment experience in TSMO, individual technical capacity needs are met via consultants, contract employees, or academic support. Permanent TSMO staff recruitment appears to be infrequent, and some of the required skills (systems engineering, information, and communications) are generated in educational institutions that have minimal contact with the transportation sector.

Chapter 5: TSMO Approach for Kansas

Similar to other states, the primary objective of TSMO in Kansas is improving safety and mobility. Since state officials have not yet determined the exact vision and mission for TSMO in Kansas, this study suggests the following:

- **Vision**: Provide reliable transportation for everyone with respect to the state's safety strategic plan.
- **Mission**: Increase the safety, mobility, and opportunities for reliable transportation for all users through statewide implementation of TSMO throughout the various dimensions.

5.1 Capability Maturity Model Self-Evaluation Process

Similar to the application of TSMO in other states, this project applied the CMM self-evaluation process to investigate the current state of practice at each dimension of capability. The self-evaluation was conducted via a survey to current employees of KDOT.

5.2 Survey Description

The self-evaluation survey, based on the proposed TSMO CMM self-evaluation process provided by AASHTO, consisted of five parts, each representing a dimension of capability and a preliminary analysis (AASHTO, n.d.). The survey began with a preliminary assessment of preexisting issues, including severe weather; disruptive vehicle crashes or breakdowns; significant road construction delay; large regular, special events; significant peak-hour traffic congestion; and inadequate traffic signal timing, and then inquired about potential problems that may have occurred because of those preexisting issues. The survey continued with a series of questions regarding business process, systems engineering, performance measurements, collaboration, and organization and staffing. These categories were selected after discussions with KDOT project managers.

The survey and corresponding participants were divided into two groups based on whether or not their job descriptions included management responsibilities. The first group (Group 1) consisted of KDOT directors (9), bureau chiefs (11), and section heads (23). All offices and areas of KDOT were included in Group 1. The second group (Group 2) included area/metro engineers for all areas in Kansas (23) and district engineers (engineers, construction engineers, and maintenance engineers) for all six districts (17).

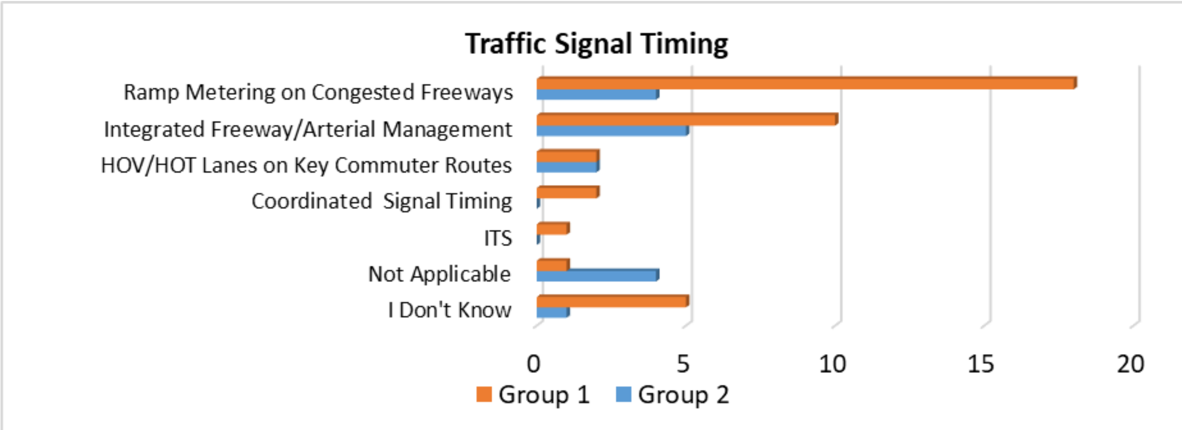
The survey, which was built in Qualtrics, was designed to maximize responses via multiple choice and short-answer responses, and it was administered to all groups via several emails that were forwarded by the researchers and the project manager. From the 43 surveyed participants of Group 1, the research team received 35 survey responses (approximately 81% response rate). From the 40 surveyed participants of Group 2, the team received 18 survey responses (approximately 45% response rate). Overall, the average response rate was 63.8%, which is considered satisfactory. All survey questions are provided in the Appendix.

Chapter 6: Survey Summary

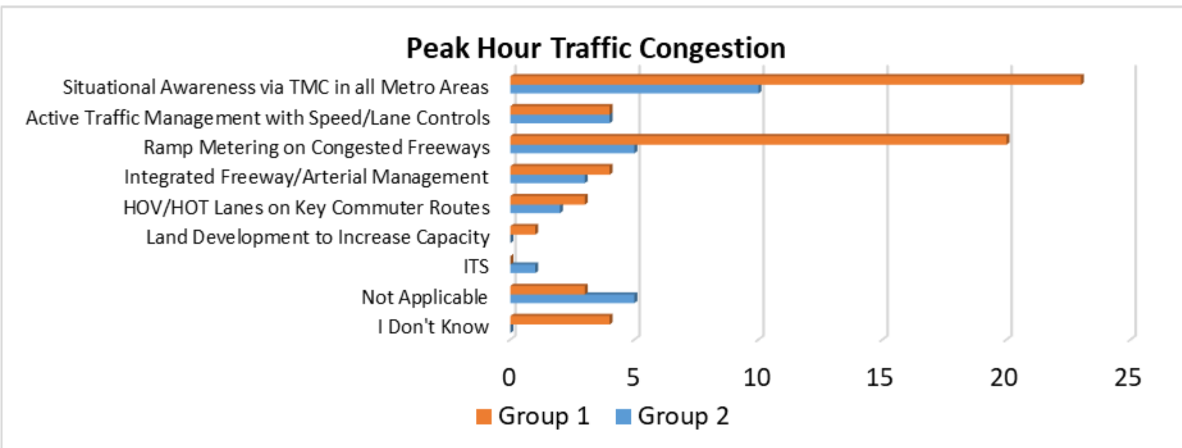
6.1 Preliminary Assessment

The preliminary assessment refers to existing strategies that are deployed in cases of severe weather, disruptive vehicle crashes and breakdowns, significant road construction delays, special events, peak-hour traffic congestion, and signal timing. Responses from managers and engineers were classified and are shown in Group 1 and Group 2, respectively, in the figure.

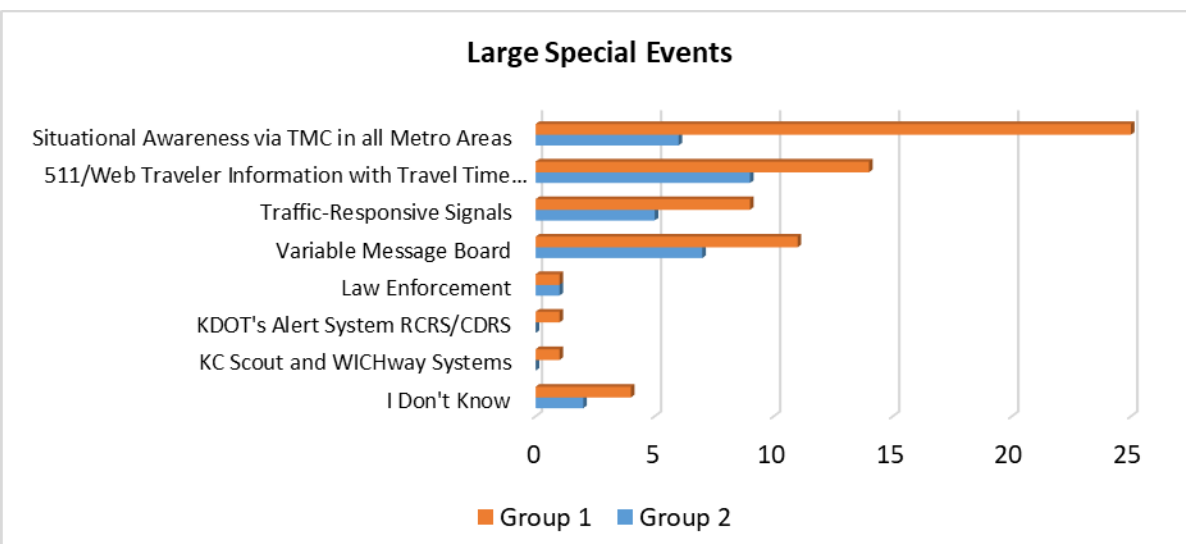
As shown in Figure 6.1a, ramp metering and integrated freeway/arterial management were frequent countermeasures for signal timing concerns. However, when peak-hour congestion was a concern, situational awareness via TMCs and ramp metering were deployed most frequently (Figure 6.1b). For large special events, situational awareness via TMCs and 511-traveler information were the most frequent countermeasures (Figure 6.1c). Likewise, concern regarding road construction delays typically resulted in the deployment of situational awareness via TMCs, 511-traveler information, work zone traffic management, and incident management partnerships (Figure 6.1d). Concerns regarding disruptive crashes and breakdowns were addressed by TMCs in urban and rural areas, incident management partnerships, the 511-traveler information system, and ramp metering (Figure 6.1e), while the 511-traveler information system and dynamic message signs (DMS) were among the most frequent strategies suggested by KDOT for severe weather (Figure 6.1f).


Traffic Signal Timing
Ramp Metering on Congested Freeways
Integrated Freeway/Arterial Management
HOV/HOT Lanes on Key Commuter Routes
Coordinated Signal Timing
ITS
Not Applicable
I Don't Know
0
5
10
15
20
Group 1
Group 2

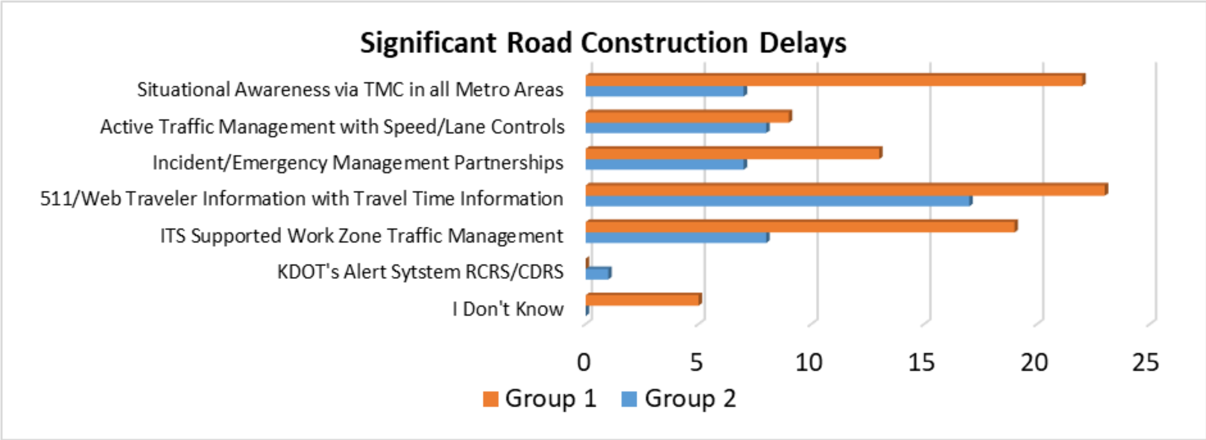
(a)


Peak Hour Traffic Congestion
Situational Awareness via TMC in all Metro Areas
Active Traffic Management with Speed/Lane Controls
Ramp Metering on Congested Freeways
Integrated Freeway/Arterial Management
HOV/HOT Lanes on Key Commuter Routes
Land Development to Increase Capacity
ITS
Not Applicable
I Don't Know
0
5
10
15
20
25
Group 1
Group 2

