REPORT S2-L01-RR-1

Integrating Business Processes to Improve Travel Time Reliability

SHRP2 RELIABILITY RESEARCH

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STRATEGIC HIGHWAY RESEARCH PROGRAM
Accelerating solutions for highway safety, renewal, reliability, and capacity

TRANSPORTATION RESEARCH BOARD
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The Second

STRATEGIC HIGHWAY RESEARCH PROGRAM

SHRP 2 REPORT S2-L01-RR-1

Integrating Business Processes to Improve Travel Time Reliability

KIMLEY-HORN AND ASSOCIATES, INC.

In association with

PB CONSULT

TRANSPORTATION RESEARCH BOARD

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The research reported herein was performed by Kimley-Horn and Associates, Inc. (KHA) and PB Consult. KHA was the prime contractor for this study, and PB Consult served as subconsultant. Pierre Pretorius, PE, Senior Vice President at KHA, served as project manager and co-principal investigator. Lisa M. Burgess, Vice President at KHA, was the co-principal investigator. The other authors of this report and members of the research team were Thomas M. Fowler, PE, PTOE, Vice President, KHA; Jeffery W. Dale, PE, Project Engineer, KHA; Deanna Townsend, Analyst, KHA; Amy Lewis, PE, Project Engineer, KHA; Amanda R. Good, Analyst, KHA; and Steve Lockwood, PB Consult, review/technical adviser.

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The SHRP 2 Reliability Project L01 workshop Integrating Business Processes to Improve Travel Time Reliability was held in Phoenix, Ariz., from May 5 to 6, 2009. Attendees were Natalie Bettger, Senior Program Manager, North Central Texas Council of Governments; Mark Bush, PE, PTOE, Program Manager for Operations, American Association of State Highway and Transportation Officials; John Corbin, PE, PTOE, State Traffic Engineer, Wisconsin Department of Transportation; John Conrad, PE, CH2M Hill; Leslie Spencer-Fowler, ITS Program Manager, Kansas Department of Transportation; Catharine Jensen, Transportation Planner, Michigan Department of Transportation; Galen McGill, PE, Intelligent Transportation Systems Manager, Oregon Department of Transportation; Terry Mullins, Bureau Chief, Bureau of Emergency Medical Services and Trauma Systems, Arizona Department of Health Services; Rick Nelson, PE, Assistant Director of Operations, Nevada Department of Transportation; David Plazak, Senior Program Officer, SHRP 2; Faisal Saleem, ITS Program Manager, Maricopa County Department of Transportation/AZTech; Battle Whitley, PE, Division Operations Engineer, North Carolina Department of Transportation; Lisa M. Burgess, Vice President, KHA; Jeffery W. Dale, PE, Project Engineer, KHA; Thomas M. Fowler, PE, PTOE, Vice President, KHA; Amanda R. Good, Analyst, KHA; and Pierre Pretorius, PE, Senior Vice President, KHA.

FOREWORD

David J. Plazak, *SHRP 2 Senior Program Officer, Capacity and Reliability*

Improving travel time reliability is an emerging business activity for transportation agencies in the United States. To improve the reliability of travel times on their roadway networks, transportation agencies must advance on a number of fronts. These include collecting and analyzing data; integrating travel time reliability considerations into planning, programming, and project delivery; adopting innovative operational strategies and technologies; and modifying their institutional structures and business practices surrounding traffic operations. This report addresses various ways that transportation agencies can reengineer their day-to-day business practices to improve traffic operations, address nonrecurring traffic congestion, and improve the reliability of travel times delivered to roadway system users.

The report is based on a series of case studies, mainly from the United States, that describe successful business processes. One case study on active traffic management from the United Kingdom is also presented. The case studies show how business processes were successfully reengineered in operational areas such as traffic incident management (TIM), work zone management, planned special-event management, road weather management, and traffic control system management. Students of traffic operations will recognize these subject areas as corresponding to five of the seven causes of nonrecurring traffic congestion. (The two that are left out are related to inadequate base roadway capacity and fluctuations in travel demand.)

This research report and an accompanying guide also provide a detailed introduction to one of the most useful tools for business process reengineering: business process mapping. An approach to business process mapping developed by the IBM Corporation for use in automating business processes, called Business Process Modeling Notation (BPMN), is used in this report and the guide. This approach proved highly adaptable to business processes related to traffic operations. BPMN uses a straightforward, graphical approach to business processes, illustrating them with objects, flows, swim pools, and swim lanes. Business processes diagrammed using BPMN are simple to comprehend and communicate.

This report, along with the accompanying guide (which focuses on showing how to use BPMN for mapping traffic operations business processes) and other SHRP 2 Reliability products related to institutional structures and business process reengineering, is intended to help transportation agencies move forward in addressing nonrecurring traffic congestion and delivering more reliable travel times on their highway networks.

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Color versions of the figures in this report are available online:
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Executive Summary

Introduction

Reliability is defined in this report as consistency of travel times for a particular trip. Travelers tend to estimate how long a trip will take based on parameters such as distance, time of day, and their own experience. Impacts to the transportation network that cause unexpected delays introduce uncertainty in travel time reliability.

The SHRP 2 Reliability focus area addresses reliability by developing specific procedures, monitoring programs, and exploring alternatives to traditional traffic management strategies. The L01 project focused on processes that directly affect network and travel time reliability, particularly those processes that enable operational functions and in which integration plays a significant part. The project identified the core of operations business processes within transportation management that had day-to-day influence over operations and network performance and, in turn, had positive impacts on travel time reliability.

The project defined "business process" as a series of actions or activities that result in a specific or desired outcome to accomplish a specific organizational goal. There are many definitions of business processes, but in general these emphasize inputs, outputs, sequences of events, and value-added results. The research focused on business process analysis that was narrowed to key operational areas that have the most effect on travel time reliability. These included the following areas:

- Incident management;
- Work zone management;
- Planned special-event management;
- Road weather management; and
- Traffic control and traffic operations.

The following were the key research objectives for this project:

- Identify and document practices that successfully integrated business processes to improve travel time reliability;
- Define key business processes within DOT and transportation operations that were linked to travel time reliability;
- Demonstrate how successful strategies and business process integration activities may be adopted by other entities;
- Help agency managers identify critical gaps in their current processes, as well as strategies to address these gaps, including combining and integrating processes to achieve greater travel time reliability; and

- Coordinate L01 research activities with other ongoing research within the SHRP 2 Reliability focus area to extract the most innovative case study examples.

This research project used three key methods for input: literature review, case studies, and a two-day workshop (*1*) that involved a panel of experts.

Ten case studies were conducted, and they comprised locations throughout the United States and in the United Kingdom. The case studies were selected from an initial list of more than 50 programs and activities that was put together from the literature review, the research team's knowledge of various operations programs, and the input from industry experts. These case studies focused on process development and integration, types of congestion addressed, performance measures, benefits related to reliability, and lessons learned. Table ES.1 describes the 10 selected case studies.

A consistent approach to mapping business processes was required to analyze the identified processes and identify key integration points within the processes. Various business processes and their applicability to transportation agency processes were researched and the Business Process Modeling Notation (BPMN) was selected. BPMN was developed to improve communication between participants at the design level of a process with those at the implementation stage. It was used in L01 to model the integrated business process for each case study that was considered.

Table ES.1. Case Studies

Case Study	Description	Participating Agencies
Washington State DOT Joint Operations Policy Statement and Instant Tow Dispatch Program	Describes one of several programs the Washington State DOT and Washington State Patrol have implemented to support their Joint Operations Policy Statement for incident response and management	Washington DOT
Florida Road Rangers	Describes the use of contracted private tow vendors and sponsors to deliver a freeway service patrol program throughout the state of Florida	Florida DOT
United Kingdom Active Traffic Management	Describes the pilot corridor for ATM strategies for recurring congestion, as well as the incident response and management program	UK Highways Agency
North Carolina DOT Traffic and Safety Operations Committee	Describes North Carolina DOT's evaluation process for major work zones and traffic and safety impacts as a result of changes in work zones	North Carolina DOT
Michigan DOT Work Zone Traffic Control Modeling	Describes the microsimulation model developed by the Michigan DOT to model the impacts of freeway construction closures on an entire network	Michigan DOT
Kansas Speedway Special-Event Traffic Management	Describes the development of traffic management procedures to support large-scale-event traffic at the new speedway facility	Kansas DOT Kansas Highway Patrol
The Palace of Auburn Hills, Special-Event Traffic Management (Michigan)	Describes the traffic signal timing plans developed specifically for events at The Palace	Road Commission of Oakland County Auburn Hills Police Department
I-80 Winter State Line Closures (California and Nevada State Line)	Describes the series of processes that are initiated by the Nevada DOT to alert travelers when Caltrans closes the state line on I-80 during winter weather events	Nevada DOT
AZTech Regional Archived Data Server (Arizona)	Describes the evolution of a database initially developed to store freeway data into a central repository for agencies to be able to access real-time incident and traffic operations data	Maricopa County DOT/AZTech
San Pablo Avenue Signal Retiming (California)	Describes a multiagency approach to developing corridor traffic signal timing plans	Metropolitan Transportation Commission

The final step in the research and analysis portion of the project involved a two-day workshop with selected representation from across the country (*1*). The individuals who were invited were from the management level of their respective organizations but were for the most part still closely and integrally involved with operations and processes that could affect travel time reliability. The invitees represented various roles in the agencies where they worked, including planning, operations, and program management.

The following were the participating agencies in the workshop:

- American Association of State Highway and Transportation Officials;
- Arizona EMS Bureau;
- CH2M Hill;
- Kansas DOT;
- Kimley-Horn and Associates, Inc.;
- Maricopa County DOT/AZTech;
- Michigan DOT;
- Nevada DOT;
- North Carolina DOT;
- North Central Texas Council of Governments;
- Oregon DOT;
- Transportation Research Board/SHRP 2; and
- Wisconsin DOT.

The workshop involved a significant amount of conversation related to the issues and challenges in the participants' departments or agencies. There also was significant conversation about the enablers identified in each case study and about how these enablers could be categorized and shared to assist other agencies in integrating their processes. The participants evaluated the applicability of the findings from the case studies and identified the information that could benefit the operations of other agencies.

Findings

The initial intent of this project was to identify clearly defined integration points in successful business processes that demonstrated a link to improved travel time reliability. As the case studies evolved, it was found that there were two distinct aspects to process integration that were critical to support reliability-focused operations: process integration at the operations level and process integration at the institutional or programmatic level. At the operations level, various processes and activities evolve and are coordinated among those who are responsible for overseeing or carrying out operational initiatives. There is often a direct link between the process and the outcome. Process integration at the programmatic or institutional level is a much more complex undertaking. Not only are there different constraints to be worked through, but there is also a much less direct relationship between programmatic processes and their contribution to travel time reliability. Yet, institutionalizing processes so that they influence training, managing staff and resources, planning, programming, and policy making is essential to effective business process integration. In order to assist agencies in implementing business process change and integrating business processes, the key influences and obstacles were identified.

Based on the analysis of the case studies and the feedback from participants at the L01 workshop (*1*), influences on business processes were categorized into specific groups according to the event or directive that initiated the process change or process development. The categories were developed into the following three tiers:

- Major-directive, or "top-down," approach: This category includes influences that involve legislative requirements or management-level goals or directives.

- Event-driven approach: This includes cases in which a specific event or hazard prompts the need for improving operations.
- Needs-based, or "bottom-up," approach: This includes cases in which process change or development is initiated or coordinated at the operations level, often in response to specific activities or needs.

Whatever the influence, it was found that all agencies encounter obstacles when they begin to evaluate, implement, or modify a process. Some of these obstacles are common among agencies, while others are unique to individual agencies. Some of the obstacles can be conquered through modifications to the process; others may require institutional changes. The obstacles listed below were identified from the interviews and the L01 workshop. They were among the most common obstacles to integrating business processes to improve travel time reliability.

- Departments of transportation historically are construction and maintenance focused and not operations focused;
- Although reliability is emerging as an important metric among agencies, often it does not spur process implementation or integration;
- The agency stakeholders or partners who contribute to reliability-focused strategies often have different motivations and approaches to process implementation and process change; and
- The process modeling that was mapped out in the case studies may not be at a level that is typical of how a DOT or other stakeholder agency would view individual operational processes, creating a challenge in identifying critical gaps or breakdowns in specific processes.

Conclusions

The case studies included in the research represent a broad range of potential processes and integration strategies and include process integration at both the operations and institutional levels. There are benefits to be derived from these case studies that could be applied in other areas as well. Guidance from the L01 workshop participants indicated that there would be more benefit in generalizing outcomes and deriving common elements from across the profiled processes. Figure ES.1 provides a representation of the generalized steps that can be referenced for mapping out business processes, showing common elements and factors to successfully integrate and institutionalize business processes.