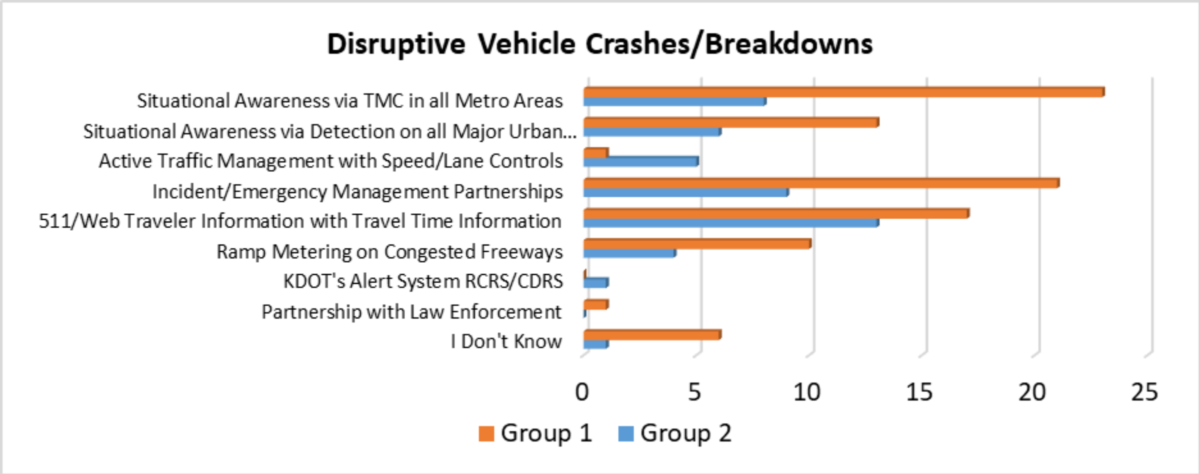
(b)


Large Special Events
Situational Awareness via TMC in all Metro Areas
511/Web Traveler Information with Travel Time...
Traffic-Responsive Signals
Variable Message Board
Law Enforcement
KDOT's Alert System RCRS/CDRS
KC Scout and WICHway Systems
I Don't Know
0
5
10
15
20
25
Group 1
Group 2

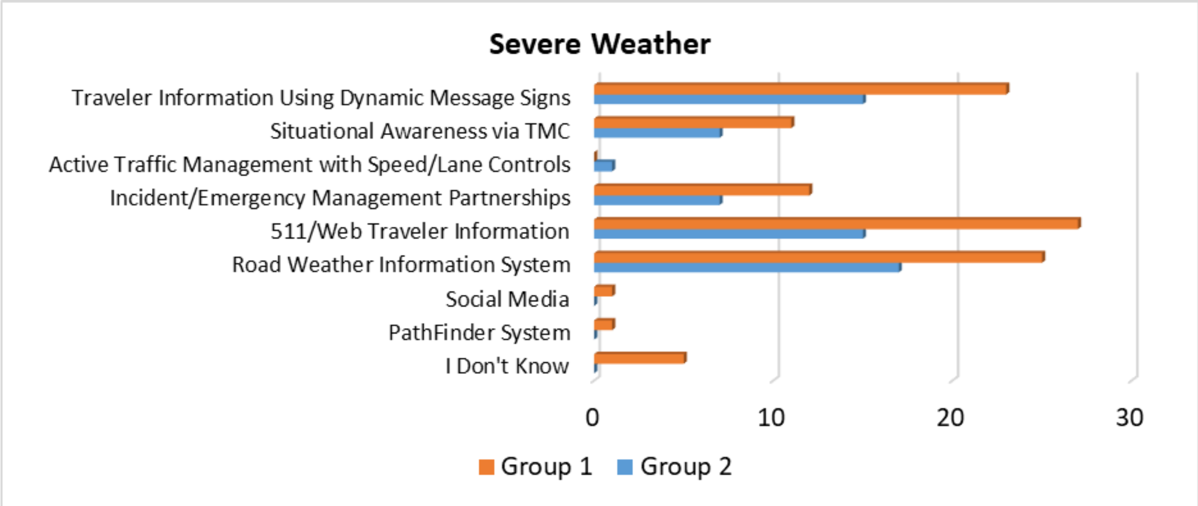
(c)



(d)



(e)



(f)

Figure 6.1: Preliminary Assessment Results for a) Traffic Signal Timing, b) Peak-Hour Traffic Congestion, c) Large Special Event, d) Significant Road Construction Delays, e) Disruptive Vehicle Crashes, f) Severe Weather

The next step in the preliminary assessment was to identify strategies that are currently deployed in Kansas. When asked to confirm the implementation of multiple TSMO-related activities, more than 80% of survey participants indicated usage of the traveler information system, especially for emergencies, severe weather and alerts, work zones and road closures, disruptive vehicle crashes, and event notifications. Although work zones are equipped with ITS features according to 58% of survey responders, they are not modeled for traffic impact and safety studies. Approximately 45% of survey recipients reported usage of incident command management and national incident management training for emergency responders, 64% of respondents reported implementation of traffic management plans in case of special events, and 10%–40% of survey participants indicated deployment of traffic responsive signalization, arterial TMC, ITS application on interstate corridors, after-action report collection for a major traffic incident, 24x7 emergency management center (EMC), 24x7 motorist assist, and incident command management. Less than 10% of the participants indicated the deployment of incident clearing time, real-time coordination between the freeway and arterial, and ITS application on transit. Interestingly, the “I don’t know” responses varied from 23% to 84% for all questions, which indicates a lack of knowledge regarding current strategies in Kansas.

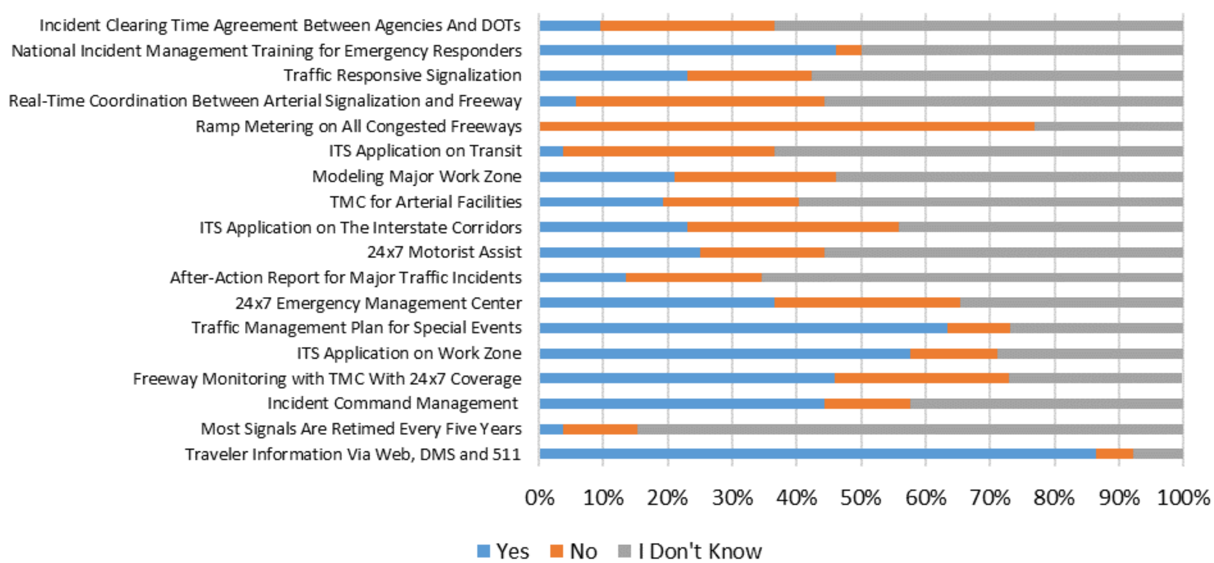


Figure 6.2: Current Practices

6.2 Business Process Dimension

Business process, the first dimension of capability evaluated within the survey, was categorized as planning process or program and budgeting. According to survey responses from engineers (Group 2), 83% and 50% reported projects geared toward managing traffic operations during and after construction, respectively. Approximately 83% of participants indicated the budgetary allocation of financial resources for traffic operations. Participants who responded positively to the traffic budget allocation also indicated that funds for safety and mobility projects are assigned through the typical funding mechanism (bidding) and project prioritization, and that, although a formal business process exists between DOTs, local government, and MPOs, improvement is needed. Survey respondents who positively reported traffic budget allocation also identified a multiyear operational plan for the capital cost and staged traffic operation with determined sources of funding and strategy prioritization for emergency situations with the available budget. Participants who selected “I don’t know” were discarded from the analysis in order to focus on participants who were aware of the funding situation.

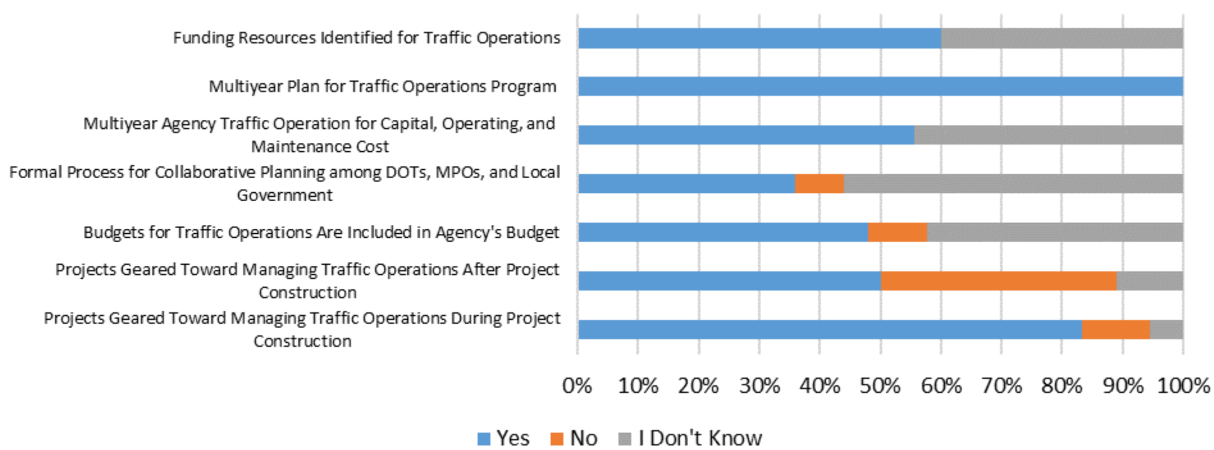


Figure 6.3: Budget for Traffic Operations

The next step of the survey sought to evaluate whether the unit’s mission, vision, and goals were defined for subjects related to traffic operations strategies, safety, congestion management, and delay reduction. Similar to the previous section, the research focus was on recipients who were aware of the DOT’s vision, mission, and goals; therefore, “I don’t know” responses were removed, and the percentages were recalculated based on yes or no responses (Figure 6.4). According to survey responses, 46% of the participants confirmed that their unit specifies vision, mission, and strategic goals for traffic operations. Approximately 85% of the participants confirmed that the mission, vision, and strategic objective aim to improve mobility and safety programs, and the majority acknowledged that the mission is being revised based on payoffs and emergency conditions.

Strategy prioritization is also considered in traffic operation budget allocation, with survey participants indicating that non-recurring congestion ranked 2.9 out of 5, with 5 being the highest priority. According to 67% of the participants, strategies related to traffic operations are reviewed based on their payoffs, 74% of the participants indicated that the strategies have been prioritized in case of an emergency situation, and 74% indicated that the immediate action plan (such as budgeting, manpower, equipment, machinery, and ITS structure) is available.

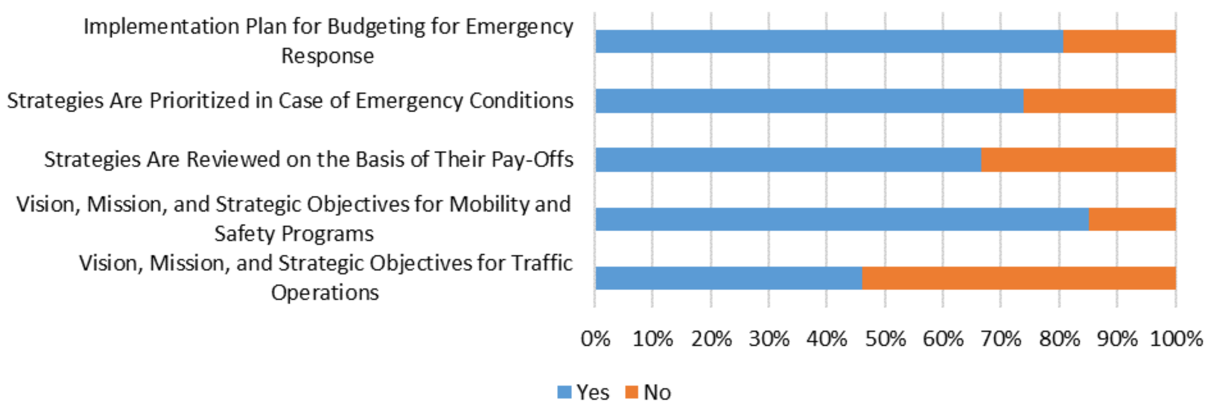


Figure 6.4: Budgeting and Funding (Mission and Vision)

Funding availability plays a critical role in funding safety and mobility plans for construction and operations, including identification of the funding source, unit/capital cost estimates, and 5–6-year-cycle cost estimates. Considering only the yes or no responses, all participants stated that funding sources have been identified, although some participants specified that the funding source has not been identified within their specific area. Approximately 80% of survey participants reported availability of unit cost estimates for traffic operations, while 85% indicated availability of capital cost. As shown in Figure 6.5, 40% of the respondents reported availability of a 5–6-year-estimate cost, and significant consideration was given to outsourcing. Communication, equipment, and field devices were the most frequent items identified for cost estimates. The survey also asked participants to identify the source of funding for construction and final project phases; normal funding, the bidding process, and basic prioritization systems were the most frequent responses.

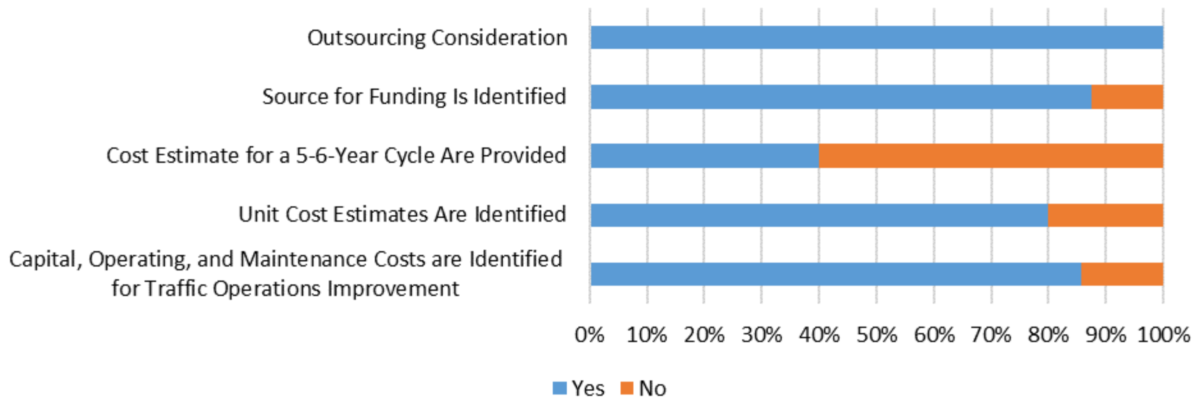


Figure 6.5: Budgeting and Funding (Application)

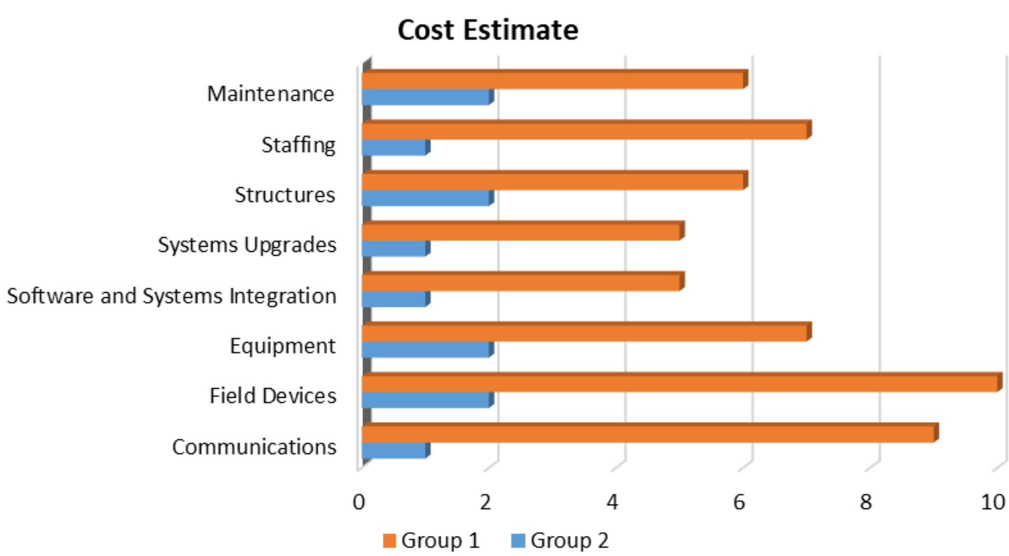


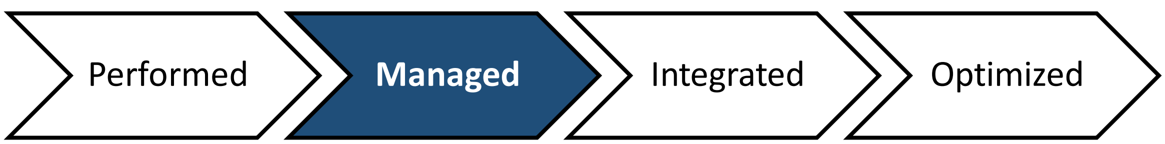
Figure 6.6: Response Frequency for Cost Estimate Items

The following conclusions were made after survey responses regarding the business process were compiled:

- Although funding resources have been identified for traffic operations, some lack of funds was reported for traffic operations projects during and after construction.

- Only 50% of the respondents confirmed the existence of a 5–6-year funding plan.
- Most (80%) of the survey respondents confirmed the existence of unit cost estimate for key elements.
- All of the respondents replied that a multiyear traffic operations plan exists.
- 67% of the respondents replied that strategies are reviewed and are prioritized based on their payoffs, but there is still room for improvement.
- All of the respondents replied that outsourcing is considered for acquisition strategies.

Based on the self-assessment summary regarding TSMO goals, deficiencies, networks, strategies, and common priorities, the status of the business process dimension of capability in Kansas can be classified at the "Managed" level.



6.3 Systems and Technology Dimension

The systems and technology dimension focuses on system interoperability, the impact of technology on decision making, ITS equipment, standards, data integration, updates for technology and software, and training for new technologies. Fifty-nine percent of survey participants identified lack of system interoperability for maintaining and updating software and hardware. Survey results further revealed the lack of committee to improve inoperability. Survey participants also indicated the lack of ITS standards to support interoperability (67%) and system development (33%), while constant system monitoring to ensure ITS architectural relevancy is not reported according to 75% of the responses. Although training sessions are available for individuals who work directly with new technology, adequate training for standards is not available according to 71% of the responses. Figure 6.7a includes all responses provided in the survey, while "I don't know" responses were removed in Figure 6.7b.

The survey also asked about funding allocation to improve systems and technology in transportation fields such as traffic operation, construction, and maintenance. Results showed that 27% of the allocation of funds goes to construction, while 23% and 19% is allocated to operations and maintenance, respectively.

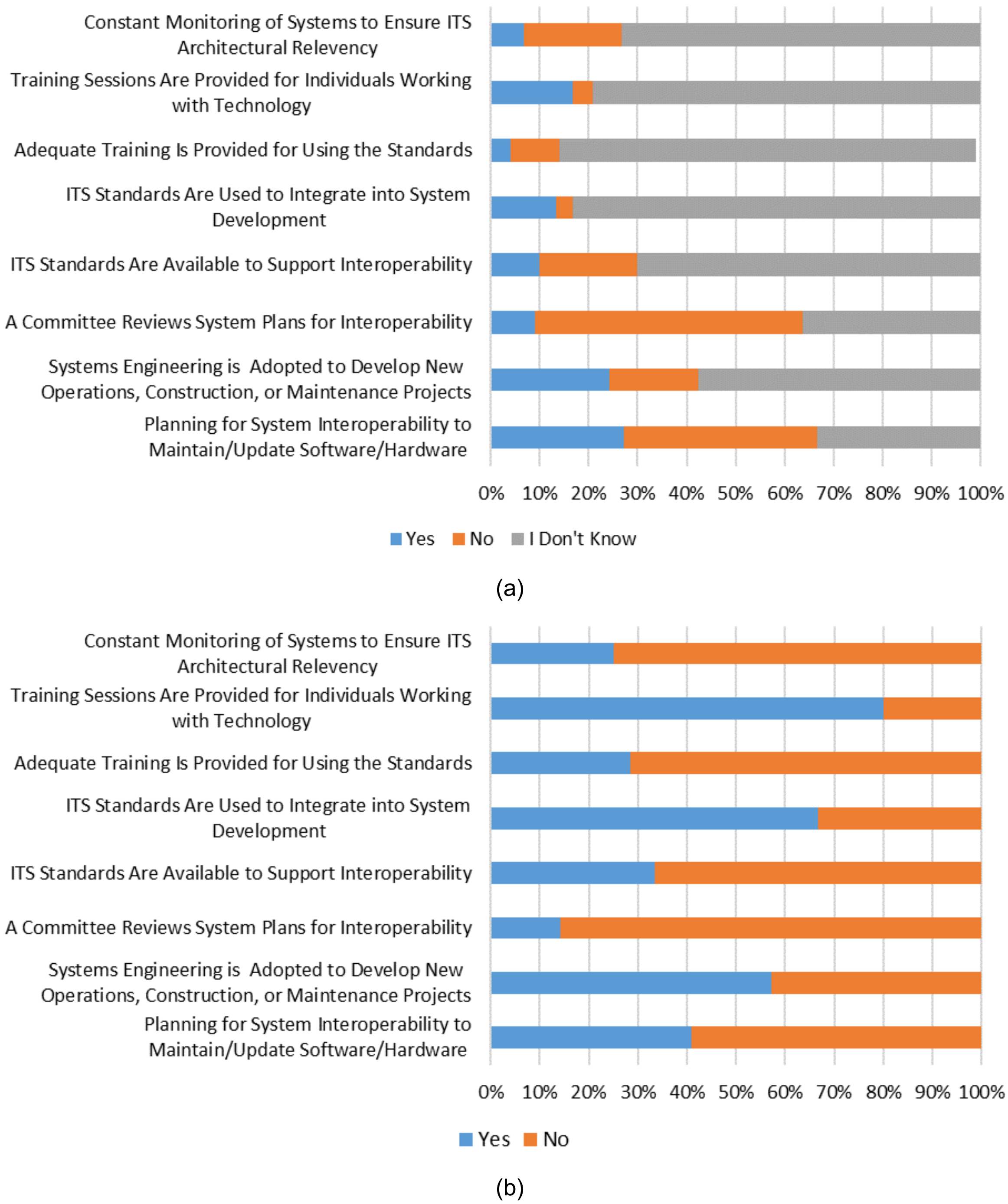


Figure 6.7: System Interoperability (a) All Responses, (b) Only Yes/No Responses

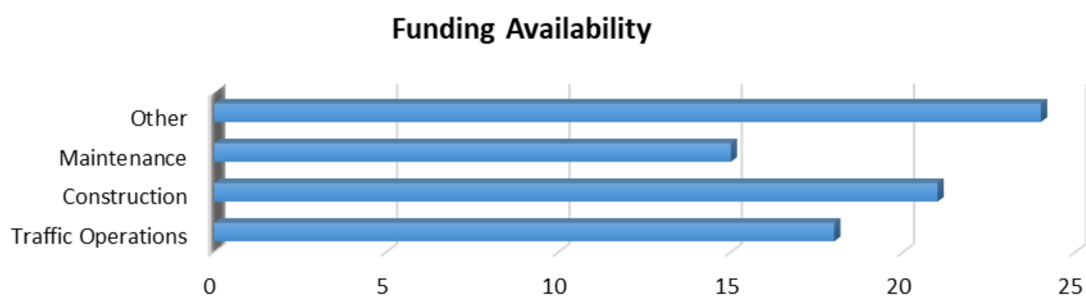


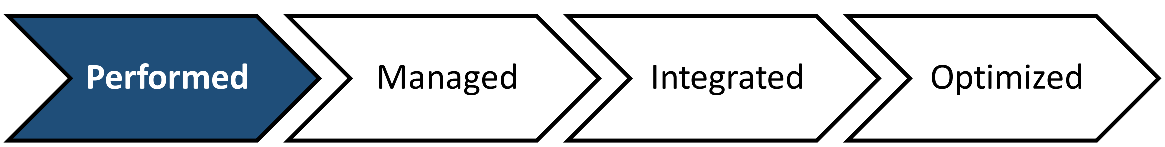
Figure 6.8: Frequency of Funding Availability to Improve Systems and Technology