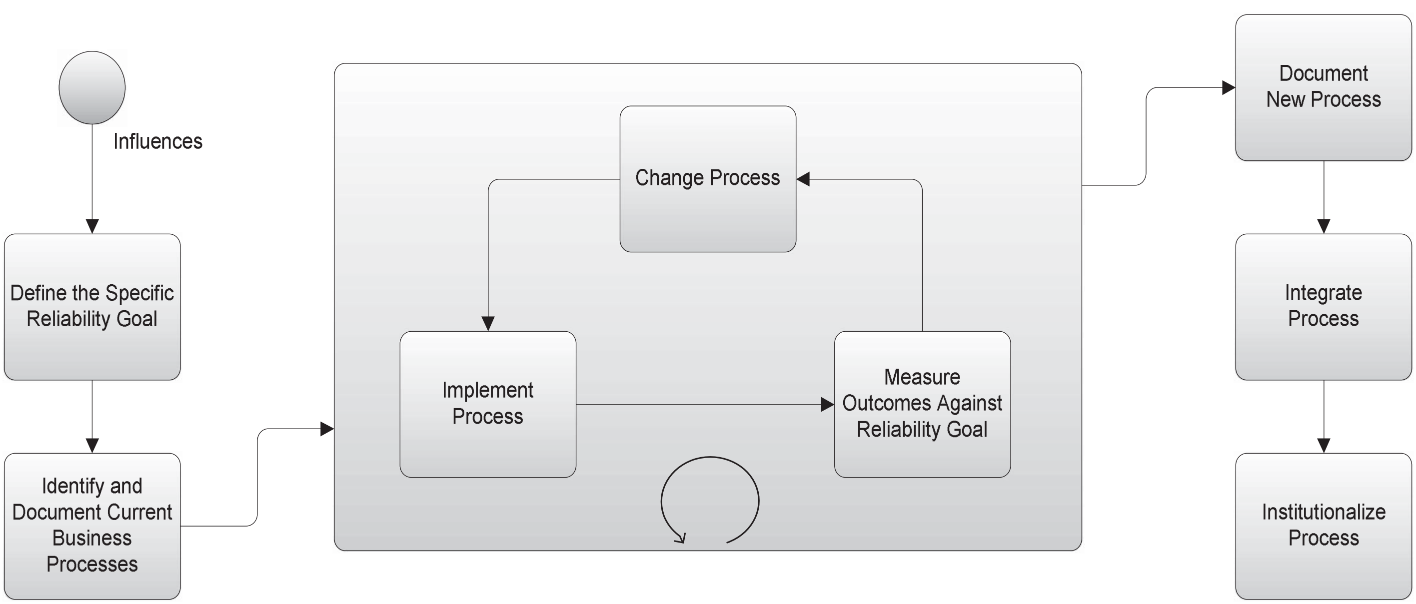

Figure ES.1. Steps in business process mapping.

Each of the steps in the business process mapping process is crucial to fully implementing a business process. Of all these steps, it is perhaps the institutionalization of the process that is most important in successfully translating a process into a core process within an organization. The research from the case studies suggests that implementing a process change and integrating various processes often occur at the operations level, but institutionalizing the process typically requires the participation and support of higher levels of the organization. Proven processes can benefit the organization and the participants for a few years, but institutionalization of a process is important to guarantee that the process will sustain and evolve beyond the current players and champions.

Enablers that led to the successful integration and institutionalization of business processes were identified in many of the case studies. Among these enablers were the following:

- Clear identification of performance measures and targets to provide senior-level managers with an incentive for process change;
- Implementation of effective evaluation and reporting abilities to clearly demonstrate the success of a process and communicate the benefits to the public; and
- Development of formal agreements to demonstrate buy-in of each participating agency and ensure consistency as personnel change over time.

Institutionalization is the final stage for implementing a process change. It should include clear documentation of the process, the roles and responsibilities of the players, and the performance metrics used to evaluate effectiveness. The level of documentation will be unique to each organization but should reflect the complexity of the business process and the level of commitment from senior management.

Recommendations

As noted earlier, process integration can be divided into two distinct aspects: at the operations level and at the institutional level. Through the case study development process, unique benefits were identified that result from process integration at both the operations level and the programmatic and institutional levels. Benefits can include increased efficiency, more savings in financial and staff resources, greater scalability and flexibility of systems, and more integrated institutional processes.

It is recommended that process integration be considered at the operational level to improve an agency's ability to effectively use its resources. Process integration can provide financial savings as a result of improved cooperation, reduced capital expenditures, and efficient use of staff. Process integration can allow agencies to plan for an integrated system that can be implemented in a scalable format that can grow commensurately with needs. By integrating agencies and processes early in the planning process, agencies are less likely to miss opportunities for integration and are more likely to build systems that can expand to meet future needs. Finally, the formal documentation of a process and of changes to the process will allow agencies to identify any correlation that might exist between changes to the process and performance metrics. As changes are made to a process, it is important to determine if those changes resulted in any measurable difference in performance. By documenting a process and any resulting change, agencies can keep a record of the processes they follow and compare changes in the process with changes in the performance metrics.

It is recommended that process integration be considered at the institutional level to allow agencies to define clear agency responsibilities that can improve cooperation and trust, because each agency and department understands its role and its partner agency's role in effectively carrying out a process. Documentation of these roles and responsibilities can provide additional benefit, inasmuch as it records the roles and responsibilities that should not change even if personnel change. Buy-in from higher-level management at agencies is a key to establishing a process that is effective and remains in place. Processes that have support from the upper levels of management are more likely to remain in place and be viewed as a high priority by all levels of staff within an agency.

The challenge that remains is to take the lessons learned from the case studies and workshop and to use them to assist other agencies in examining their own business processes and in looking for gaps and opportunities in process integration. It was evident, through development of the case studies, that there is no single approach to business process integration that will work for all agencies. The factors that led to process changes varied among three categories: major directives, event driven, or needs based. The differences in agency organization, institutional arrangements, political climates, and other variables mean that process integration will happen in different ways and at different paces in different areas.

It is recommended that greater focus be placed on assisting agencies to integrate business processes at the institutional or programmatic level rather than at the operations level. At the operations level, processes vary widely and are usually coordinated among those who are responsible for carrying out operational initiatives.

One forum to help elevate process integration within agencies could be a training course or workshop based on case studies across the country with a focus on the elements that led an agency to implement and institutionalize a programmatic change. Focus could be on both general case study reviews and specific needs in a region. Action plans for implementing and institutionalizing specific business processes for better travel time reliability would be the goals of the workshops. The workshops or training courses should teach a method of documenting business processes, such as BPMN. They should also emphasize the enablers that lead to the institutionalization of business processes, such as performance measures, evaluation methods, and formal agreements. Finally, workshops or courses should emphasize the role of business processes in developing regional ITS architectures and systems engineering analysis. Both the architecture and system engineering analysis efforts can be effective methods of assisting agencies in developing more efficient and integrated processes.

Reference

1. SHRP 2 L01 Workshop: Integrating Business Processes to Improve Travel Time Reliability. Phoenix, Ariz. May 5–9, 2009.

CHAPTER 1

Background

As departments of transportation (DOTs) move toward more customer-based performance metrics, network and travel time reliability begin to take a more prominent role among the potential measures on which a transportation management agency rates its own performance. With the strong focus on the Federal Congestion Initiative, agencies need innovative approaches to deal with congestion and delay; travel time reliability is a key measure of such approaches, as well as of overall system operations (*1*). Tools and approaches that can improve reliability or an agency's response to impediments to travel time reliability can yield valuable benefits to an overall operations strategy. Integrating key processes can further demonstrate the positive effects and operational influences.

L01 is an integral part of the SHRP 2 Reliability focus area in that it establishes a baseline of knowledge of current agency business processes—and the integration of these processes—that have significant impact on travel time reliability (*2*). Reliability is defined in this report as consistency of travel times for a particular trip. Travelers tend to estimate how long a trip will take based on parameters such as distance, time of day, and their own experience. Impacts to the transportation network that cause unexpected delays introduce uncertainty in travel time reliability.

Project Overview

The results of L01 identify the core of operations business processes within transportation management that have day-to-day influence over operations and network performance and, in turn, have positive impacts on travel time reliability.

The L01 project differs from other research activities that are part of the SHRP 2 Reliability focus area, some of which are also developing specific procedures, monitoring programs, or exploring alternatives to traditional traffic management strategies. L01 specifically looks into the processes that enable operational functions that directly affect network and travel time reliability and in which integration plays a significant part. This integration involves operational processes, as well as the broader efforts to institutionalize core processes at the agency level.

The outcomes of this project are envisioned to assist transportation agency and authority managers in developing and integrating business processes with a tangible goal in mind—to improve travel time reliability. These processes and their relationship to travel time reliability may initially seem abstract, but the intent is to map out clearly defined paths toward successful integration of processes that have been demonstrated to enhance travel time reliability, thereby guiding transportation managers and officers in adopting and integrating these processes within their respective agencies and operations.

The following were the project's key research objectives:

- Identify and document successful practices that integrate business processes to improve travel time reliability. This was accomplished through researching available literature, identifying appropriate case studies, and interviewing agencies that have demonstrated innovative approaches or integration strategies. An important research focus was on those agencies that have integrated various business processes concerning factors that affect nonrecurring congestion, because these factors tend to have the most negative impact on reliability.
- Define key business processes within DOT and transportation operations that are linked to travel time reliability.
- Promote awareness of the business process concept within DOT operations and demonstrate how relating integrated business processes with operational enhancements results in travel time reliability.
- Demonstrate how strategies and business process integration activities successfully employed by agencies can be adopted by other entities, and document the factors that could affect such adoption.
- Help agency managers identify critical gaps in their current processes and strategies to address these gaps, including

combining and integrating processes to improve travel time reliability. This provides a foundation for more detailed analytic and program application activities being conducted through other SHRP 2 Reliability efforts.
- Coordinate L01 research activities with ongoing research within the SHRP 2 Reliability focus area to extract the most innovative case studies. Leveraging the research activities among the multiple Reliability projects will enhance the overall product of this focus area.

Business Process Focus

Defining a Business Process

In general, a business process is a series of actions or activities that result in a specific or desired outcome or accomplish a specific organizational goal. There are several interpretations of business process, depending on the context or focus. In systems engineering and information technology, business process management and mapping take a quantitative approach. Efforts are under way to standardize how processes are shown and integrated to provide a detailed road map of events, actors, inputs, outputs, activity sequences, and outcomes.

Sparx Systems (*3*) describes a business process as

> a collection of activities designed to produce a specific output for a particular customer or market. It implies a strong emphasis on how the work is done within an organization, in contrast to a product's focus on what. A process is thus a specific ordering of work activities across time and place, with a beginning, an end, and clearly defined inputs and outputs; it is a structure for action. A business process:
>
> - Has a goal;
> - Has specific inputs;
> - Has specific outputs;
> - Uses resources;
> - Has a number of activities that are performed in some order;
> - May affect more than one organizational unit (horizontal organizational impact); and
> - Creates value of some kind for the customer (internal or external).

The Queensland Government (Australia) Chief Information Office describes a business process as "the execution of a sequence of related steps in response to an event that leads to a clearly defined deliverable or outcome. A number of role-players may contribute to the execution of an end-to-end Business Process. End-to-end business processes may also cross functional boundaries" (*4*).

In each of these broad definitions, there is an emphasis on inputs, outputs, sequence of events, and a value-added result. For the purposes of this study and with a focus on transportation operations and management, a similar view of business processes and the steps within a process were analyzed to identify where critical actions and activities come together and to identify their impact on travel time reliability.

Relationship of Business Processes to Transportation Operations and Travel Time Reliability

SHRP 2 and the program's Reliability Technical Coordinating Committee identified a range of potential business processes that have a key role in transportation operations. Some of these processes at the institutional level were broad, such as policy development, planning, programming, and incident management. Others were focused at the operations level, such as active traffic management (ATM), snow and ice removal, and coordination of traffic signal operations. These represent varying levels within an organization of where and how specific processes may be implemented. For example, although policy development, planning, and programming are often separate from day-to-day operations, in many cases there is a direct relationship between a transportation agency's policy set and how operations are conducted. Similarly, although planning and programming may influence available resources or implementation time frames for certain operational activities, the day-to-day relationship between these might not be clear or even apparent to personnel in the field who are responsible for typical operations activities.

For this research to have the greatest impact, the focus of the business process analysis was narrowed to those key operational areas that have the most influence on travel time reliability. These corresponded to the root causes of congestion as identified by the Federal Highway Administration (FHWA) and through numerous performance monitoring/reporting documents and ongoing reliability research. These key operational areas are as follows:

- Incident management;
- Work zones;
- Planned special events;
- Weather/road weather management;
- Traffic control/traffic operations;
- Capacity/recurring congestion; and
- Fluctuations in demand.

Within each of these areas are key business processes that have come together to provide a set of integration points, roles and influences of stakeholders, sequences of activities, and outcomes. It is also expected that by identifying core business processes and establishing a link to reliability, there will be definitive relationships within each area to

- Policies needed to support operations within an agency, as well as relationships with stakeholders from multiple agencies;

- How programming, infrastructure planning, or resource planning supports the process or integration;
- Where important data or information originates, links, or transfers within the process;
- Key dependencies among actions (which are critical and which are secondary);
- Where certain actions are automated or are carried out manually; and
- Where and how impact on reliability is measured or could be measured, and how agencies view performance measures in relation to reliability.

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CHAPTER 2

Research Approach

Guiding Principles

The focus of this research is not merely to capture and document innovative operations and management programs, although those do provide the starting point for identifying case studies of process integration to deliver improved reliability. The purpose of the research is to investigate, identify, and report on business processes that improve travel time reliability, particularly those in which specific process integration points have significant impact on overall reliability. Clear business process diagrams are needed to demonstrate these processes. The diagrams must have an easy-to-understand format geared toward the decision makers and a general audience. They also must capture and accurately portray the following information:

- Data flows;
- Decision points;
- Where process integration occurs;
- Critical input and output for travel time reliability;
- Entities responsible for certain actions and processes;
- How action translates into a business process linked to travel time reliability; and
- Integration of processes to support travel time reliability.

To further define the key business process aspects examined as part of this research, a preliminary framework was developed to identify core processes and elements. This helped to frame both the literature review and, more importantly, the individual interviews and process discussions. Recognizing that processes would need to be modeled, it was necessary to establish some of the important parameters that would ultimately constitute the process analysis and mapping.

Within incident management, there are myriad potential business processes that could be examined as part of this research, many of these with potentially significant impact on overall reliability. One aspect of incident management that has demonstrably reduced network impacts is quick clearance policies or specific clearance time parameters aimed at faster clearance of minor incidents on freeways. Table 2.1 illustrates mapping of potential business process aspects of quick clearance policies.

Using this approach, the research team was able to identify where specific processes come together at the field operations, interagency operations, and intra-agency levels. The following were among the principles that guided the review of potential diagramming methodologies:

- Multiple agencies and personnel need to be portrayed within the diagram;
- Each function and role needs to be assigned to a specific agency and person;
- Integration points need to be identified; and
- The diagram needs to present information chronologically.