The survey also inquired about the role of software and technology in safety and mobility decisions. Survey participants identified KC Scout, alert bulletins, WICHway, smart work zones, AASHTOWare Safety Analyst, Synchro, CCTV/radars for vehicle detection, MPO traffic models, Queue warning detection, DMS, real-time information system for road closure, and TMCs as current ITS features.

The main conclusions from the systems and technology survey are as follows:

- Constant monitoring of systems and technology is limited.
- Training sessions are in place for new systems and technology to train personnel.
- No committees exist (or exist but at a limited level) to review plans for interoperability.
- ITS standards are not widespread to support interoperability.

Based on the self-assessment process, the current capability of the systems and technology dimension falls into the "Performed" level, or the lowest dimension of capability.



6.4 Performance Measurement Dimension

The self-evaluation survey assessed performance measurements that are currently monitored by KDOT. According to the survey, incidents, weather, work zones, and traveler information were among the most frequently monitored activities, while performance measurements for freight and signal control were less frequent.

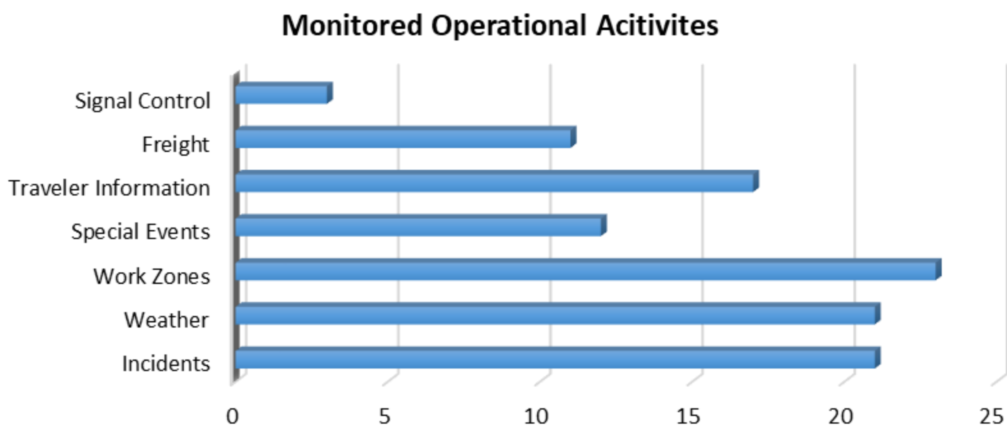


Figure 6.9: Frequency of Monitored Operational Activities

The next step for the performance measurement dimension was to evaluate the status of the outcome and output performance measurements. Outcome performance measurements, which measure the success of any system, relate to conditions outside the activity of a program and are of direct importance to customers and the public. Output performance measurements are more available, and they can be used to determine how efficiently resources are utilized to implement a given scale and level of specific TSMO function. In general, output performance measurements are actionable and can be changed by the agency. Outputs encompass the work an organization performs, while outcomes highlight what the outputs accomplish for the customer.

Identified output performance measurements by frequency were logged for each activity. Survey responses showed that, although output performance measurements exist in all activities, outcome performance measurements are not as prevalent. The outcome performance measurement to address MAP-21 requirements by the FHWA was requiring the Traffic Management Plan (TMP) for metro areas. Moreover, a crash reduction program to reduce crash severity was reported in accordance with the Strategic Highway Safety Plan (SHSP).

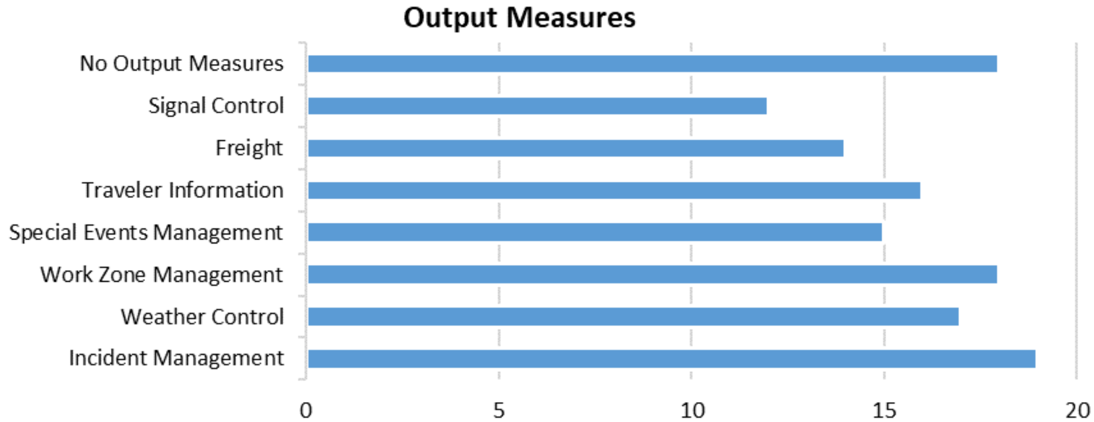


Figure 6.10: Frequency of Output Performance Measurements from Various Activities

Survey respondents expressed uncertainty about a unified definition for the output and outcome performance measurements throughout Kansas. An accountability program to set targets for performance measurements does not exist, and very limited efforts have been made to achieve these targets. Also, most respondents were unaware of sharing performance measurements with the public.

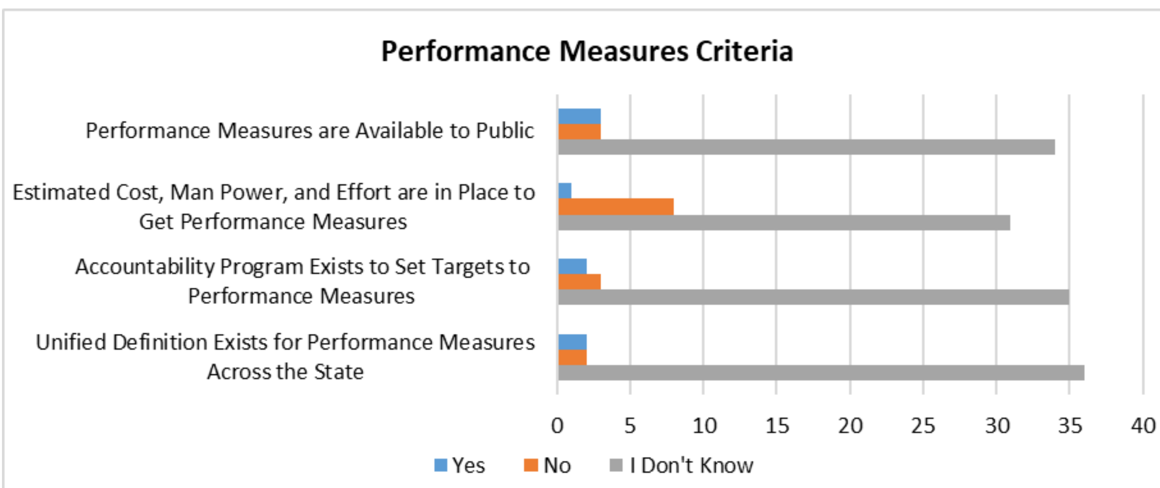


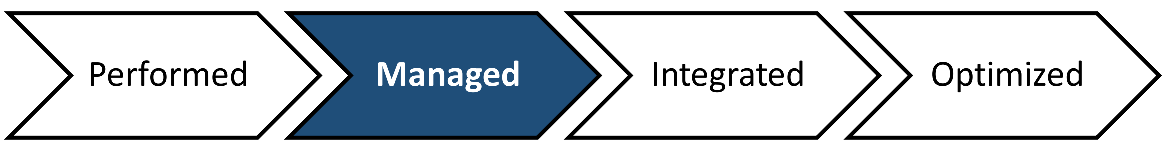
Figure 6.11: Frequency of Performance Measurements in Various Strategies

The main conclusions from the performance measurements survey are as follows:

- KDOT currently monitors and collects outputs data for incidents, weather, work zones, and traveler information.

- It is not clear whether an accountability program to set targets for performance measurements exists in Kansas, since from the five responses received, only the two were "yes."
- There is very limited application of outcome performance measurements.
- Participants' overall knowledge of performance measurements was limited, as evident from the majority of responses being "I don't know."
- Costs, manpower, efforts, and technology have not been estimated.

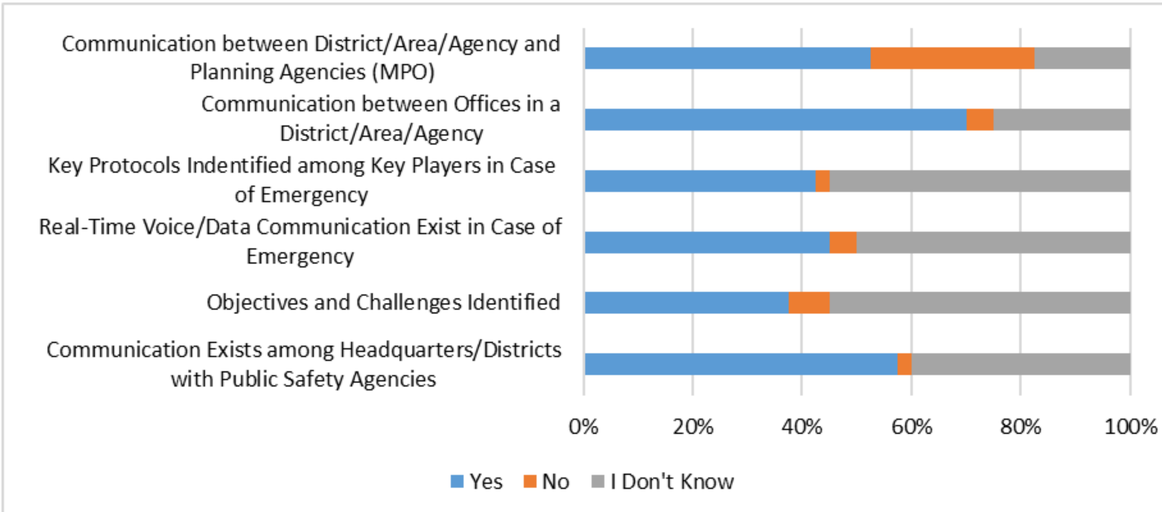
Based on the evaluation, TSMO strategies performance measurement is done largely via outputs, with limited after-action analysis; therefore, the current maturity level for performance measurements is "Managed."