Literature Review

The research team embarked on a comprehensive review of available literature to identify potential case studies and examples of successful process integration that resulted in improvements in travel time reliability. With the focus on nonrecurring congestion, the research team identified potential operations programs and activities that mapped to the seven root causes of congestion and variability in travel times to review as a starting point.

The impact of incidents on travel time variability (accounting for almost 25% of nonrecurring congestion) indicated a greater emphasis on processes that support improved incident management, response, and coordination. There was significant emphasis placed on researching innovative practices related to incident management and response that demonstrate a linear relationship to improvements in travel time reliability.

The literature review also included syntheses and research efforts that captured broader concepts of reliability, including

Table 2.1. Operations Business Process Components: Quick Clearance Example

Impetus or Catalyst for Business Process	What Was the Driving Factor Behind Establishing Quick Clearance Policies?
Stakeholders	• State DOT • State police • Emergency responders (fire and emergency medical services [EMS]) • Freeway Traffic Operations/Management Center operators • Freeway service patrol • Towing and recovery operations
Information inputs	• Law enforcement dispatch and computer-aided dispatch (CAD) • Visual identification (via closed-circuit television [CCTV] camera) • Response request (e.g., towing, EMS, state police)
Information outputs	• Impact of incident • Traveler information to warn of incident • Updates to responders from DOT and law enforcement CAD
Sequence of events or actions	• Identify incident • Notify responders • Monitor and manage from Traffic Operations Center (TOC) • Dispatch freeway service patrol • Coordinate responders • Implement lane restrictions • Notify adjacent agencies of the incident
Process integration points	• Automated CAD feed from law enforcement to DOT • Automated video feed from DOT to law enforcement • On-scene coordination among law enforcement, DOT, tower/wrecker
Potential measures	• Clearance time • Response time • How results are reported and used • Aggregate and monitor archived traffic flow data for comparisons
Policy impacts or needed policies	• Legislative action to implement broad clearance policy • Interagency initiative to develop policy, educate agency staff • Formal agreements with other stakeholders and responders
Relationship to programming and planning	• Using measures and results to identify and plan for resource needs (staff, equipment and systems, as well as time frame for when those need to be implemented) • Using measures and results to identify where additional policies may be needed
Influences on other operational areas	• Traveler information, media agreements • Local agency communications • DOT maintenance (e.g., on-call staff, extended hours)

documentation from the Future Strategic Highway Research Program (F-SHRP), which was the precursor to many of the research efforts currently under way with SHRP 2.

Available literature, including program summaries, performance monitoring reports, synthesis documents, operations manuals, and other resources largely focused on broader operations processes. In some cases, outcomes including capturing lessons learned, measures used, and challenges met were discussed. Information for actual process catalysts, underlying grassroots efforts to implement and effect process change, or some of the challenges in institutionalizing those operational processes are not typically captured as part of program documentation.

Case Study Evaluation Criteria

The process of narrowing the case study focus required establishing a general set of criteria from which to assess the wide range of potential case study options. While the literature review yielded some quantitative information about operational processes and outcomes, the research team assumed that much of the qualitative and anecdotal information about how business processes evolved, were coordinated with other processes, and, in general, how process change was actually instituted would be derived more from interviews with individual agencies than from what had been documented in most of the publicly available literature.

An initial list of potential programs and activities was established based on the literature review, the research team's knowledge of various operations programs, and input from industry experts. More than 50 programs and activities were further discussed among the research team for their potential to serve as case studies for process integration. From this list, 21 candidate case studies were selected for further evaluation. The 21 candidate case studies included incident management programs and policies, work zone management activities, ATM applications from international examples, and nonurban case studies that focused on weather and freight operations.

Several criteria were established to guide the assessment and narrow the 21 candidate case studies down to 10 for further evaluation; however, a formal scoring process ultimately was not implemented. One of the challenges in applying a standardized set of criteria to this assessment was the broad range of potential processes that were reviewed. In some cases, processes referred to specific actions within a specific sequence; in other cases, processes were linked to overarching programs that influenced specific operational areas. To narrow the list of 21 candidate case studies to 10, the research team reviewed the assessment criteria presented in Table 2.2.

Selected Case Studies

Table 2.3 presents the programs and activities that were selected for further development as case studies of process integration based on the criteria assessment review. Contacts for each agency were identified and interviewed or provided input to the case study development. Case study discussions are included in Chapters 3 through 7.

Interviews with Agency Representatives

A key component of the process documentation was to interview representatives from the programs and agencies that were being featured as part of the case studies. While available literature can provide high-level information about operational processes, involved agencies or entities, as well as quantitative outputs of the effectiveness of the programs, additional insights were needed to accurately capture key steps, processes, and outcomes. Aspects such as catalysts for process change or integration, barriers or challenges that were experienced and how they were overcome (or not), and policy needs and impacts were an integral part of the interview strategy.

Interviews were arranged with one or more representatives from the agencies or programs, and a brief overview of the L01 research and the guiding questions were provided to each interviewee before the discussion. Most interviews were held via teleconference, with the exception of two that were conducted in person. Teleconference interviews were recorded for future reference. Diagrams of each process were then drafted to capture the process of the case study. They were reviewed by other team members to assess whether adequate information was provided or if additional answers were needed from the interviewee.

National Workshop with Key Stakeholders

The next step in the research and analysis portion of the project involved a two-day workshop with hand-selected representation from across the country (*1*). It was decided that the individuals invited needed to be from a management level within an organization that had influence on operations, but who were also still closely and integrally involved with operations and processes that can affect travel time reliability. The invitees represented various roles within the multiple agencies where they worked, including representation from planning, operations, program management, and even senior management.

The workshop was held on May 5 and 6, 2009, in Phoenix, Ariz. It included a presentation of the L01 project, overviews of the case studies, preliminary findings and direction of the report, and a discussion on the approach for a guide. The

Table 2.2. Assessment Criteria

Assessment Criteria	Considerations
Does the process involve coordination among more than one agency or division within an agency?	Although single-agency processes and process integration yield value, a higher priority was given to those processes and process integration points that involved more than one division or agency. This would yield beneficial information about institutional agreements and cooperation toward enhanced operational procedures.
Does the process integration positively impact one or more types of nonrecurring congestion?	Focus was placed on those processes and integration strategies that could address more than one dimension or source of nonrecurring congestion. The ability to leverage benefits of coordinating processes that could point to tangible benefits in more than one operational area was a key consideration.
Are there documented impacts on improved travel time reliability, including qualitative and quantitative?	This proved to be one of the more challenging criteria to map to candidate case studies. Although many programs and regions are embarking on formal performance monitoring programs, available data are too inconsistent to draw a linear relationship between process integration and improvements to travel time. In some cases, where agencies or partnerships have implemented specific processes and procedures to reduce the time it takes to respond to and clear incidents from roadways, there is a relationship to specific metrics that would indicate the impact on travel time. In other cases, important enablers to process integration and change (such as instituting training programs or having a programming process within an agency that gives priority to congestion management enhancements) may ultimately yield positive impacts on reliability, but the link may not necessarily be direct.
Are there clear examples of business processes that have been integrated at the operational level or the institutional level?	Process integration was initially viewed as multiple steps within an operational activity that were brought together in a specific way. As the project evolved, the integration at the institutional level emerged as an important separator in identifying successful integration strategies.
Are there policy-related impacts, or required policies to support business process integration?	There are different policy considerations for the various processes involved in this research. Candidate case studies were reviewed to identify the role that formal policy plays in either implementing a business process or integrating a process with another entity or within an organization.
Can outcomes or approaches be applied to other areas with similar results of improved travel time reliability?	An important outcome of this research was to identify successful strategies that regions could apply to their situation and achieve similar results. There will be some variability among strategies, but concepts and processes that may be transferable will aid in applying the research.
Are the measures of effective integration sustainable? Have they demonstrated consistent results over time?	This criterion refers to the sustainability of the process to support longer-term reliability goals and objectives. Processes that are aimed at recurring strategies (such as incident clearance procedures and weather event management) can help demonstrate repeated benefits.

workshop involved a significant amount of conversation related to issues and challenges faced within the stakeholders' departments or agencies. There also was significant conversation about the enablers of each case study and how to overcome challenges throughout implementation of new processes. It was important for the attendees to evaluate the applicability of the findings to arrive at information that could benefit operations within other agencies.

Modeling Business Processes

The L01 project focused on identifying and documenting business processes that have successfully improved travel time reliability. In order to analyze the identified business processes and, more importantly, to identify key integration points within the processes, a consistent approach to mapping business processes is required. Various business processes were researched for their applicability to transportation agency processes. Once an effective modeling tool was identified, it was important to look at the key elements within the process and determine how these elements would be used to map business processes from transportation agencies.

Process Model Approaches and Notations Considered

A consistent approach to process diagram is needed to present the case studies and demonstrate that the actions or activities result in a specific or desired outcome. Business processes are activities encompassing several agencies or departments within an agency that ultimately produce an outcome or output.

Through initial research, several alternate approaches to business process models were identified for analysis. Five approaches that were considered by the research team are

Table 2.3. Case Studies

Case Study	Description	Agency
Washington State DOT Joint Operations Policy Statement and Instant Tow Dispatch Program	Describes one of several programs the Washington State DOT and Washington State Patrol have implemented to support their Joint Operations Policy Statement for incident response and management and to support their goals for faster clearance of incidents on highways.	WSDOT
Florida Road Rangers	Describes the use of contracted, private tow vendors and sponsors to deliver a freeway service patrol program throughout the state of Florida. Also describes the performance metrics for measuring effectiveness of the program and the impact on incident clearance times.	Florida DOT
United Kingdom Active Traffic Management	Describes the pilot corridor for ATM strategies for recurring congestion, as well as the incident response and management program.	UK Highways Agency
North Carolina DOT Traffic and Safety Operations Committee	Describes North Carolina DOT's evaluation process for major work zones and traffic and safety impacts as a result of changes in work zones. This committee has established a process to identify, evaluate, and implement mitigation strategies to offset negative impacts on travel time reliability and safety within the work zone.	North Carolina DOT
Michigan DOT Work Zone Traffic Control Modeling	Describes the microsimulation model developed by the Michigan DOT to model the impacts of freeway construction closures on an entire network. Results of the microsimulation model were applied to incident management and operations strategies, as well as to alternate route planning. The goal was to minimize impacts to the surrounding freeway network as a result of a major freeway reconstruction (I-75 Ambassador Bridge).	Michigan DOT
Kansas Speedway Special-Event Traffic Management	Describes the development of traffic management procedures to support large-scale event traffic at the new speedway facility. Through effective process coordination, agencies have reduced the number of officers needed in the field for traffic ingress and egress management and have reduced the time to clear parking lots following large-scale events.	Kansas DOT and Kansas Highway Patrol
The Palace of Auburn Hills, Special-Event Traffic Management (Michigan)	Describes the traffic signal timing plans developed specifically for events at the Palace. Plans were developed to flush traffic away from the event venue, and have resulted in reduced event venue clearance times, and streamlined the number of officers required to manage event traffic.	Road Commission of Oakland County and Auburn Hills Police Department
I-80 Winter State Line Closures (California and Nevada State Line)	Identifies the series of processes that are initiated when Caltrans closes the state line on I-80 during winter weather events. Nevada DOT is focused on notifying westbound travelers, particularly freight, of the state line closure to minimize the illegal parking and truck queuing that can occur on I-80 while trucks wait for the state line to reopen.	Nevada DOT Headquarters and Nevada DOT District 2 Operations
AZTech Regional Archived Data Server (Arizona)	Describes the evolution of a database initially developed to store freeway data into a central repository for agencies to access real-time incident and traffic operations data. Information available from the Regional Archived Data Server allows agencies to implement changes in their traffic management strategies to respond to real-time conditions in neighboring jurisdictions that could affect their roadways.	Maricopa County DOT
San Pablo Avenue Signal Retiming (California)	Describes a multiagency approach to developing corridor traffic signal timing plans. Overall program measures show an improvement in travel time and a decrease in fuel consumption.	Metropolitan Transportation Commission

identified in Table 2.4. Each approach was analyzed based on its applicability to modeling different transportation operations processes.

Business Process Modeling Notation

After identifying and considering all the options for modeling business processes, the research team selected the Business Process Modeling Notation (BPMN) for this project. The BPMN was developed to improve communication between participants at the design level of a process with those at the implementation stage. In order to improve communication, a simplified, easy-to-understand set of rules were required. It also was important that these rules could be applied against several industry types beyond software development.

Table 2.4. Business Process Modeling Approaches

Process Modeling Type	Primary Use	Advantages	Disadvantages
Business Process Modeling Notations (BPMN)	A standard modeling tool used as a common visual representation to display the business process design for all stakeholders within the process flow.	• IBM template for use with Visio is available. • Diagramming elements are relatively easy to understand for all stakeholders. • Recognized industry standard for different types of processes, including activities, data, and outputs.	• Converting to another tool may be difficult. • It may not be conducive to modeling routine work.
Unified Modeling Language (UML) (*2*)	A standard modeling language used as a visual representation, including graphical notation, to model the parts of a system or methodology. UML diagrams represent three views of a system model: functional requirements view, static structural view, and the dynamic behavior view. UML can be used as the basis for activity diagrams and interaction overview diagramming.	• Combines several data modeling practices into one model language. • Can be used with all processes. • Can be used with different technologies for implementation purposes.	• Can be difficult to learn and adopt to nondata processes. • Line styles are very similar, making it hard to distinguish different types of information flows. • Information may be lost when trying to import the information into another tool.
Unified Software Development Process (Unified Process) (*3*)	A generic tool that is used as framework for customizing analysis and design for the life cycle of a system. It uses the UML standards.	• It is use-case driven; each used through implementation, test, and deployment. • Supports multiple architectural models and views. • Focuses on addressing critical risks.	• Not user-friendly; requires much more in-depth understanding of the workflow of a system. • Involves many detailed steps and phases. • Can be time-consuming to develop. • Used more for system design than for system diagramming.
IBM Rational Unified Process (RUP) (*4*)	A refinement of the Unified Process, but also a trademark of IBM, RUP provides guidance and examples that are tailored by the organization to assist in the development and implementation of a system or used as a project management tool.	• Can be adapted and customized to fit project or organization needs. • Uses processes that have already proved successful for other similar projects. • Adaptable to other countries; the tool is available in several languages.	• Presented at a higher level, which makes it hard to determine key processes. • Must satisfy criteria already defined in the process in order to continue to the next phase, which could be time-consuming. • Used more for system design than for system diagramming.
Event-Driven Process Chain (EPC)	A graphical depiction of events and functions that represent a dynamic modeling business process. The Event-Driven Process Chain was developed within the framework of Architecture of Integrated Information Systems (ARIS).	• Several tools can be used to create the diagram. • Uses simple and easy-to-understand notation.	• Not all the tools support the EPC markup language (EPML). • Has to be event-driven; the diagram must start and end with a specific event.

IBM published the BPMN notations and specifications in 2004 and continues to provide guidance and support for organizations looking to use the BPMN approach. IBM also provides a Visio stencil containing BPMN elements, which can be downloaded from their website. The benefits of using the stencil include allowing the user to incorporate BPMN-standard objects and definitions within Visio. IBM also provides on the website a software demonstration for BPMN using the stencil and Microsoft Visio, one of the most widely used desktop design tools for modeling various processes and integration scenarios business processes. The diagram can be imported into a process engine or copied into a document as a figure.

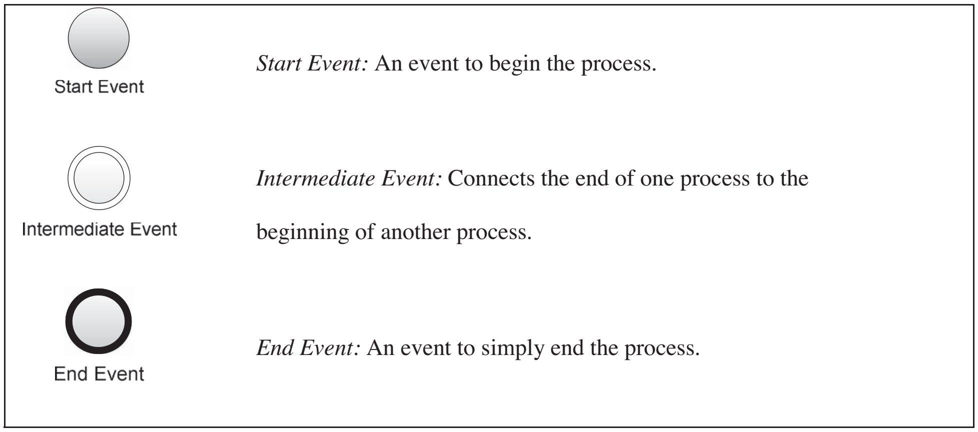


Figure 2.1. BPMN flow objects for events.

BPMN is a strong fit for diagramming operational procedures and processes. The use of the stencil and Microsoft Visio creates an intuitive tool that helps users in modeling complex operational processes. BPMN uses four basic categories of shapes familiar to business analysts to determine whether an activity is a procedure or a process. The four categories of shapes are as follows:

- Flow objects (events, activities, gateways);
- Artifacts (data objects, groups);
- Connecting objects (sequence flow, message flow, association); and
- Swim lanes (pools, lanes).

The flow objects events typically affect the flow of the process by either cause or effect. The events can start the process, end the process, or have an intermediate effect within the process to suggest several choices the process may precede. Three event items are used for this project, which are presented in Figure 2.1.

Flow objects activities are the tasks or subprocesses associated with the overall process. The task can be a single task or one that includes additional subtasks that may not need to be displayed within the current diagram. If need be, the additional steps of the subtask can be displayed within another diagram and then referenced in the main process diagram. The standard tasks that were used for this project are shown in Figure 2.2.

Flow objects gateways are decision markers to display where information diverges or converges within the sequence flow. Gateways are used for forking, merging, and joining paths as the sequence flows through the processes. For decision making, they are used to show the direction, depending on the answer to typical questions, such as yes or no, or to more complex questions that have three possible answers. For this project, four main gateways were used (Figure 2.3).

Artifacts are provided within BPMN for the user to have a little more flexibility in presenting information about objects or tasks. They do not change the basic structure of the process but are model tools that provide additional notation or information to the basic objects within the diagram. At the time

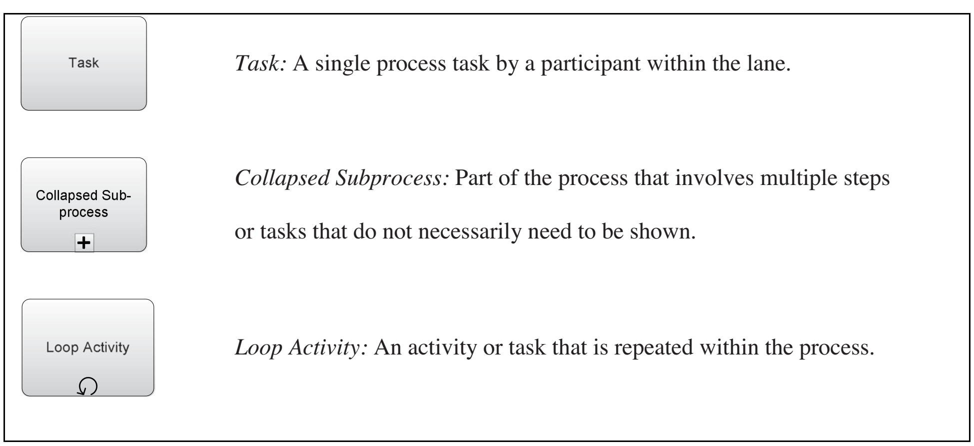
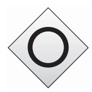


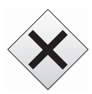
Figure 2.2. BPMN flow objects for activities.

Parallel Gateway: Designates that either one flow can take two alternative paths or two paths diverge into one flow. All criteria must be met before the flow can proceed.

Complex Gateway: Designates that the decision results in a complex answer or that there are complex issues surrounding the decision.



Inclusive Gateway: Designates that a decision needs to be made to determine the path of the flow through the process.



Exclusive Gateway: Designates that a decision does not need to be made to determine the path of the flow, but that the path is expected. All criteria do not need to be met before the flow can proceed.

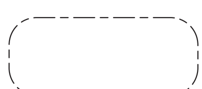
Figure 2.3. BPMN flow objects for gateways.

this report was prepared, BPMN had three predefined artifact types; however, this project only focused on two types of artifacts (Figure 2.4).

Connecting objects are used to connect the flow objects (events, activities, and gateways). They are the connectors or flows in the process that show the many paths possible from the many activities or tasks. The diagrams in Figure 2.5 define all three BPMN types of connecting objects.

In addition to the available elements, swim lanes, or cross-functional connections, are used to differentiate the elements that correspond to each owning agency. They are used in BPMN to categorize functionalities. Swim lanes include either a pool, which represents each participant in the activity, or a lane, which is a subpartition to categorize activities. For each case study presented in this analysis, horizontal swim lanes are used to present each of the agencies or working groups in an agency that are involved. Vertical swim lanes are used to divide the overall process into three core areas. Figure 2.6 shows vertical and horizontal representations of the pools and lanes diagrams.

Data Object: Displays the data required or produced by activities or tasks.



Group Object: Displays for the reader when certain activities or tasks occur at the same time. It is used primarily for documentation or analysis purposes.

Figure 2.4. BPMN artifacts.

Sequence Flow: Designates the main flow throughout the process. The flow connects events to gateways, vice versa, or to tasks or activities.

Message Flow: Designates the flow between two pools or two business roles or participants. This cannot be used to connect activities or events within the same pool.

Association Flow: Designates a relationship between an *Artifact* and a *Flow Object* (task or gateway).

Figure 2.5. BPMN connecting objects.

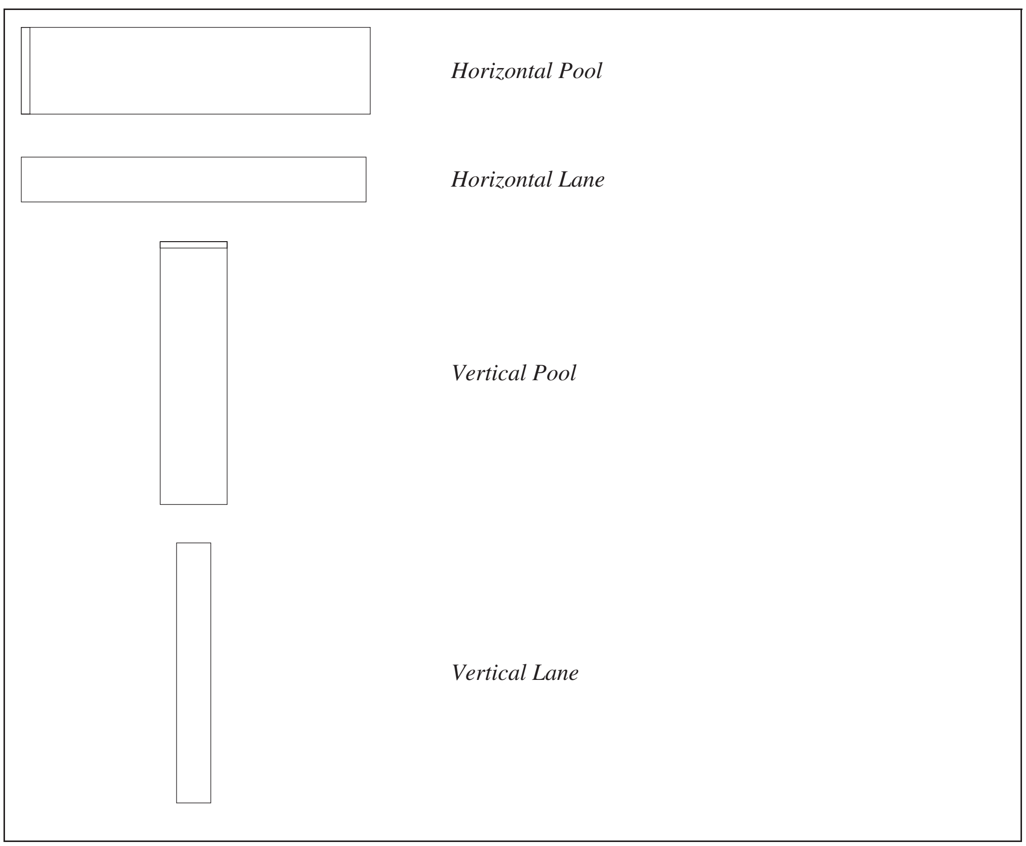


Figure 2.6. BPMN pools and swim lanes.

BPMN Diagrams for the L01 Project

As previously mentioned, interviews were conducted with several agency representatives about their strategy or process of operational functions that can affect travel time reliability. The processes were then modeled using the BPMN language into diagrams that could be shared with other agencies. These diagrams included any combination of the elements described in the previous section and focused on integration points, decision points, and documentation that could be used as examples for other agencies.

Horizontal swim lanes represent the participating agencies or stakeholders involved in the process. All participants in the process that serve the same functionality are part of the same pool. Otherwise, a new pool is created displaying the participant(s) that has a different functionality than the others.

Three vertical swim lanes are used to divide the overall process into three core concentration areas. They are Policy Level/Organizational Structure, Operations/Specific Process, and Evaluation/Documentation:

- Lane 1: The organizational structure and policies that are in place to support the case study and process presented. This could support various processes and is not specific to any one particular case. Anything specific to a particular case should be contained within Lane 2.
- Lane 2: The process specific to a case study that could be extracted and stand alone as a process or be replaced with another process within the two bookends. It is supported by the existing organization and must produce information that feeds into the evaluation and documentation depicted in Lane 3.
- Lane 3: The resulting documentation and evaluation of the process. This is fed by multiple processes and exists without dependency on the specific case.

The process begins in Lane 1 with either a start event or a meeting that continues into Lane 2. Lane 2 is where the bulk of the process takes place. This lane illustrates the tasks involved, any decisions to be made, and complex issues that evolve from the process. The sequence flows connecting the events follow the path of the process. Lane 2 should be dependent on the project at hand. Lanes 1 and 3 should be consistent with any project that is placed in Lane 2.

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CHAPTER 3

Case Studies: Incident Management

According to the FHWA, traffic incidents account for 25% of traffic congestion and are the largest source of nonrecurring congestion in the United States (*1*). Effectively managing congestion can reduce travel delay, increase safety, and ultimately improve travel time reliability. The traffic incident management case studies presented in this section examine the processes that three agencies have developed to improve their incident management capabilities. The Washington State DOT (WSDOT) Joint Operations Policy Statement is discussed with a focus on a specific process that was developed to implement the Instant Tow Dispatch Program. The Florida DOT (FDOT) Road Ranger program and the integration of public and private partners as part of that program are reviewed. Finally, the United Kingdom's Highways Agency's (HA) program for ATM and how it is used for incident management is presented.

Washington: WSDOT Joint Operations Policy Statement

The State of Washington has developed one of the most comprehensive and effective incident response programs in the United States. WSDOT and the Washington State Patrol (WSP) are the two primary agencies responsible for incident response on highways in Washington. WSDOT and WSP have a long history of working together to improve incident response and reduce incident clearance times in Washington. In 2002, WSDOT and WSP developed a Joint Operations Policy Statement (JOPS) Agreement that formalized each agency's roles and responsibilities for freeway operations, including incident response. This document is signed by the Washington State Secretary of Transportation and the Chief of the Washington State Patrol and is updated each year (*2*). The JOPS Agreement clearly defines how incident response will be conducted in the State of Washington, identifies a specific employee from both WSDOT and WSP responsible for each program, and sets performance measures for the program.