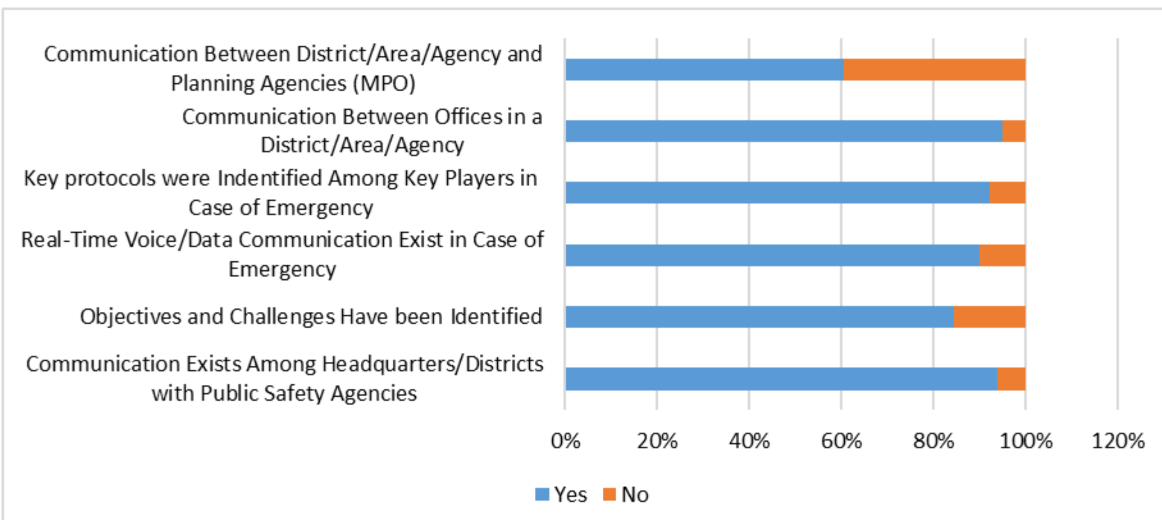
6.5 Collaboration Dimension

The next topic in the self-assessment survey included questions related to communication between KDOT, public safety agencies, and MPOs. Figure 6.12 summarizes all survey responses (Figure 6.12a) and yes/no responses (Figure 6.12b). According to survey respondents, communication between the respondents' offices, MPO, and public safety agencies (e.g., fire department, Emergency Medical Services [EMS], and/or police) exists, but improvement is needed. Real-time data communication is available in case of an emergency situation in which key protocols and procedures are implemented. Key challenges between the respondents' offices and other public offices were identified. As for mobility/safety-related activities, survey participants specified that service patrols and TMCs have been considered for outsourcing. Participants were also asked to identify interagency sections that are coordinated with their agency. According to survey results, interagencies such as emergency (e.g., incident/crashes, wildfires, flooding, and weather emergencies), maintenance (e.g., bridge inspection), construction (e.g., road closure and road/bridge construction), and mobility (e.g., congestion, event, coordinated incident management, and traffic control layout) most frequently coordinated with their respective agency (Figure 6.13).

Interagency communications include the Kansas Highway Patrol (KPH), Kansas Turnpike Authority (KTA), and KDOT. Mobility/safety-related activities identified for outsourcing and/or hybrid staffing include operation centers (KC Scout), TMCs and system management, service patrols, and design and planning.



(a)



(b)

Figure 6.12: Collaboration Dimension Summary (a) All Responses, (b) Only Yes/No Responses

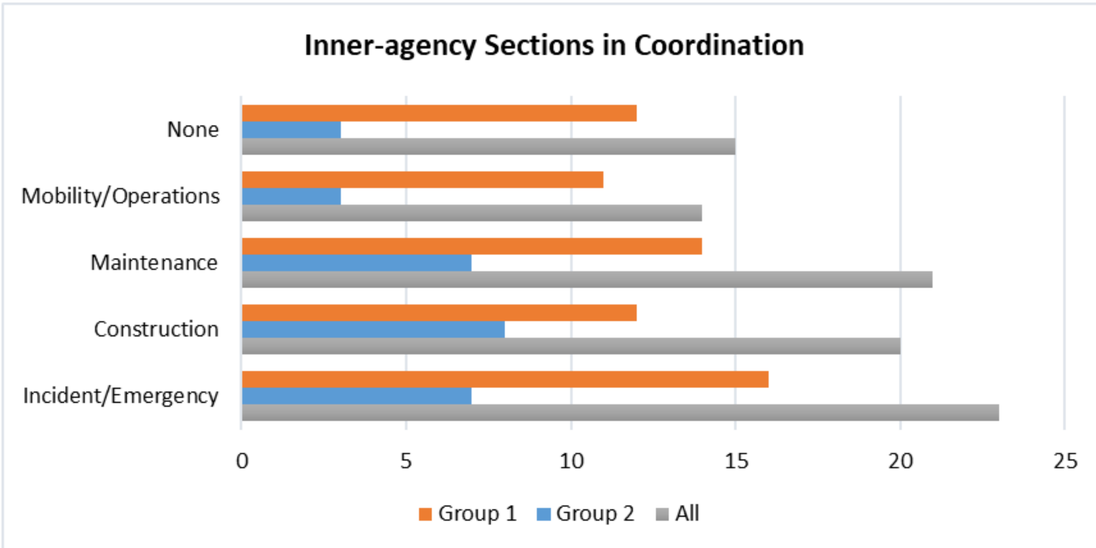


Figure 6.13: Sections in Coordination with the Respondents' Agency

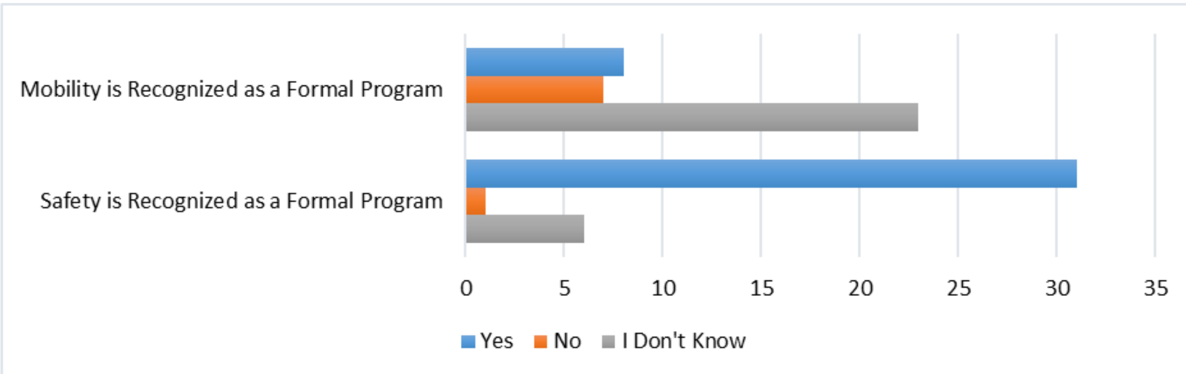
The main conclusions from the collaboration dimension survey are as follows:

- Collaboration between the offices and planning agencies (MPOs) exists at some level, but improvement is needed.
- Key protocols and procedures were identified among key players for emergency situations.
- Communication lines exist between key personnel at the headquarters and each district and public safety agency.
- Real-time data communication exists between key players in case of emergency events.

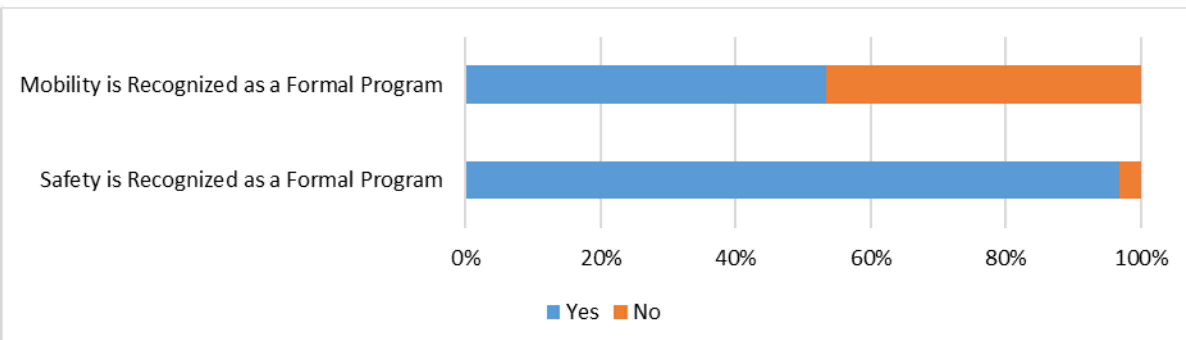
Based on this evaluation, collaboration between KDOT, safety offices, and MPOs is satisfactory, relationships and roles among units are rationalized, and core staff capacities are identified. However, top-level management positions and core staff for TSMO have not yet been established in the central office and districts, so the current maturity is the "Managed" level.

6.6 Organization and Staffing Dimension

The final part of the survey focused on the last dimension of capability, organization and staffing. The survey initially sought to recognize a formal safety program, mobility program, and funds to support its initiatives at headquarters, district, and area levels. Survey responses showed that safety program initiatives were considered more frequently than mobility program initiatives.



(a)



(b)

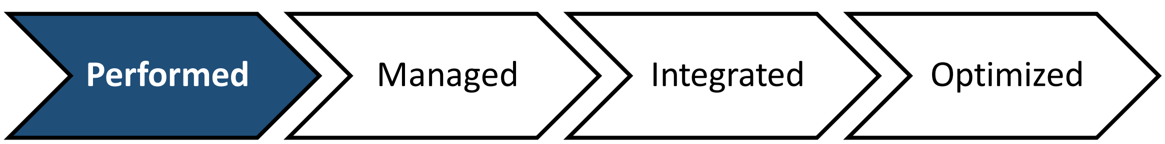
Figure 6.14: Safety and Mobility Program Initiatives (a) All Responses, (b) Only Yes/No Responses

When asked about relationships and lines of communication between headquarters and the field regarding responsibilities for traffic and safety applications, survey respondents identified field communications with public affairs; communication with district/area engineers, KDOT planning, and other area personnel; communication with headquarters for mobility and safety issues (e.g., supervising safety specialist in districts); field decision-making recommendations from headquarters; hierarchy chain command; and coordination between designers and staff throughout project development.

When asked about safety and mobility management responsibilities, survey responses included consistent connection with legislators; reviewing TMP and temporary traffic control (TTC) plan; addressing Americans with Disabilities Act (ADA) requirements; reviewing the SHSP, Behavioral Highway Safety Plan, Whichway, TMP, and TTC plan; and supervision of area and metro engineers for traffic safety and mobility in the area.

Finally, when asked about barriers in staff development, recruitment, retention, and organizational structure for safety and mobility programs, respondents reported lack of agency staff; insufficient staff experience; lack of sufficient funding for projects; heavy reliance on federal funding to advance safety initiatives; lack of funding for safety components of state-funded highway programs; lack of exposure to university curriculum; low pay and benefits; and no TSMO process within the organizational structure.

Repeatedly reported lack of staff and insufficient funding are barriers to ongoing programs. Survey responses showed that, although the relationship and roles between units are rationalized and core staff capacities are identified, TSMO has not been integrated into the agency structure. Therefore, the current organization and staffing dimension maturity level is "Performed."



Chapter 7: Moving Forward With TSMO

Once the current state of each dimension was determined, the action items and the path to the next level of capability needed to be identified.