Washington State was selected for a case study because of the well-documented and proven results they have demonstrated for their Incident Response Program. One aspect of the Incident Response Program, the Instant Tow Dispatch Program, was selected for more detailed consideration in this case study (*3*).

As part of this case study, an interview was conducted with Rick Phillips who, at the time of this writing, was serving as the incident response program manager for WSDOT, where he oversaw the Instant Tow Dispatch Program. Before joining WSDOT, Phillips was with the WSP for 28 years, retiring as a district commander. In his role with WSDOT, he coordinated the statewide Incident Response Program for WSDOT and worked closely with the WSP to update the JOPS Agreement each year. Phillips was also responsible for reporting the performance of the Incident Response Program to the governor's Government Management Accountability and Performance report and the WSDOT Gray Notebook (*4*).

Description

The Washington State Incident Response case study examines the process that is used in Washington State to document the Incident Response Program through the JOPS Agreement and includes a close look at the Instant Tow Dispatch Program, one of many successful programs for incident response in Washington State. The JOPS Agreement was first developed in 2002 and covers 13 areas of operation, including traffic incident management, enforcement, winter operations, work zone safety, and transportation safety and security. This case study focuses on the traffic incident management section of the JOPS Agreement. There are seven subcategories that are included in the JOPS Agreement under traffic incident management:

- Responder safety;
- Safe and quick clearance;
- Incident-Response Team Program;

- Contracted service patrols and motorists assistance vans (MAVs);
- Instant Tow Dispatch Program;
- Blok-Buster Major Incident Tow Program; and
- Using technology and education to expedite investigations.

An expanded look at the Instant Tow Dispatch Program is included in this case study.

Background of Agency

WSDOT and WSP are the two agencies that partner together and lead incident response on Washington State highways. The two organizations have a long history of successfully working together. For instance, all WSDOT incident response vehicles have WSP-compatible radios. Although there are some areas of the country where opening public safety radio communication to a non-public-safety agency would be difficult, in Washington State this is the expectation. This relationship between WSDOT and WSP was formalized in the JOPS Agreement.

WSDOT is divided into six regions, each with its own Incident Response Program. The greatest focus for incident response has been in the Puget Sound area, where congestion is greatest. Puget Sound is covered by the Northwest and Olympic WSDOT regions. To coordinate the program and act as a liaison to WSP, WSDOT has created a position for an incident response program manager within its headquarters. This role has traditionally been filled by someone with a law enforcement background who can speak the language of WSP and work closely with WSP to continue the strong incident response partnership between WSDOT and WSP.

Process Development

WSDOT's Incident Response Program can be traced back to 1963 when WSDOT tow and push trucks began clearing blockages on the Mercer Island and Evergreen Point floating bridges. In the 1990s, incident-response teams were introduced as a pilot program during the Goodwill Games. In 2000, WSDOT began a small pilot service patrol program, contracting out with WSP and private tow companies to provide roving units. The program continued to grow, and, in 2002, the management of WSDOT and WSP developed the JOPS Agreement to formalize each agency's roles and responsibilities for freeway operations.

The development of the JOPS Agreement was a major step in moving the Incident Response Program forward. By formalizing the roles and responsibilities of each agency, identifying individuals to lead the different programs, setting timelines and goals, and meeting annually to review and update the JOPS Agreement, accountability was placed directly on individuals at WSDOT and WSP.

Development of the JOPS Agreement also led to the development of consistent performance measures because it required the agencies to define how data are collected and reported. For example, WSDOT was measuring clearance times based on when the last incident response vehicle left the scene. This method of reporting affected another program that WSDOT was implementing to provide incentives for meeting the 90-min clearance goal by tow providers. WSDOT could not effectively measure if tow providers met the 90-min clearance goal if they measured based on when the last incident response vehicle left the scene, because police and fire may stay on the scene after all lanes are clear. On the other hand, WSP measured clearance time based on when all lanes were clear. In order to report clearance time consistently during the development of the JOPS Agreement, WSDOT and WSP reached an agreement to record clearance times based on when all lanes were clear.

In 2006, the governors' office requested that WSDOT and WSP begin reporting jointly on performance monitoring and accountability goals related to incident response and clearance time. Meeting the 90-min goal became a joint responsibility of WSDOT and WSP that both agencies would be evaluated on together. The reports that WSDOT and WSP provided were used as part of the Government Management Accountability and Performance Program that was being implemented in Washington State (*5*). The joint reporting and joint responsibility for incident response was identified as one of the most significant enablers for Washington State to deliver such an effective incident response program. WSDOT and WSP had already established a good working relationship, but now their programs were tied to each other for success.

One example of the cooperation and innovative thinking of WSDOT and WSP is found in the development and implementation of their Instant Tow Dispatch Program. This low-cost program has shown significant benefits in terms of clearance time and is a great example of WSDOT and WSP sharing resources and providing assistance to each other. The next section describes this program in more detail.

Detailed Process and Integration Points

The Instant Tow Dispatch Program initially began as a program on the Tacoma Narrows Bridge to allow the quick removal of disabled vehicles from travel lanes. Traditionally, when a disabled vehicle was reported or spotted using the WSDOT CCTV cameras, a WSP trooper was dispatched and would verify that a tow was needed after arriving on scene. Under the Instant Tow Dispatch Program, as soon as an incident is verified on the CCTV cameras, a tow truck can be dispatched before a WSP trooper verifying the need for a tow. In the initial program used on the Tacoma Narrows Bridge, tow operators on each side of the bridge participated and were dispatched based on which operator could access the disabled vehicles the fastest. An evaluation of the program by the University of Washington Transportation Research Center found that the Instant Tow Dispatch Program saved an average of 15 min for clearance compared to having an officer first respond to the incident. However, the problem with the program was how to reimburse drivers for dry runs. Dry runs occurred when tow truck drivers were dispatched, but before they arrived, the disabled vehicle was already able to move out of the lane. This might happen if the driver was able to get his or her car restarted or if a passing motorist provided assistance. When this occurs, tow operators could waste as much as 30 min; they then would not want to participate in the program unless they could be reimbursed for such lost time. There were also other inconsistencies with this initial program, as identified in the University of Washington study, including how units were dispatched (*6*).

To address this concern, WSDOT implemented a pilot program over a larger area that would reimburse drivers $25 for each dry run. When a disabled vehicle that is blocking at least one lane of traffic is identified by WSDOT CCTV cameras in an area with the Instant Tow Dispatch Program, WSP will dispatch a WSP trooper and an Instant Tow Dispatch truck. WSDOT Incident Response monitors the dispatch of the WSP and will deploy a unit to the incident as well. WSP has up to 10 min to cancel the call before the Instant Tow Dispatch operator is eligible for a dry run reimbursement. If the WSDOT Incident Response unit arrives on scene first and can clear the incident, the Instant Tow Dispatch operator is only entitled to a dry run reimbursement. If the Instant Tow Dispatch operator does tow the vehicle, then the tow operator is reimbursed by the driver of the vehicle.

In 2008, there were 597 calls for Instant Tow Dispatch, resulting in 347 tows, 192 cancellations, and 58 dry runs. WSDOT was not billed for every dry run, and the program resulted in total direct costs of less than $1,000 for WSDOT. Results in 2007 were similar, with 235 calls for Instant Tow Dispatch, resulting in tows and total direct cost to WSDOT of less than $1,000 (*7*).

The Instant Tow Dispatch Program works well because of the trust between WSDOT and WSP and the formalized program established in the JOPS Agreement. WSP dispatches Instant Tow Dispatch vehicles and determines if the call should be canceled, but WSDOT is responsible for paying for dry runs. Even though WSDOT is essentially paying for a program run by WSP, there have been no issues with the program or payment procedures thus far. The program is providing a tremendous benefit to motorists by clearing traffic lanes an average of 15 min faster and is doing so at a cost of less than $1,000 per year to WSDOT.

The process used for the WSDOT Instant Tow Dispatch Program is displayed using the BPMN method in Figure 3.1.

Several key integration or communication points were identified in the Instant Tow Dispatch Program process, including the following:

- WSP Communications and Instant Tow Operators for dispatch of tow operators to incident scene;
- WSDOT and Instant Tow Operators for providing reimbursement to Instant Tow Operators for dry runs; and
- WSP on-scene officer and Instant Tow Operator on-scene to allow tow operator to remove vehicles.

As noted, the JOPS Agreement is updated annually and signed by the Washington State secretary of transportation and the chief of the WSP. As part of the update process, each of the 13 areas of operation is reviewed and updates are made if necessary to the objective, policy, action items, measures of performance, and timeline for that area. One of the most important updates is the designation of a specific lead employee from WSDOT and WSP. By assigning an individual who is responsible for each area, the JOPS Agreement adds an important level of accountability for each area of operation.

Types of Agencies Involved

The incident response program in Washington State requires the involvement of WSDOT and WSP at all levels. From the WSDOT secretary of transportation and the WSP chief who sign the JOPS Agreement to the WSDOT incident-response teams and WSP troopers in the field, there is collective cooperation at all levels. One of the most important roles in the Incident Response Program is the WSDOT incident response program manager. This person is responsible for coordination with WSP for all the Incident Response Programs. The incident response program manager also coordinates with WSDOT regions. While each region has an Incident Response Program, the level of implementation varies. For example, the Instant Tow Dispatch Program is only provided in the Puget Sound area, Vancouver, and Spokane. The incident response program manager can coordinate with WSDOT personnel in other regions to be sure they understand the benefits of the program and help them determine if and when it would be appropriate to implement such a program in their region.

In order for the Incident Response Program to be effective, WSDOT and WSP also had solicited the help and input of private tow operators in Washington State. WSDOT and WSP understood that the only way to make the Instant Tow Dispatch Program fair was to compensate the tow operators for dry runs. The tow operators had to accept that the Instant Tow Dispatch requests could be canceled within 10 min of initial dispatch. WSDOT and WSP have also listened to the other suggestions from private tow operators. The operators suggested that it would be more effective for Instant Tow Dispatch to

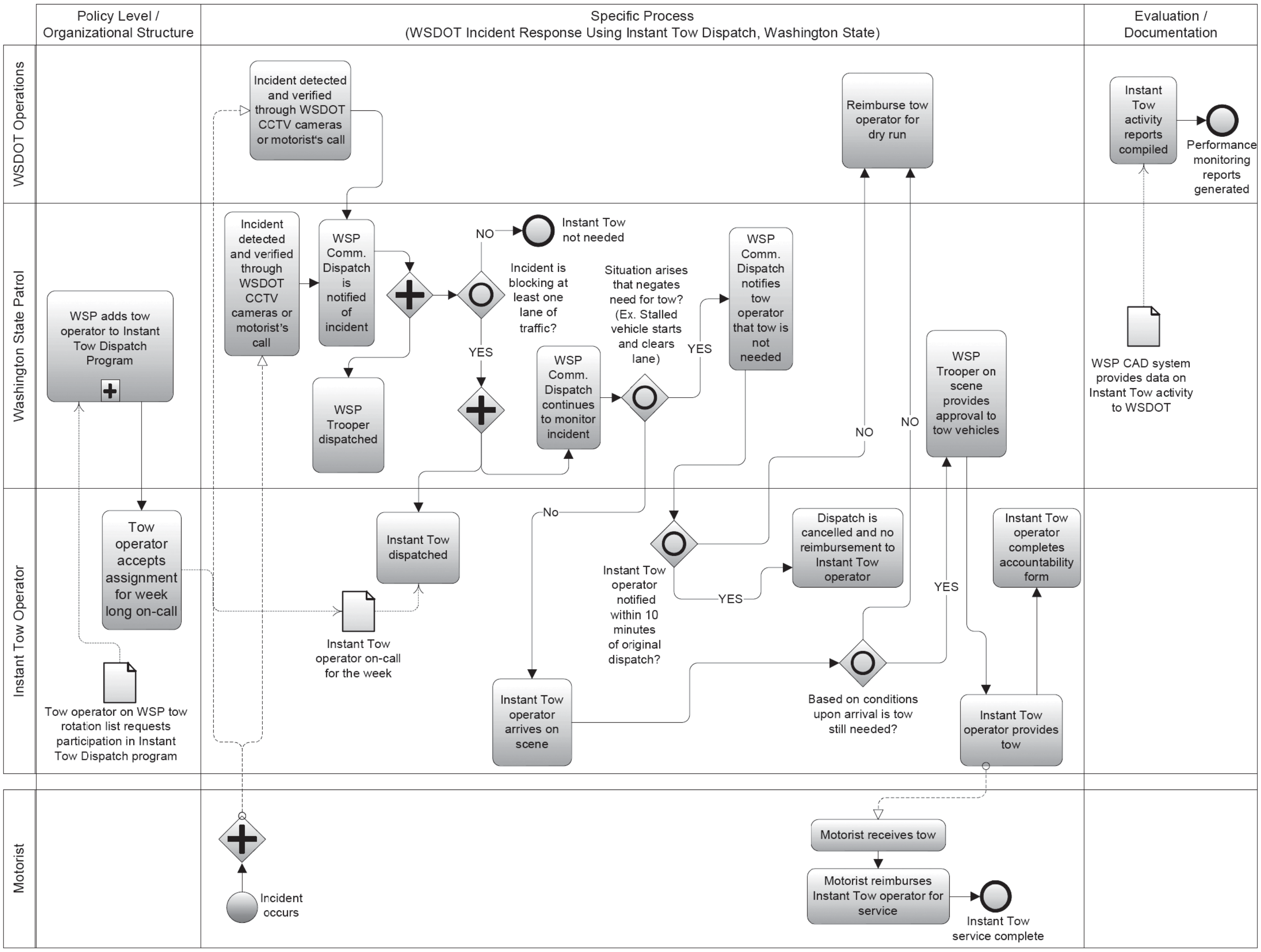

Figure 3.1. Detailed business process diagram of WSDOT incident response.

assign a day or week to a particular Instant Tow Dispatch company rather than use a rotation list. This would allow them to add additional staff during the time they were on-call. This has resulted in WSDOT and WSP receiving better service and operators who can appropriately staff for the weeks they are on-call.