7.1 Business Process Dimension

The primary objectives of the business process dimension should be establishing or developing a multiyear statewide TSMO plan and program and integrating new goals into department activities as formal and standard procedures. The following sections describe recommended actions to advance TSMO to the next level (Integrated) for each of the three subdimensions of the business process: the planning process, programming/budgeting, and project development/procurement.

7.1.1 Planning Process

The main goal of the planning process is to develop a multiyear TSMO plan and program for Kansas that is integrated into the statewide planning processes. This section provides recommendations on how to achieve this goal.

It is recommended to identify various opportunities for TSMO implementation in ongoing or future construction projects to reduce TSMO implementation costs. To achieve this, it is important to identify ITS equipment required for each project based on their payoffs. Because the lack of ITS standards was repeatedly reported within the survey, ITS should be incorporated into standard procedures for new projects. In addition, the development of working groups from operations and project development (design and construction) staff can help achieve this goal.

It is also recommended to extend KDOT's consultation in plan development with other KDOT offices, MPOs, and local public safety agencies. KDOT needs to work closely with other DOT offices to identify ongoing issues related to safety and mobility for short-term and long-term planning. Here, it would be important to analyze and evaluate TSMO strategy applications using performance measurements.

It is further recommended to identify state and federal funding for innovative projects, as well as track funding programs related to ITS, TSMO, or connected/automated vehicles, and identify areas where testbeds or pilots may be sought.

Lastly, it is recommended to extend the incorporation of TSMO into planning and programming to develop a statewide TSMO plan. To achieve this, it would be important to present policies that express the TSMO interests of the agency, and also include TSMO in regional multimodal planning and programming. It is also suggested to incorporate agency/area/district goals into TSMO, and identify existing deficiencies related to congestion, weather, construction and work zones, and special events. Establishment of a statewide standard approach to TSMO strategy application that includes ConOps, system architecture, technologies, and procedure could assist in achieving this goal. This effort requires working in groups with the central office statewide and district/regional operations staff.

7.1.2 Programming/Budgeting

The main goal of the programming/budgeting subdimension is to develop a multiyear statewide TSMO program and plan. To achieve this goal, it is recommended to develop a staged multiyear program and budget for statewide TSMO, that considers capital, staffing, maintenance, and ITS upgrade needs, as well as costs and benefits. It is also suggested to incorporate planning and budgeting processes into local partners, public safety agencies, etc. It is advised to create working groups that combine KDOT central office and statewide staff on programming and budgeting.

Consideration should also be given in making TSMO an explicit consolidated line item in the statewide budget to promote rational and transparent resource allocation, authorized by top management and implemented by central office budgeting staff. Administrative or legal adjustments may be required to accommodate TSMO-related budgets in case of restrictions to existing program resources. This can be performed by central office and budgeting leadership in collaboration with KDOT’s legal counsel.

7.1.3 Project Development/Procurement

The main focus of the project development/procurement subdimension is the creation of standardized procedures for the development and procurement of TSMO projects. To achieve this goal, KDOT will need to modify and document the existing project development process to incorporate TSMO in conjunction with systems and technology development. It is important to evaluate current experience with ITS/TSMO management of project development, as well as document the project development process that considers TSMO and integrate this process into KDOT's project development manuals. Senior management needs to be trained accordingly and collaboration between central office operations staff and project development and procurement staff needs to be maintained.

It is also recommended to identify and adapt procurement procedures for various TSMO strategy deployments. A working group could be created to develop appropriate state procurement strategies for expansion and enhancement of existing or new ITS and TSMO systems.

7.2 Systems and Technology Dimension

The main objectives of the systems and technology dimension include introducing systems engineering into the project development process and developing tools, equipment, and training sessions to support the standardized engineering process. The following sections describe recommended actions to advance TSMO to the next level (Managed) for each of the three subdimensions of the systems and technology process: regional architecture; systems engineering, testing, and validation; and standards and system interoperability.

7.2.1 Regional Architecture

In general, system architecture provides a framework for institutional agreement and technical integration for implementing ITS projects. It will be important to assign responsibilities for leading architecture development, improvement, and maintenance to a qualified person in the agency (architecture lead). The individual should have sufficient knowledge of TSMO ConOps, and should attend and hold training sessions for ITS architecture. If it is not possible to identify an architecture lead within KDOT, a consultant can undertake this role under the oversight of an individual within the agency.

It is also recommended to form a review committee to review the system architecture and review the functionality of stakeholders to ensure they are sufficiently represented by the architecture.

7.2.2 Systems Engineering, Testing, and Validation

Systems engineering is a methodology to design, update, and manage complex systems. It is also an interdisciplinary process that includes concept, design, focus on customer needs and requirement, documentation, and validation. It is important to adopt the systems engineering process as a requirement for project procurement and development and to develop policies that require systems engineering implementation to procure new systems or improve existing systems. Specific steps are required to be included in the systems engineering approach, such as risk management, configuration management, and ConOps. It is expected that senior management will develop the policy.

In addition, it is recommended to train personnel who interact with new technologies and high-tech systems. Although the survey indicated that some training sessions are in place, especially on new systems, the current system should be improved. Management staff could be required to participate in the development, enhancement, and utilization of advanced technology to attend a minimum of 16 hours of training related to systems engineering for advanced transportation projects.

7.2.3 Standards and System Interoperability

The standards and system interoperability subdimension facilitates data communication, software, and hardware exchange among regions. Therefore, standards must be integrated into systems engineering. It is proposed to identify and require standards that support the interoperability of various systems, and integrate standards developed by the ITS industry to harmonize data communications, database exchanges, and information displays among various systems into the system development and acquisition program.

It might also be useful to train systems development staff who encounter standards and system interoperability, and identify required courses and prepare training budget. A basic background of ITS standards is required for staff.

7.3 Performance Measurement Dimension

Performance measurements significantly impact the effectiveness of ongoing programs and are useful for decision-making. The main goal of the performance measurement dimension is to identify output and outcome performance measurements and utilize them to improve project management. The following sections describe recommended actions to advance TSMO to the next level (Integrated) for each of the three subdimensions of performance measurement: definition measurement, data acquisition, and utilization measurement.

7.3.1 Measures Definition

The main goal of defining measures is to identify outcome measures used for statewide and national reporting purposes. As a first step, it is advised to identify operational activities (e.g., special events, traveler information, freight, work zones, weather, incidents, etc.) that can be used to generate performance measures, and find practical output performance measures to determine the agency's efficiency in strategy applications.

The FHWA rules for performance measurement requirements need also to be reviewed. The FHWA defines a comprehensive list of recommended performance measurements for various operational activities, available in the Transportation Performance Management (TPM) segment on the FHWA website (FHWA, 2020a). A statewide task force can be created to improve existing output and outcome performance measurements based on FHWA standards.

All state, local, and regional plans and policies need to be reviewed to identify relevant performance measurements. In addition, KDOT's mission commitments must be reviewed and linked to appropriate performance measurements, specifically those related to travel time, delays, and reliability. Measures in related programs, such as crash-related measures that are relevant to both incident management and work zone management, should also be reviewed for potential overlap. Local performance issues must be compared with national approaches and consideration should be given to peer exchange. It is also recommended to consider customer satisfaction and feedback as a performance measurement (e.g., perceived congestion by the user). Performance measurements should be developed based on three dimensions: temporal (depending on the time-slice: peak hour, peak period, off-peak, weekend/holiday), spatial (depending on the geographic area: segment, corridor, subarea, and area-wide), and source of congestion (recurring and nonrecurring).

In addition, it is recommended to identify and establish policy accountability and reporting of a system's operational performance. The existing accountability program needs to be evaluated to identify improvements in measuring, data, action, and communication devices.

Lastly, it is advised to develop an outreach program to report performance measurements to the public. It is important to find methods to relate performance measurements to customer interest, including elected officials in major decisive roles, agency management, agency personnel responsible for programming the annual budget, and other agency and non-agency personnel who benefit from coordination with performance measurement reporting.

7.3.2 Data Acquisition

The primary goal of the data acquisition subdimension is to develop a data collection and management business plan for collecting, integrating, managing, reporting, and applying performance measurements. This could be achieved by developing output measures using available data, and reviewing the goals regarding each performance measurement (based on available data) and the ease of data retrieval, including the system (software) used for data collection and how data are stored continuously.

It is important to identify data gaps where new data collection is required, and develop a simple data management system to facilitate future expansion. A data acquisition plan for outcome performance measurements through indirect measurements and analytic methods must also be established. The data acquisition plan should be multipurpose and consider multiple operational activities, such as safety, planning, and freight. Staff knowledge regarding outcome performance measurements needs to be improved.

Consideration should be given to private data acquisition, including the use of data sources from a third-party vendor. Emerging technologies and private companies provide valuable data to improve system coverage for operational activities such as highway network, demand, and crash data.

7.3.3 Measures Utilization

The focus of the measures utilization subdimension is to develop a formal process that uses performance reports to measure the effectiveness of TSMO strategies. KDOT could create standard report on performance measurements for internal use so problems can be found, targeted, and addressed. The TSMO performance measurement reports could be developed periodically (weekly, monthly, quarterly, or annually), and a variety of performance measures could be included for reporting depending on data availability of operational activities (incidents, work zone, weather, special events). The reports should include trends analysis. Trends explain how conditions change in a system and can be categorized based on the region, time of day, and seasons. In addition, trends analysis may identify patterns and irregularities that cannot be explained readily and need further investigation. The analysis should also define what is acceptable by the agency and what is acceptable for the public. Trends can be extrapolated for future predictions. Based on future and current results of the performance measurements, qualitative scenario responses such as "do nothing," "business as usual," "maintain the current condition," or "aggressive action" are possible.

It is also recommended to develop an internal performance measurement data analysis process that includes targets and benchmarks. A process for setting hard targets must be established, considering input from a number of sources, including elected officials, professionals in the field, and the public. KDOT should also focus on performance measurements that are a current or future concern. For example, if Kansas City is going through major growth (but has not yet a concern for traffic congestion), the traffic should be monitored to develop future performance measurements once congestion gradually becomes an issue. Targets for the performance measurements should be set in accordance with MAP-21 requirements and goals for congestion, reliability, safety, and freight performance categories.

A process should be developed to incorporate operations performance measurements into the development of highway projects. Using the benefit-cost performance measurement analysis, the expert should rank the upcoming projects due to the increasingly competitive fiscal environment. Operation performance measurements must include delay imposed by recurring and non-recurring congestion, travel time reliability, and estimates of secondary crashes. Congestion reporting should be coordinated with planning staff, while incident reporting should be coordinated with safety staff.

Reporting of performance measurements internally, externally, and publically must also be improved. This could be done by developing reports and websites with dashboards to report performance measurements in various areas to a range of audiences. A brief (non-technical or technical, based on the audience) explanation could also be included while reporting the performance measurements. It is recommended to use visualization to communicate results to the audience for ease of understanding.

7.4 Collaboration Dimension

The development and implementation of TSMO relies on collaboration and coordination between all partners. The following sections describe recommended actions to advance TSMO to the next level (Integrated) for each of the three subdimensions of the collaboration dimension: collaboration with public safety agencies, collaboration with MPOs and local governments, and outsourcing.

7.4.1 Collaboration with Public Safety Agencies

The main goal of collaboration with public safety agencies is to establish working relationships and develop cooperation between agencies. More specifically, relationships between KDOT, district-level agencies, and public safety agencies (e.g., fire department, police department, sheriff department, and other emergency first responders), focusing on incident management and emergency responses must be established. Such collaboration could be achieved through meetings to discuss traffic-related issues and find mutual goals to increase traffic safety. In addition, working relationships between KDOT, district-level agencies, and public safety counterparts could be identified. It could also be helpful to determine mutual objectives among KDOT, public safety agencies, and MPOs to address TSMO challenges and performance management.

It is also recommended to review existing voice and data communication channels among KDOT, district-level agencies, and public safety offices, such as interagency communication and the mutual availability of computer-aided dispatch (CAD). This process will help in identifying potential improvement in communication and reaching the desired interoperability level.

For this goal, it is also important to review data requirements, roles, and responsibilities for incident and emergency responses in terms of real-time communication. Review of best practices (i.e., responsibilities, lines of communication, and protocols) from the National Incident and Management Systems (NIMS) could be helpful here (FEMA, 2020).

Consideration should be given in implementing formal agency agreements to develop a cooperative approach to incorporate TSMO in emergency and incident management. This could be achieved through the establishment of a Traffic Incident Management (TIM) working group comprised of field and management personnel, or by developing an agenda on traffic incident and emergency operations from peer and national best practices.

Lastly, it is recommended to develop guidance and training procedures for emergency incident response and institutionalize common protocols. The National Incident Management Responder Training Program can be used as a reference to develop this guidance (FHWA, n.d.).

7.4.2 Collaboration with MPOs and Local Governments

The main goal of this subdimension is to carry out collaborative planning and budgeting for priority improvements. Most importantly, the lines of communication among KDOT, MPOs, local government, transit authorities, and other transportation-related agencies need to be improved. As such, key participants within each sector (e.g., regional planning, system and planning, highway, transit, etc.) need to be identified to conduct a mutual briefing regarding ongoing and future TSMO policies. Coordination and inclusion of local government is also important while setting paths and goals for incident management and traffic safety.

TSMO should be developed during planning and programming. Local governments should participate in regional planning policies and funding priorities for potential TSMO activities. The role of TSMO in short-term and mobility, safety, livability, and responsibility in regional planning should be emphasized by providing materials for its role in those areas.

7.4.3 Outsourcing

The goal of this subdimension is to develop relevant policies for outsourcing. Outsourcing has shown to be revenue-raising and cost-saving in a variety of operational activities such as service patrols, traffic management centers, system maintenance, etc. It is recommended to identify functions and tasks that would benefit from outsourcing based on KDOT's objective to lower costs and training for unnecessary tasks, capitalizing on special interest, and improving the quality and application of new technology.

KDOT should weigh the advantages, disadvantages, and trade-offs regarding outsourcing, considering costs (capital, labor, management, maintenance), staffing (sufficient staff with required knowledge and training), and system (technology) availability. Performance measurement should be the basis for outsourcing contracts.

KDOT should also develop a business model regarding the role, benefit, and cost of outsourcing. For tasks in which outsourcing is considered, an annual resourcing and staffing plan that integrates public and private sector resources could be developed. It is also possible to conduct a pilot test to evaluate potential outsourcing for tasks that have not yet been outsourced but may be considered in the future.

7.5 Organization and Staffing Dimension

A combination of coordinated organizational functions and technically qualified staff with management authority and accountability must be attained. The following sections describe recommended actions to advance TSMO to the next level (Managed) for each of the four subdimensions of the organization and staffing dimension: program status, organizational structure, staff development, and staff requirement and retention.

7.5.1 Program Status

The goal of the program status subdimension is to advance TSMO from ad-hoc status towards a formal process with established responsibilities between key players at the statewide level and district/regional levels. To advance TSMO, leadership responsibilities at KDOT and regional levels need to be identified. This can be done by establishing agreement among top-level managers at KDOT, districts, and regions to support TSMO program development. Also, it is important to identify top-level management sponsors and champions at KDOT or key district offices, and clarify internal and external roles and relationships among TSMO-related units and personnel.

The relationships between senior management in KDOT and districts must also be clarified. All existing relationships among KDOT and district/area offices regarding TSMO activities need to be reviewed, and the organizational chart must be changed to include TSMO responsibilities as a parallel program with preexisting programs. TSMO's relative hierarchy compared to other program activities within KDOT should also be clarified.

7.5.2 Organizational Structure

The goal of the organizational structure subdimension is to identify the basis for efficient consolidation of relevant units. In doing so, it is important to develop a comprehensive organizational structure for TSMO, including a task force of TSMO managers. Unlike other civil engineering fields, TSMO has its own unique features that require a special organizational structure. TSMO ConOps activities and services features, such as real-time activity, dependence on close collaborators, and intensiveness of systems and technology should be identified. All identified features should be compared to the existing organizational structure, including ITS, systems operations, and incident management.

All relationships, lines of communication, span of control, and accountability for all TSMO-related units should be clearly defined. It is also recommended to define key functions to transition TSMO from concept to execution, including field operational responsibilities in different districts/areas and support activities (e.g., data archiving, standards development, procurement, system engineering, and planning).

It is also suggested to involve non-TSMO staff members in key positions to increase collaboration and cooperation, focusing on areas that require a high level of cooperation.

Development of a TSMO policy group of internal and external stakeholders could assist with the development of TSMO plans and policies. Potential participants may come from key agencies, senior managers, public safety agencies, private companies that work closely with KDOT, or other DOTs (e.g., MoDOT).

7.5.3 Staff Development

The staff development subdimension requires staff needs be met with respect to the development of TSMO activities. Core-TSMO technical and management capabilities required to develop the TSMO program need to be identified. The focus should be on required capabilities in systems and technology development, acquisition and implementation, as well as planning and programming, administration, and management.

KDOT should also develop TSMO positions descriptions, including roles and responsibilities. The position description should include position title, civil service classification, reporting relationships, function of the position, and knowledge, skills, and abilities (KSA). It should be determined if additional training is required for these positions.

In addition, it is important to assess whether existing TSMO staff meet the required KSA of TSMO, identify gaps, and implement appropriate training procedures. There may be training opportunities for key staff that require core and non-core skills, even from outside organizations such as the Institute of Transportation Engineers (ITE), FHWA, and/or the National Highway Institute.

Lastly, it is advised to work with peer states that are at a similar level of capability to obtain useful examples of TSMO strategy applications, staff development, and resource allocations.

7.5.4 Staff Recruitment and Retention

The staff recruitment and retention subdimension focuses on the recruitment and promotion of key staff within the agency. Existing staff should be surveyed to identify qualifications and interested individuals. To advance TSMO, it is recommended to identify and recruit essential core capacities that cannot be outsourced. Lastly, the recruitment process of peer agencies could be reviewed by contacting peer states and examining how they approach the recruitment process.

7.6 Summary and Conclusions

This research investigated the current level of TSMO implementation and integration within KDOT at the headquarters and all areas and districts in Kansas. A detailed questionnaire was sent to 43 KDOT senior employees (directors, bureau chiefs, and section heads), and 35 area engineers and metro engineers throughout Kansas. The questionnaire included an initial evaluation to understand which TSMO strategies are currently implemented and the level of knowledge of these strategies from the surveyed state employees. The survey was also designed to perform CMM analysis on five dimensions (business process, systems and technology, performance measurement, collaboration, and organization and staffing), as these were selected by the project monitors. Many of the survey responses were "I don't know," indicating a low level of familiarity with current processes.

Based on the answers received, the research team determined that the current status of the business process is "Managed," which indicates that there is a statewide plan and program related to TSMO. In addition, the current capability of the systems and technology dimension is "Performed," as many of the responses received on the relevant questions were negative, indicating ad-hoc approaches in systems engineering and interoperability. In terms of performance measurement, the survey concluded that several key performance measurements are recorded via outputs; however, due to limited after-action analysis, the current maturity level is "Managed." In terms of collaboration, the survey revealed that some communication channels exist between various KDOT offices and MPOs, between the headquarters and each district, and between key players in case of emergency events. As such, collaboration between KDOT, the safety offices, and the MPOs is at a satisfactory level, and the current maturity is at the "Managed" level. Lastly, in terms of organization and staffing, survey responses showed a lack of staff and insufficient funding within KDOT, which constitutes significant barriers to ongoing programs. Also, results indicated that the relationship and roles between units are rationalized, and, although core staff capacities have been identified, TSMO has not been integrated into the overall agency structure. Therefore, the organization and staffing dimension maturity level is "Performed."

After the CMM evaluation was completed, the research team prepared a complete list of recommendations in the form of actions and targets to advance each of the five dimensions to the next levels of capability. The findings of this report suggest specific steps that KDOT must take to advance TSMO regionwide within its operation.

References

American Association of State Highway and Transportation Officials (AASHTO). (n.d.). *Guidance to improving transportation systems management and operations*. Retrieved from http://www.aashtoTSMOguidance.org/

Federal Emergency Management Agency (FEMA). (2020). *National Incident Management System (NIMS)*. Retrieved from https://www.fema.gov/national-incident-management-system

Federal Highway Administration (FHWA). (n.d.). *SHRP2 solutions: National traffic incident management responder training program (L12/L32A/L32B)*. Retrieved from https://www.fhwa.dot.gov/goshrp2/Solutions/Reliability/L12_L32A_L32B/National_Traffic_Incident_Management_Responder_Training_Program

Federal Highway Administration (FHWA). (2013). *MAP-21: Performance management*. Retrieved from https://www.fhwa.dot.gov/map21/factsheets/pm.cfm

Federal Highway Administration (FHWA). (2015). *Organizing for reliability – Capability maturity model assessment and implementation plans executive summary*. Retrieved from https://ops.fhwa.dot.gov/docs/cmmexesum/cmmexsum.pdf

Federal Highway Administration (FHWA). (2020a). *Transportation performance management: TPM guidance*. Retrieved from https://www.fhwa.dot.gov/tpm/guidance/

Federal Highway Administration (FHWA). (2020b). *What is TSMO?* Retrieved from https://ops.fhwa.dot.gov/TSMO/index.htm

Florida Department of Transportation (FDOT). (2017). *Transportation systems management and operations (TSM&O) strategic plan*. Retrieved from https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/content/traffic/doc_library/pdf/2017-tsm-and-o-strat-plan-aug-24-2017-final.pdf?sfvrsn=d38c3054_0

Iowa Department of Transportation (Iowa DOT). (2016). *Transportation systems management and operations (TSMO) strategic plan*. Retrieved from https://iowadot.gov/TSMO/TSMO-Strategic-Plan.pdf?ver=2016-05-02-113238-673

Maryland Department of Transportation (MDOT). (2016). *Maryland transportation systems management & operations strategic implementation plan*. Retrieved from https://www.roads.maryland.gov/OPPEN/MD_TSMO_Strategic%20Implementation%20Plan_Aug%202016.pdf

Missouri Department of Transportation (MoDOT). (2017). *Transportation systems management and operations (TSM&O) program and action plan*. Retrieved from https://itsheartland.org/wp-content/uploads/2018/10/MoDOT-TSMO-Program-Plan.pdf

Texas Department of Transportation (TxDOT). (2017). *TxDOT transportation systems management and operations (TSMO) statewide strategic plan*. Retrieved from https://ftp.dot.state.tx.us/pub/txdot-info/trf/tsmo/statewide-strategic-plan.pdf

Transportation Research Board (TRB). (2015). *The second Strategic Highway Research Program (SHRP2)*. Retrieved from http://www.trb.org/StrategicHighwayResearchProgram2SHRP2/Blank2.aspx

Appendix: Survey Description

A.1 Pre-Evaluation [ALL GROUPS]

This initial step is to determine the area of concerns for each District and implementation status of various strategies.