Types of Nonrecurring Congestion Addressed

The JOPS Agreement addresses all types of nonrecurring congestion caused by incidents. It includes quick clearance policies, incident-response teams, motorist assist vans, instant tow, major incident tow programs, and technology and education to expedite investigation. The JOPS Agreement is essentially a living document because it is closely reviewed and updated annually. The JOPS Agreement is applied statewide, although there are certain programs that have only been implemented in urban areas because of the higher levels of congestion in the urban areas. The Instant Tow Dispatch Program that has been highlighted in this case study also relieves nonrecurring congestion caused by incidents, but it is limited to incidents that block traffic lanes and is not used for nonblocking incidents.

Performance Measures

The primary performance measure used in the Incident Response Program is the 90-min clearance goal for all incidents. WSDOT began discussing the 90-min clearance goal in 1997 and 1998, but the agency did not establish it as a performance measure and develop specific actions to accomplish it until the JOPS Agreement was put into place. Since then, WSDOT has worked with WSP to develop a consistent definition for how to define when an incident is cleared and agreed to use data from the WSP computer-aided dispatch (CAD) software to determine incident clearance times. Because WSDOT uses the same CAD database for dispatch of their incident-response teams, they can compare data and use written logs of the incident timeline to rectify any inconsistencies. The achievement of the 90-min clearance goal is reported jointly by WSDOT and WSP; both agencies are accountable for this performance measure. The 90-min clearance goal is reported as part of the Government Management Accountability and Performance Program and in the WSDOT Gray Notebook.

For the Instant Tow Dispatch Program, WSDOT keeps track of the total number of calls each year, as well as the number of calls requiring tows, the number canceled, and the number of dry runs. Total cost for reimbursement of dry runs also is tracked.

Benefits

Since the JOPS Agreement was put into place, WSDOT and WSP have seen numerous benefits regarding incident response. It was noted during the interview that after the 90-min clearance goal was first discussed in the late 1990s, there were few formal actions to help achieve those goals. The JOPS Agreement formally documented the goal, identified specific actions that were needed, and put people at WSDOT and WSP in charge of accomplishing these actions. The JOPS Agreement defined how performance would be measured and ensured that performance was measured consistently across the state. The information from these performance measures has been useful to WSDOT when seeking additional funding because it can clearly demonstrate its progress toward important statewide goals.

One of the most significant benefits to both WSDOT and WSP was the joint reporting of the 90-min incident clearance goal required in the Government Management Accountability and Performance Program. This forced WSDOT and WSP to partner together closely and each dedicated the resources that were needed to reach this common goal.

The Instant Tow Dispatch Program has resulted in significant benefits for WSDOT at minimal cost. A University of Washington study found that without the Instant Tow Dispatch Program, it would take an average of 18 min to dispatch a tow truck after an incident is detected and verified. With the Instant Tow Dispatch Program, it takes an average of 3 min to dispatch a tow truck. The program has reduced the time for a tow truck to arrive at an incident by approximately 15 min for most incidents. WSDOT looked at the savings this created in terms of lost time and wasted fuel from congestion and estimated that for less than $1,000 per year to operate the program, WSDOT has seen annual benefits of approximately $6.5 million to $11.1 million.

Lessons Learned

The formalizing of roles, responsibilities, and goals in the JOPS Agreement regarding freeway operations was an important step to move WSDOT and WSP from discussing goals to actually getting things accomplished. Assigning joint responsibility to the two agencies for the reporting of the 90-min incident clearance goal was also important. WSDOT and WSP already had a strong working relationship, but the joint responsibility required even closer coordination between the agencies because they were both measured against the same goal.

WSDOT has learned to speak the other agency's language to effectively communicate. By hiring a former WSP officer to serve as the WSDOT incident response program manager, WSDOT was able to effectively communicate with WSP and present ideas and programs that could be mutually beneficial.

The importance of a good Department of Transportation maintenance program was noted as necessary for effective incident response. If WSDOT thinks an incident will last more than an hour, it calls for WSDOT maintenance to come to the scene and establish a traffic control system that is compliant with the Manual on Uniform Traffic Control Devices (MUTCD). This makes the incident scene safer for both emergency management responders and motorists and relieves the incident response team so they can respond to other incidents if necessary.

Finally, so that they can share ideas and learn from each other, WSDOT works closely with several other states, including Wisconsin and Florida, which are considered to have outstanding incident management programs.

Analysis and Research Observations

The Incident Response Program in Washington is successful because WSDOT and WSP have a close working relationship and coordinate well with each other. The agencies, further strengthening their relationship with the JOPS Agreement, have taken the time to evaluate the performance of their programs and can show clear benefits that have allowed great buy-in around the state and assisted WSDOT in finding funding to continue programs. They have also involved the leadership of both organizations by requiring that both the WSDOT secretary and the WSP chief sign the JOPS Agreement. This has added credibility to the document and increased the priority both agencies put on accomplishing the JOPS Agreement goals.

Florida: FDOT Road Rangers

The Florida Road Rangers are a freeway service patrol operated by FDOT in all seven FDOT districts and on the Florida Turnpike. Statewide, there are more than 100 Road Ranger vehicles in service patrolling more than 1,000 centerline miles of freeways. To operate the Road Ranger program, FDOT contracts with private vendors to provide vehicles and drivers and uses private sponsorship to supplement funding for the program. This case study examines the use of private tow vendors and sponsors to successfully deliver the FDOT Road Ranger program. Close coordination between public agencies and the private tow vendors that provide the Road Ranger service in each district is required for the service patrols to operate successfully. Joint FDOT and private sponsorship funding is required for FDOT to continue to offer the Road Ranger service without significant cuts to the miles of freeways covered or the hours of operations involved.

For this case study, Patrick Odom, FDOT's traffic incident management and Road Ranger program manager, was interviewed. In his position, Odom coordinates the program throughout the state. Part of his responsibilities includes working closely with the districts to assist them with the implementation, evaluation, and funding of their Road Ranger program and ensuring that a consistent level of service is provided by the program throughout the state.

It is interesting to note that although the Road Ranger program in its current format has only been in place since the year 2000, FDOT has provided various service patrol functions since the 1980s. Service patrols were first used by FDOT to manage incidents in work zones for major construction projects. In the 1990s, a service patrol was initiated in what is known as Alligator Alley, a desolate stretch of I-75 through the Florida Everglades in southern Florida. FDOT has been able to coordinate the different service patrols offered around the state and develop a program that is recognized by motorists across Florida (*8*).

Description

The Florida Road Ranger case study focuses on the use of private tow vendors and sponsors to deliver a freeway service patrol program throughout the state of Florida. Delivery of the Road Ranger program includes the participation of FDOT, Florida Highway Patrol (FHP), private service patrol providers, and private sponsors. The Road Ranger program is coordinated through the FDOT Central Office and operated by the FDOT districts and the Florida Turnpike Enterprise. The Road Ranger program in its current format began in 2000, but at that time the program was completely funded by the State of Florida. Budget cuts later forced FDOT to look elsewhere for funding or consider reducing the hours and miles of service covered by the Road Ranger program. FDOT was able to successfully implement a sponsorship program to supplement funding of the Road Ranger program through corporate sponsorship. This case study focuses on how the Road Ranger program was able to grow from a local program that was only offered in a few districts into a statewide program with deployments in every district.

Background of Agency

FDOT includes a Central Office, seven District Offices, and the Florida Turnpike Enterprise. Each of the seven districts and the Turnpike Enterprise operate Road Ranger service patrols, although the level of coverage varies with each district. Road Ranger roving patrols are used on heavily congested freeways, high incident locations, and work zones. The State Traffic Engineering and Operations Office coordinates the Road Ranger program statewide, but each district has independent supervision and control over its Road Ranger program. Districts contract directly with private companies to provide the operators and vehicles for a specified number of miles that need to be patrolled. To ensure program consistency across the state, each tow vendor provides white vehicles affixed with the Road Ranger logo, provides uniforms to drivers, and offers the same types of services as all other tow vendors. Road Ranger operators are trained in the same manner and all must have training in first aid and CPR.

Since 2000, the Road Rangers have provided more than 2 million assists to motorists and currently patrol more than 1,000 centerline miles. Road Rangers are equipped to assist in lane clearance and traffic control during incidents. They also provide limited amounts of fuel, tire changing assistance, cell phone calls for car service, and other types of minor emergency repairs to disabled vehicles to get them off the freeway and reduce the potential for secondary incidents. Road Rangers will move disabled vehicles off the roadway to the nearest safe place and contact the FHP to request a towing service to assist the driver at the driver's expense. During hurricane evacuations, the Road Rangers may be called upon to assist in traffic control and incident management as well.

The FDOT Road Rangers work closely with the Florida Highway Patrol in providing incident management. Motorists can dial *-F-H-P from their cell phones to request assistance. When appropriate, FHP will transfer calls from motorists to the FDOT District Traffic Management Center (TMC) and TMC operators will then dispatch a Road Ranger unit. In some areas of the state, dialing *-F-H-P will link the caller directly to the FDOT TMC.

Process Development

Service patrols have been used in Florida for more than 20 years; however, the Road Ranger program in its current format was implemented in 2000. In the late 1980s, service patrols were used to assist disabled vehicles in construction zones and were operated by the contractor doing the construction. In 1995, FDOT and the FHP worked together to develop a service patrol to assist disabled vehicles on I-75 through the Florida Everglades. This desolate stretch of interstate had a shortage of FHP officers to patrol it and a service was needed to assist stranded motorists and relieve FHP of that duty. The Alley Service Patrol was implemented in 1995, with FDOT contracting the service out to a private vendor. FDOT provided funding and the private vendor was responsible for providing trucks and operators.

Although service patrols were operating in several areas of the state in the late 1990s, FDOT lacked a consistent program statewide. The service patrols that had been deployed through the 1990s had received excellent feedback and their benefits were well understood by many at FDOT. To expand the service patrols, FDOT began formally funding the Road Ranger program in 1999 and the name Road Ranger was selected in 2000 through a statewide contest. The Road Ranger program was coordinated by the FDOT Central Office, but each FDOT district was responsible for the Road Ranger program in their respective jurisdictions. Through a competitive bid process, contracts were established with private companies in each district to provide drivers, training, and vehicles for the Road Ranger service. A majority of the companies that were awarded these contracts are towing companies, with the exception of District 5 in Central Florida. District 5 contracts with LYNX, the Central Florida Regional Transportation Authority, which also coordinates public transportation in three counties in Central Florida.

Despite proven benefits and an extremely positive response from the public, the Road Ranger budget was reduced in 2008 because of the economic downturn. In order to prevent a reduction in service of the Road Ranger program, FDOT gave permission to the private tow vendors to seek sponsorship to supplement funding of the Road Ranger program. Sponsorship funding allowed tow vendors to maintain or expand the hours of operation and miles of freeway serviced. In exchange for sponsorship, the Road Ranger vehicles are wrapped with logos from the sponsor, although there are still some elements of consistency for the Road Ranger vehicles. All will remain primarily white and will prominently display the Road Ranger logo. Sponsors must be considered family friendly by FDOT. Oversight of the sponsorship program is provided jointly by the FDOT Central Office and the districts.

In addition to the regular Road Ranger service patrols, FDOT requires that contractors provide a service patrol within work zones on some large construction projects. These service patrols are usually operated by the contractor, and the cost for the program is covered in the contractor's bid for the project. Most contractors understand that the service patrols provide an added element of safety within the work zones for both workers and motorists. There have been some cases where FDOT did not require contractors to provide service patrols, but the contractor implemented a program on their own because of the benefits they believe the patrols provide.

Detailed Process and Integration Points

Figure 3.2 documents an example of the process used by the Road Ranger program for incident response. The specific process shown in Figure 3.2 demonstrates the integration that is necessary between the FDOT District TMC, the FHP, and the private tow vendor that provides the Road Ranger service, to effectively respond to incidents. Incidents are typically identified by an FHP officer, the TMC, the Road Ranger operator during roving service, or by a stranded or observant motorist. Depending on the incident, the Road Ranger unit may respond independently to motorists who call for help, such as a stranded motorist who needs fuel, or they may respond in coordination with FHP to assist with traffic control during a major incident that closes part or all of a freeway. The Road Ranger operators complete an incident report for every incident they respond to and the FDOT District Office compiles the incident reports to monitor performance of the Road Ranger program.

In the process diagram, some of the initial steps that need to occur to implement a Road Ranger program are also documented. Competitive proposals are solicited for private companies to contract with FDOT districts to provide the Road Ranger service. These contracts are typically paid on an hourly basis and require the tow vendor to provide the Road Ranger vehicles, operators, and training of the operators. Sponsorship will continue to be sought to supplement the budget for the Road Ranger program.

Several key integration points were identified in the Road Ranger incident response process, including the following:

- Integration between FDOT TMC dispatch and private tow vendors responsible for providing Road Ranger service;
- Integration between FDOT Headquarters and private tow vendors to document services provided and develop the performance monitoring reports;
- Integration between FDOT TMC and FHP for identifying and responding to incidents;
- Integration between FDOT Headquarters and private sponsors for funding of the Road Ranger service; and
- Integration still needed between FHP and Road Ranger operators to allow FHP offices to talk directly to Road Rangers in the field.

The incident report that Road Ranger operators complete for each incident provides a detailed log of what services were provided, time to clear incident, and any other relevant information about the incident. FDOT keeps numerous performance measures to track the benefits of the Road Ranger program, such as the miles of freeway patrolled with roving service, number of patrols operating, and the number of assists provided to motorists. In addition, comment cards are provided by the Road Ranger operators to every motorist that receives assistance. The cards allow motorists to rate the service they received and can then be mailed back to FDOT.

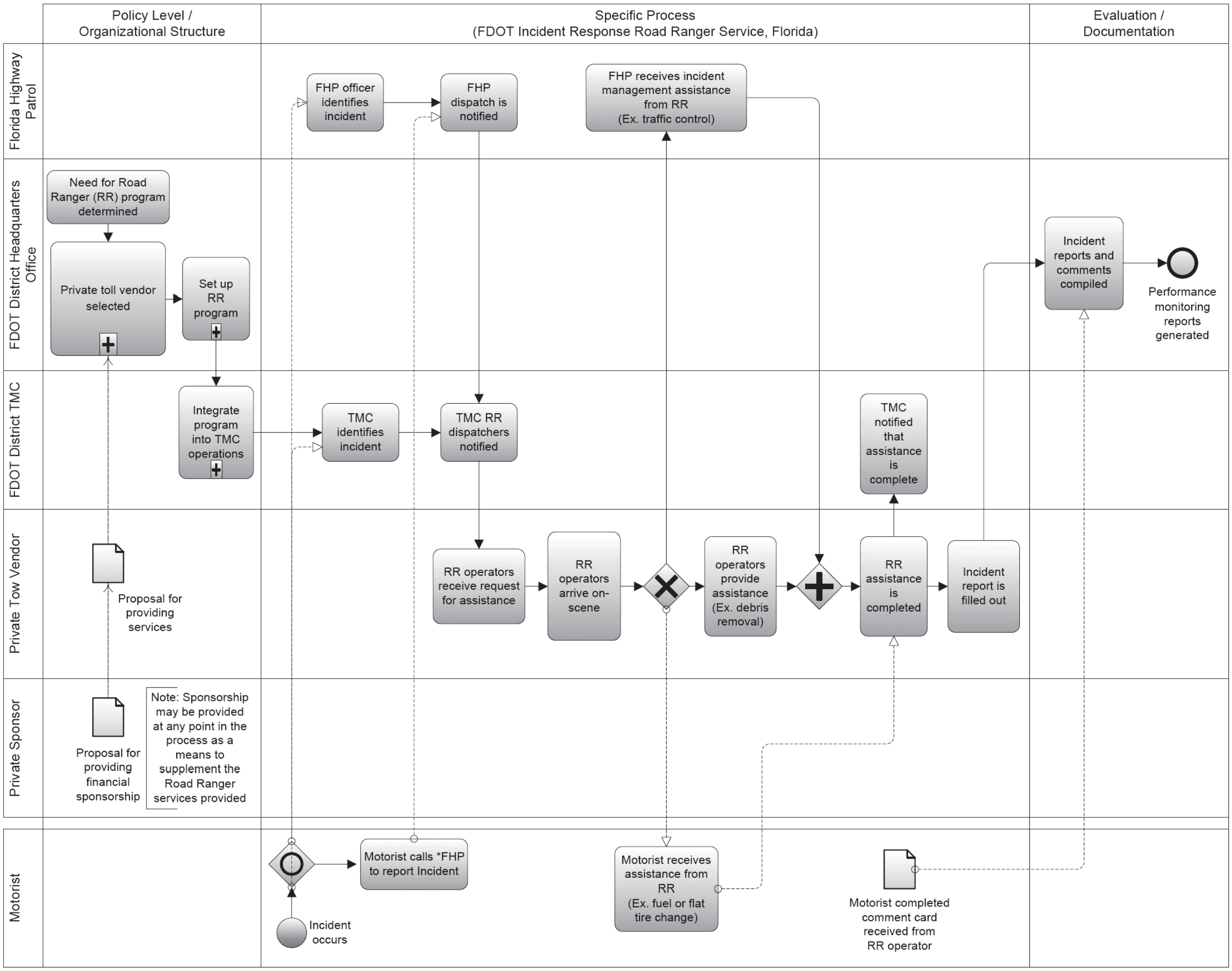

Figure 3.2. Detailed business process diagram of FDOT Road Rangers incident response.

Types of Agencies Involved

Three primary agencies work together to deliver the Road Ranger program: FDOT (Central Office and districts), FHP, and private tow vendors. FDOT provides the oversight for the program through the Central Office and districts. Day-to-day monitoring of the freeways and dispatch of the Road Rangers are provided by the FDOT TMC. In the Central Office, the traffic incident management manager and Road Ranger program manager are responsible for coordinating with each district to provide a consistent level of service for the Road Ranger program and to compile performance information. FHP identifies incidents through their patrol officers, as well as through dispatchers answering calls from motorists. FHP also coordinates directly with Road Ranger operators in the field during incidents. Private tow vendors contract with FDOT to provide the equipment and staff necessary to deliver the Road Ranger program in each district. In addition, private sponsorship supplements the funding provided by the state, thereby allowing FDOT to enhance the Road Ranger program.

Types of Nonrecurring Congestion Addressed

The Road Ranger program primarily addresses nonrecurring congestion caused by traffic incidents, through assistance to stranded motorists and provision of traffic incident management for major incidents. Stranded motorists present a potential hazard to other motorists and often contribute to congestion when other vehicles slow down as they pass the stranded vehicle. By assisting stranded motorists with such services as tire changes, fuel, or short tows to remove them from the freeway, the Road Rangers are removing this potential hazard and avoiding a possible secondary incident.

During larger incidents when emergency responders are called to the scene, the Road Rangers can provide traffic management through assisting with placing cones and flares, setting up detour routes, or providing warning, with truck-mounted dynamic message signs (DMSs), to motorists near the back of queues caused by incidents.

Road Rangers have also been used to address nonrecurring congestion caused by hurricane evacuations. Road Rangers can assist in traffic control and assist motorists who may be stranded during an evacuation. Assistance during evacuations is extremely important because motorists stranded on the side of the road may block some or all of a travel lane and may cause secondary incidents. Because capacity is critical during an evacuation, it is extremely important that assistance is provided to stranded motorists during evacuations to move them off the evacuation routes as quickly as possible.

Performance Measures

FDOT collects both output- and outcome-based performance measures for the Road Ranger program. Output-based performance measures include the number of assists provided to motorists and the number of miles of freeways covered by Road Ranger patrols. Outcome-based performance measures include the incident duration, travel time reliability, and customer satisfaction. Of the outcome-based performance measures, the Road Ranger program only has a direct impact on the customer satisfaction measure. Motorists who receive assistance from a Road Ranger unit are given a comment card to complete and mail back to FDOT to rate their satisfaction with the Road Ranger service. Responses have been extremely positive, with more than 90% of responses rating the Road Rangers as "very useful." In addition to the comment cards, FDOT routinely receives letters and e-mail thanking them for the Road Ranger service.

The performance measures for incident duration and travel time reliability are not a direct measurement of the Road Ranger program; however, the Road Rangers have a significant impact on both of these measures. Through close cooperation between the FDOT Road Ranger program, FDOT TMCs, FHP, and local fire and EMS, these agencies can improve incident detection, response, and clearance times. An overall decrease in incident clearance time will reduce nonrecurring congestion, reduce the chances of secondary incidents, and improve overall travel time reliability.

Benefits

In November 2005, FDOT sponsored a benefit-cost analysis to evaluate the cost-effectiveness of the Road Ranger program. The analysis was conducted under the direction of the Center for Urban Transportation Research at the University of South Florida. The overall benefit-cost ratio of the Road Ranger program was measured at 25.8:1. Benefits of the program included a savings of 1,138,869 vehicle hours of delay and 1,717,064 gallons of fuel. At the time, the program cost approximately $1.1 million statewide and the benefits were estimated at $29.2 million. The results of this evaluation clearly show that the Road Ranger program provides a major benefit and cost savings to travelers in Florida (*9*).

FDOT has also emphasized that, compared with the construction of new roadways, the Road Ranger program provides exceptional value. For example, FDOT has stated that the cost for construction of two new lanes of road for 2 mi is approximately $45 million and will provide additional capacity only in one localized area. That same funding for the Road Ranger program will benefit the entire interstate highway system in Florida.

FDOT's unique approach to using private tow vendors and private sponsors has been beneficial. Through the private tow vendors, FDOT is able to reduce some of its administrative burden of managing the program and can seek competitive bids to provide the service after each contract expires. The private sponsorship has provided a revenue source to replace funding cuts to the Road Ranger program by the Florida legislature. Without sponsorship, FDOT would have had to cut back on the Road Ranger service severely in the last two years and future operation of the system might have been in jeopardy. The private sponsorship has been a true win-win program. It has allowed FDOT to continue to offer an important component of its incident management program while allowing private sponsors an opportunity to build goodwill with the community through provision of the very popular Road Ranger program.

Lessons Learned

Despite FDOT's efforts to clearly document the benefit-cost ratio of the Road Ranger program and the positive response from the public, FDOT saw funding for the Road Ranger program reduced as the state looked for ways to reduce expenditures to deal with the national economic downturn. There is little doubt that the program has been successful, but FDOT is concerned that, given the continued economic downturn, the Road Ranger program could endure a funding cut once again.

One lesson that FDOT has learned is the importance of emphasizing that the Road Ranger program is not a courtesy patrol program. These types of programs are easy to cut because the perception is that they only benefit a few motorists. They are important services to provide but easy to reduce or eliminate when budgets are tight. To emphasize the incident management function of the Road Ranger program, FDOT promotes the functions that respond to incidents that affect traffic on the interstate system, provide safety alerts to oncoming traffic, provide temporary maintenance of traffic to the incident scene, and clear the road of incidents. Road Ranger patrols help distressed motorists on the interstate because these motorists create a situation that is a traffic hazard that could compromise safety, cause delays because of onlookers, and distract motorists, which often leads to secondary incidents.

The relationship and cooperation between FDOT and FHP have been good, and the benefits of the Road Ranger program to both agencies is clearly understood. One challenge has been in interoperable communications between FHP officers and Road Ranger operators in the field. Interoperable communication is especially important during major incident response, when Road Rangers may be managing traffic several miles away from the actual incident scene itself. FHP officers and Road Ranger operators used to relay messages through their respective dispatchers to communicate in the field. Interoperable 800-MHz radios are being implemented by FDOT and was set to be fully implemented by the end of 2009. The radios would then allow direct field communications and reduce the amount of time and potential for erroneous messages to be conveyed.

Analysis and Research Observations

The Road Ranger program has been successful in part because it fulfills a critical incident management need, and is the result of several years of grassroots efforts before expanding statewide. Service patrols were implemented in Florida over 20 years ago to assist with work zones and later expanded to include coverage of I-75 through the Everglades to assist stranded motorists in an area with little amenities. The service patrol on I-75 through the Everglades relieved FHP of the burden of assisting motorists on a stretch of road where the FHP patrols were already sparse. By the time the Road Ranger program was expanded statewide and implemented across Florida, there was strong buy-in from FDOT, FHP, and many of the tow vendors who saw the benefits of service patrols in work zones. FDOT continued to monitor the benefits of the Road Ranger program through an ongoing performance measurement effort, customer surveys, and a benefit-cost analysis by the Center for Urban Transportation Research. Early buy-in from FDOT and FHP, coupled with continual measurement of the performance and benefits of the Road Ranger program, have been key to its success.

Private sponsorship of the Road Ranger program was needed in 2008 to supplement the service due to budget reductions. FDOT was able to get the support of private sponsors by allowing them to tie their name to a program with a proven track record of great customer service and strong public support. Even with the slow economy in 2008 and 2009, FDOT has not experienced cancellations or reductions from any of the program sponsors.

Continued expansion of the program is one of the future challenges for FDOT. Typically, freeways need to reach a critical level of congestion or show a high crash rate to receive roving Road Ranger patrols. FDOT is continuing to seek funding sources to allow for expansion of the Road Ranger program. There are clear benefits to having the service patrols operate on freeways even if congestion is not at peak levels. FDOT would like to find ways to expand the program and bring the proven benefits of Road Rangers to an expanded area of Florida in the near future.

United Kingdom: Active Traffic Management

Active traffic management (ATM) is a method of managing traffic through a dense deployment of technology applications that reduces congestion and improves traffic flow. This method focuses on improving travel reliability, enhancing efficiency, and increasing throughput and safety along the existing roadway. ATM is based on several new or modified operational strategies that together produce a fully managed corridor, optimizing the existing infrastructure along the roadway. Currently, ATM is used in a number of European countries, including Denmark, Germany, the United Kingdom, and the Netherlands. In addition, several states are in the process of implementing some elements of the ATM practice and technologies to enhance their current networks.

The United Kingdom initiated a pilot program along M42, southeast of Birmingham, England. The program consists of gantries, detection, variable speed limit (VSL) signs, cameras, and variable message signs (VMS) along a 10.5-mi section. The Regional Control Center (RCC) in the area, West Midlands Regional Control Center, actively operates the ATM deployment. The success of the pilot project has generated significant benefits that have led to the support and funding for an extensive expansion of the ATM project to over 300 mi (*10*).

David Grant, the group manager and head of ATM within the Highways Agency (HA) was interviewed for this case study. The HA is an executive agency within the Department for Transport of the United Kingdom. It manages traffic and congestion, provides information, and improves safety.

Description

This case study investigates how ATM practices and technologies are used to improve travel time reliability. HA took a different approach to designing and developing its ATM program by conducting a safety analysis of the corridor. Based on the identified safety issues, mitigation strategies were determined and packaged into the ATM solution for the corridor. The work completed during the safety analysis provided before-data that could be used to calculate actual benefits of the fully implemented pilot project. After the M42 ATM deployment was in operation for 12 months, a private firm was hired to review its effectiveness and document its benefits. These documented benefits were used to gain support for funding of a full ATM program, including extending ATM to all seven regions in England.

The UK case study was selected because of its excellent documentation of benefits and because of the analytical approach it used to define the components of the ATM pilot project.

Background of Agency

The HA is responsible for operations, maintenance, and improvements of approximately 5,500 mi of strategic roadways, or trunk roads, within England. Over 105 billion vehicle miles are travelled along the roadways each year. The HA has eight transportation control centers throughout the region to monitor traffic. The National Traffic Control Center (NTCC) near Birmingham is the main hub for travel information within England.