1.1. When severe weather is a major concern, which of the following strategies are currently being deployed or considered?
   a. Traveler Information Using Dynamic Message Signs
   b. Situational Awareness via Traffic Management Center
   c. Active Traffic Management with Speed/Lane Controls
   d. Incident/Emergency Management Partnerships
   e. 511/Web Traveler Information
      - With Travel Time Information
      - With up to date road condition information
   f. Road Weather Information System
   g. Other: __________________

1.2. When **Disruptive Vehicle Crashes/Breakdowns** are a major concern, which of the following strategies are currently being deployed or considered?
   a. Situational Awareness via Traffic Management Center in all Metro Areas
   b. Situational Awareness via Surveillance and Detection on all Major Urban Corridors
   c. Active Traffic Management with Speed/Lane Controls
   d. Incident/Emergency Management Partnerships
   e. 511/Web Traveler Information with Travel Time Information
   f. Ramp Metering on Congested Freeways
   g. Other: _________________

1.3. When **Significant Road Construction Delays are** a major concern, which of the following strategies are currently being deployed or considered?
   a. Situational Awareness via Traffic Management Center in all Metro Areas
   b. Active Traffic Management with Speed/Lane Controls
   c. Incident/Emergency Management Partnerships
   d. 511/Web Traveler Information with Travel Time Information
   e. ITS Supported Work Zone Traffic Management
   f. Other: _________________

1.4. When **Large Special Events are** a major concern, which of the following strategies are currently being deployed or considered?
   a. Situational Awareness via Traffic Management Center in all Metro Areas
   b. 511/Web Traveler Information with Travel Time Information
   c. Traffic-Responsive Signals
   d. Other: _________________

1.5. When **Peak Hour Traffic Congestion** is a major concern, which of the following strategies are currently being deployed or considered?
   a. Situational Awareness via Traffic Management Center in all Metro Areas
   b. Active Traffic Management with Speed/Lane Controls

c. Ramp Metering on Congested Freeways
d. Integrated Freeway/Arterial Management
e. HOV/HOT Lanes on Key Commuter Routes
f. Other: ________________

1.6. When **Traffic Signal Timing** is a major concern, which of the following strategies are currently being deployed or considered?
   a. Ramp Metering on Congested Freeways
   b. Integrated Freeway/Arterial Management
   c. HOV/HOT Lanes on Key Commuter Routes
   d. Other: ________________

1.7. Which of the following processes is currently being deployed or considered in your region of Kansas? Provide "yes," "no," "I don't know" to the following statements.
   a. Systems conditions data (e.g., travel time, weather, incidents, special events) are available to customers via 511, websites and on Dynamic Message Signs, at urban and rural locations.
   b. Most signal systems are retimed at least every five years.
   c. Incident Command System (used for coordinated incident management) is co-trained among DOT and public safety personnel.
   d. Work zone traffic management for projects includes ITS technology for motorist information, speed monitoring, and queue control.
   e. Freeway areas are monitored and controlled by Traffic Management Centers with 24x7 coverage.
      i. Yes, all freeway areas
      ii. Yes, some freeway areas
      iii. No
      iv. I don't know
   f. Traffic Management plans exist for special events or seasonal activities.
   g. Statewide Traffic or Emergency Management Centers operate 24x7.
   h. After-action reports are prepared following all major traffic incidents and used to adjust operational concepts.
      i. In your opinion, who should be responsible for preparing the after-action report?
   i. Motorist Assist provides peak and evening or 24x7 coverage.
   j. Interstate Corridors outside metro areas have uniform ITS applications statewide.
   k. Traffic Management Center coverage includes urban arterial facilities.
   l. Work zones are modeled for scheduling and managed in real time.
   m. Transit operations are coordinated with transit operator using ITS technology (such as HOV/HOT lanes, signal priorities, time of arrival).
   n. All congested freeways have ramp metering.
   o. Freeway operations and arterial signalization are coordinated in real time (Integrated Corridor Management).
   p. Traffic-responsive or traffic-adaptive signals are applied on arterial corridors with unpredictable traffic demand.
   q. Key incident responders and emergency managers have National Incident Management System training.

r. DOT, public safety, and towing incident responders have agreed-upon incident clearance times via formal agreement.
s. Other:________

A.2 Business Process

Planning Process

Provide “yes,” “no,” “I don’t know” to the following statements.

Group 2

1. Do the projects generated from your Area of KDOT include strategies geared toward managing traffic operations during and after project completion?

Group 2

2. Are budgets for traffic operations included in your part of the agency’s budget?
   a. Is there a formal process for collaborative planning among state DOT, local government, and MPOs in place?
   b. Does a multiyear agency statewide traffic operations plan and policy exist, including the capital, operating, and maintenance dimensions?
   c. Does a multiyear statewide costed and staged traffic operations program exist?
   d. Is there a sustainable funding resource base for traffic operations identified and utilized?
3. Does your unit’s (statewide or District/Area) mission, vision, and goals include traffic operations - related strategies and outcomes to specific stakeholders? If yes, go to the next questions:
   a. Does your agency’s mission, vision, and goals include mobility and safety programs, including congestion management, delay reduction, and improvement of reliability?
   b. On a scale from 1 to 5, to what degree are these programs focused on non-recurring congestion? (1 means not focused at all, and 5 completely focused)
   c. Have these strategies been reviewed on the basis of their payoff and projected improvements?
   d. Have strategies been prioritized in case of emergency responses due to inclement weather, debris, and land-slide, work zone events, or structure failures?
   e. During the emergency response, is there an implementation plan for immediate actions such as budgeting, manpower, equipment and machinery, ITS infrastructure, and roadside emergency service in place?

Program/Budgeting

Provide “yes,” “no,” “I don’t know” to the following statements.

4. How do you fund for safety and mobility impacts during construction and final condition? [comment box]
5. Have capital, operating, and maintenance cost estimates for specific traffic operations improvements been developed? If yes,
   a. Have unit cost estimates of key elements been identified? Elements to be included are communications, field devices, equipment, software and systems integration, systems upgrades, structures, staffing, and maintenance. (Check all that apply) make sure that selection is skipped if the answer is no/I don’t know.

b. Are costs determined for a 5-6 years budget cycle?
c. Have the sources for funding been identified?
d. Has any consideration been given to acquisition strategies such as turnkey, leasing, and outsourcing?

A.3 Systems And Technology

Regional Architectures

Provide "yes," "no," "I don't know" to the following statements.

Group 1

1. Has a person been identified in your Area of KDOT that is able to plan for software and hardware deployments in such a way to allow those systems to be interoperable? This could include signals or ITS or RWIS or Maintenance systems and could tie to regional or statewide systems.
   a. Does your Area of KDOT or any other area have a committee to review such system plans for interoperability?
2. How do you use technology and software to collect data? Provide specific examples. [comment box]
3. How do you use technology and software to make decisions for safety and mobility impacts during construction and final condition? Provide specific examples. [comment box]

Group 1

4. Systems engineering is a methodology by which complex hardware and software systems should be designed, updated, and managed. Is a systems engineering process adopted for the procurement and development of new projects?
5. Working together in a region requires standards that support the interoperability of various systems and ease of replacement of field and central system hardware and software operations. Standards developed for ITS are used for harmonizing data communications, database exchanges, and information displays among various systems.
   a. What means/ITS equipment do you use to facilitate interoperability? [comment box]
   b. Do you use specific ITS standards to support interoperability? Provide a description of standards and their application. [comment box]
   c. Are these standards integrated into the system development and acquisition program?
   d. If you are using standards, have you had adequate training to apply them to your unit?
6. Do you update technology and software during:
   a. Construction
   b. Maintenance
   c. Other:______
7. Is funding available for improving technologies and software in the following areas?
   a. Traffic operations
   b. Construction
   c. Maintenance
   d. Other:______
8. Are special training sessions provided to individuals who are working with technologies and software? If yes, please state the technologies and software that you have received training. [comment box]
9. Are system developments and your unit's activities regularly being monitored to ensure that ITS architectural relevancy is maintained?

a. What procedures/mechanisms are used to monitor such developments? [comment box]

Systems Engineering/Testing/Validation

10. Is a systems engineering approach used for the procurement and development of new systems, relevant to operations, construction, and maintenance?
11. List any training that you/other personnel has received related to the systems engineering process as it applies to advanced transportation projects. Include a number of training hours. [comment box]

A.4 Performance Measures

Provide "yes," "no," "I don't know" to the following statements.

Outcome performance measures are used to measure the success of a system. Outcomes relate to conditions that are outside the activity of a program itself and that are of direct importance to customers and the general public.

Output performance measures are more available and they can be used to determine how efficiently resources are utilized to implement a given scale and level of specific TSMO function. In general, **output** performance measures are **actionable, which can be changed by the agency**.

While outputs are the work that the organization does, outcomes are what these outputs accomplish for the customer. **Outcomes are not what the program itself did but the consequences of what the program did.**

1. Select the operational activities that your agency (statewide and District/Area) has identified to monitor.
   a. Incidents
   b. Weather
   c. work zones
   d. special events
   e. traveler information
   f. freight
   g. signal control
   h. Other: _______________
2. List the <u>output</u> performance measures your agency has identified for each activity. (Example measure may include a number of events responded to, time to complete a given function, coverage of detection, miles of safety service patrol, costs and level of effort, etc.)
   a. For incident management:
   b. For weather management:
   c. For work zone management:
   d. For special events management:
   e. For traveler information:
   f. For freight:
   g. For signal control:

   h. For Other: ______________
   i. No output performance measure is identified
3. List operations-specific <u>outcome</u> performance measures that your agency has identified to address the MAP-21 performance measurement requirements by FHWA, related to congestion, reliability, and freight movement. [comment box]
4. Is there a unified definition of the performance measures across the state?
5. Is there an accountability program in place to set targets to performance measures to be met within a specific time interval? Have you estimated the cost, technology, effort, and manpower to achieve these targets?
6. Are you making these performance measures available to the public?
   a. If yes, what information are you reporting and how? [comment box]
7. Do you have access to all required data to calculate the various performance measures needed?
8. Do you have set up a data management plan, to collect, store, retrieve data, and analyze output measures?

A.5 Collaboration

Provide "yes," "no," "I don't know" to the following statements.

Collaboration with Public Safety

1. Have working relationships and communications been established among key personnel at the headquarters level and District level with public safety agencies (fire, police, emergency management, and other responders), with focus on emergency, incident, and special event management? Have shared objectives and key challenges been identified?
2. Does a real-time voice and data communication coordination exist in case of an incident/emergency, to facilitate real-time availability of critical information?
3. Have key protocols and procedures been identified among key players in response to an incident/emergency?

Collaboration with other Offices and Headquarters

4. List the sections/units within your agency that you typically coordinate with, in case of [comment box]
   a. Incident/emergency:
   b. Construction:
   c. Maintenance:
   d. Mobility/operations:
5. List specific examples related to incidents/emergency, construction/maintenance, and mobility where your unit communicates with different units within KDOT. [comment box]
6. Have working relationships and communications been established among your office and other offices within your District/Area/agency?

Collaboration with MPO

7. Does your section/unit communicate with planning agencies (MPOs)?
   a. List specific examples of interagency communications. [comment box]

Outsourcing and Private Partnership

2. List identified mobility and safety-related activities that you have identified, which may lend themselves to outsourcing and/or hybrid staffing. Examples of activities include traffic management center staffing, service patrol, systems maintenance, and systems engineering, and planning and design responsibilities. [comment box]

A.6 Organization and Staffing

Provide "yes", "no", "I don't know" to the following statements.

1. Is <u>safety</u> recognized as a formal program within your agency? Is such a program established as a separate/visible entity, in terms of leadership and dedicated funds to support its initiatives at the Headquarters/District/Area level?
2. Is <u>mobility</u> recognized as a formal program within your agency? Is such a program established as a separate/visible entity, in terms of leadership and dedicated funds to support its initiatives at the Headquarters/District/Area level?
3. What relationships and lines of communication between Headquarters and the Field have been established (or are in the process of being established) to carry responsibilities for traffic safety and mobility applications? Please explain [comment box]
4. What safety and mobility management responsibilities exist in your unit? [comment box]

Group 2

5. Who is responsible for traffic safety and mobility in your Area of KDOT, and where are they in the chain of command? [comment box]
6. In your opinion, what barriers exist in terms of staff development, recruitment and retention, and organizational structure for establishing a safety and mobility program? [comment box]

K-TRAN

KANSAS TRANSPORTATION RESEARCH AND NEW-DEVELOPMENT PROGRAM

AD ASTRA PER ASPERA

Kansas

Department of Transportation