The NTCC is used to relay information to motorists along the national network. NTCC provides continuous information about incidents, notification of congested sections, and alerts concerning severe weather that may affect the roadway. The other seven regional control centers (RCC) are used for tactical issues along the roadway. They dispatch support to disabled vehicles, help clear incidents, provide traffic management support, and operate ATM deployments. Currently, only one of the regional facilities has ATM in its jurisdiction, but eventually, all seven will operate some level of ATM.

The NTCC uses a variety of technologies to monitor traffic along the HA network. Some of the technologies include traffic flow monitoring equipment, cameras (including automatic number plate recognition [ANPR]), vehicle sensors or detection, and floating car technology. This information is relayed to a variety of traveler information tools, which include Traffic England (traveler information website), kiosks, VMS, and the media.

Process Development

In 2000, The UK government's Transport 2010 strategy included the idea of an ATM solution. After a comprehensive review of five potential sites (including M25, London's Orbital Motorway), the M42 was selected for a pilot study. The HA performed a safety evaluation of M42 during 2002 and 2003. The safety analysis identified over 2000 new and existing safety issues on the corridor. A risk assessment was performed for each hazard type to determine the probability of occurrence. The impacts were reviewed and mitigation strategies specific to each hazard were identified. Data in several areas including safety, traffic conditions (mobility), noise, and user perspective were documented so the benefit of ATM strategies could be evaluated appropriately and to guide future decisions for the HA (*11*).

The pilot project was designed and construction began in March 2003. It included variable speed limit (VSL) signs, emergency refuge areas (ERA), hard shoulder running, vehicle detection, and VMS. One of the larger concerns of the pilot project was user compliance; HA needed to verify that motorists would comply with variable speed limits. To address this issue, HA used specially developed digital cameras to enforce the variable speed limits. HA was not concerned with the monetary penalties received, but with the impact on reducing the safety risks of those who are speeding.

Another issue that HA considered was the accuracy and timeliness of the messages provided. The message signs are used to give travel information or detour routes during severe incidents. If the information is not consistent or current on the VMS, drivers likely would stop heeding the messages, thereby affecting the impacts of the overall ATM solution.

Detailed Process

The process used for managing an incident using ATM is displayed in Figure 3.3. When an incident occurs, the RCC receives notification through various means, including data collected by the detection equipment and cellular phone calls to the police agency. RCC operators continually monitor the roadway from cameras located along the corridor and can verify the incident location and severity.

The role of the police at any roadway incident is for investigation only; they do not play a role in traffic management. Uniformed traffic officers run the control room and can dispatch personnel to the scene. In the West Midlands RCC, the police also share the control room and can dispatch units to a serious incident. Traffic officers are personnel that help monitor and patrol the roadway network. When the detection deployment acknowledges a change in the traffic flow, the VSL signs are automatically adjusted to slow the approaching traffic and reduce the risk of rear-end crashes. This integration allows RCC to monitor the incident and activate the gantry signals to move traffic out of the affected lane. VMS also are activated from RCC to divert traffic onto alternate routes and alert traffic of the upcoming incident. RCC closely monitors and continues to divert additional traffic, if warranted, in conjunction with the NTCC.

Traffic officers are tasked with providing onsite traffic management, such as full ramp closures, to supplement the ATM and protect the incident scene for the police. Traffic officers are strategically located in depots adjacent to the road network so they can easily be dispatched by RCC operators along with

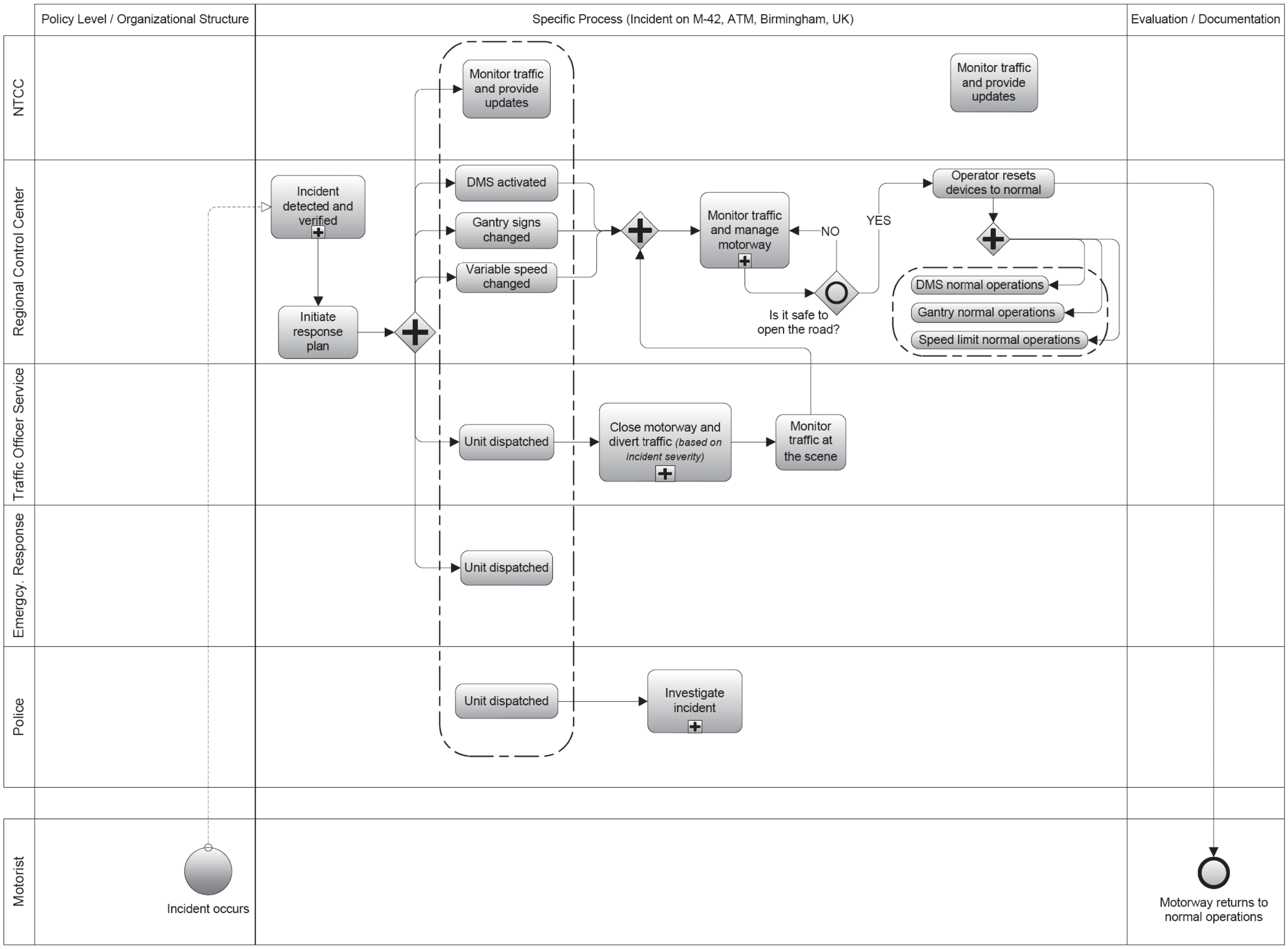

Figure 3.3. Detailed business process diagram of United Kingdom active traffic management.

emergency response personnel (i.e., fire and first responders) and the police. Based on the observed incident location and severity, the RCC operators activate messages on the VMS to share information concerning the incident and to manage lane use of approaching traffic.

In addition, ERAs have been installed to assist in quickly clearing incidents and stalled vehicles from the hard shoulder. These locations also provide safe and easy access for maintenance of the ATM field devices. ERAs include phones with multilingual, hearing loops, and texting capabilities. The refuge areas improve safety and capacity by providing a location for travelers and maintenance personnel to move off the hard shoulder and out of the roadway.

Once the incident has been cleared, the RCC operators will evaluate the safety of the roadway and decide when to reopen traffic lanes. Once the operators decide the roadway is safe, the devices are reset to normal operations and the VMS are used to continue sharing updates on traffic flow. The VSL signs will automatically adjust to higher speeds as the traffic flow regains capacity and speeds slowly increase.

Several key integration points were identified in the ATM incident management process, including the following:

- Integration between NTCC and the regional control centers to monitor incidents and to activate devices, respectively;
- Integration between NTCC and the traffic officer service, emergency response, and the police;
- While monitoring the incident location, the on-road traffic officer service integrates with the RCC; and
- Integration between the RCC operator and the field devices.

The process is documented in a 12-month performance report about the project, the process, the outcomes, and the benefits (*12*). The HA website also contains comprehensive information about the ATM pilot project. This information includes details of the project scope, funding, how ATM manages traffic, and the results.

In addition, all incidents require a report. The complexity of the report depends on the severity of the incident. A more severe incident requires a larger number of agencies involved with investigation and clearance and is therefore more complex. Some severe incidents also require debriefings with the agencies involved.

Types of Agencies Involved

There were more than 120 stakeholder groups that provided input to guide the development of the ATM system. HA is one of seven executive agencies within the Department for Transport that is responsible for ATM and has led the effort since its inception. Another significant supporter of ATM is the Freight Transport Association. Trunk roads connect the ports with inland delivery destinations and therefore have a significant impact on freight operations.

Types of Nonrecurring Congestion Addressed

This ATM pilot project was developed to address recurring and nonrecurring congestion. ATM is used to alert travelers of any incident occurring along the corridor by means of VSL signs, vehicle detection, and VMS. Advanced capabilities of the system provide technology and infrastructure to address all forms of nonrecurring congestion on the corridor. Before implementation, congestion on M42 was so severe that motorists were regularly experiencing stop-start conditions. However, as congestion continued, safety improved. Because of lower average travel speeds, crashes often did not involve any fatalities or severe injuries.

Before ATM was implemented and an incident occurred, the impact on capacity was severe, with impacts lasting for several hours. Travel time along the corridor was extremely volatile, ranging from 30 min to 3 h. Use of arterials was limited because of the lack of traffic management strategies and limited coordination with local agencies. The pilot project provided the regional center with comprehensive monitoring and traffic management strategies along the 10.5-mi corridor. This coordination has significantly improved impacts related to nonrecurring congestion.

Performance Measures

As mentioned, HA hired a consultant to evaluate and document the impacts of ATM on the roadway network. The consultant conducted surveys with local users, local nonusers (those who live near the roadway but have not traveled on it in the previous three months of the survey), and long-distance users. They surveyed the users' thoughts about the ATM modifications, specifically as they pertain to congestion along the corridor, the ATM measures, environmental impacts, enforcement, driver information, and overall use of the corridor.

It was understood that users need to have reliable, accurate information displayed at all times to trust the message at a given time. The operators within the control centers are constantly monitoring the flow of traffic along the corridor to ensure that what is happening on the roadway is being displayed. Based on effective operations of ATM, the motorists on M42 have experienced a 27% improvement in travel time variability and a 24% improvement in travel times during the worst pm peak. The ATM pilot project also has resulted in a 4% decrease in fuel consumption; a 10% decrease in vehicle emissions; and a decrease in the crash rate from 5.1 to 1.8 per month (*12*).

Benefits

The ATM pilot project demonstrated several congestion and safety benefits along the M42 corridor. The documentation of these benefits has helped to gain the support of government ministers and industry. As stated, the benefits include improvements in travel time, emission and fuel consumption reduction, and a decrease in the crash rate. These benefits are due in large part to the overwhelming compliance rate of the drivers.

Driver compliance with VSL signs and VMS was a concern before implementing the pilot project. However, HA has documented a 95% compliance rate for speed limits equivalent to 50, 60, and 70 mph and an 85% compliance rate for speed limits equivalent to 40 mph (*12*).

Another benefit of the ATM project is the lower cost and reduced schedule compared to a road widening project. Widening of the corridor by one additional lane was estimated to cost about $820 million, take 8 to 12 years to complete, and would require an environmental statement and public involvement. The ATM pilot project cost only $160 million and was complete within 3 to 4 years, with no environmental impacts or need for additional right-of-way.

Finally, the benefits demonstrated from the pilot project provided sufficient documentation to support funding for project expansion. In January 2009, government ministers announced that a $10 billion project, Managed Motorways, was initiated to expand ATM to over 300 roadway miles. The expansion will provide ATM coverage across England, with ATM control being conducted from all seven regional control centers.

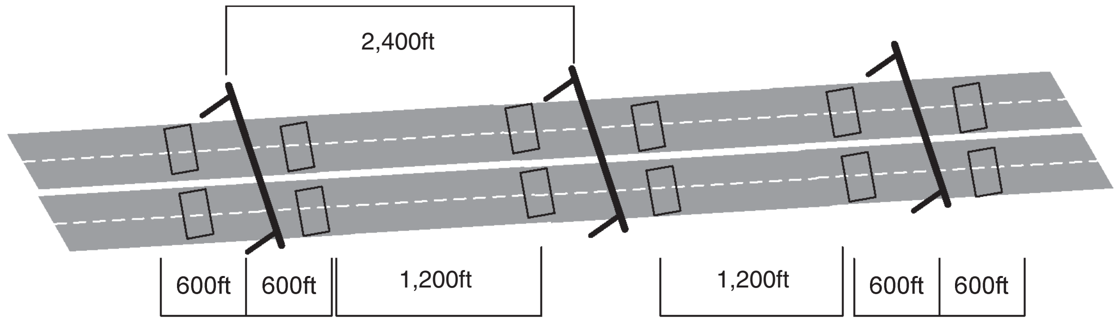

Figure 3.4. UK ATM gantry and detector spacing schematic.

Lessons Learned

Even with the success of the pilot program, there are still some elements that will be modified or improved during the expansion of ATM. Some of these modifications will affect the approach for detection, cameras, ERA, and new technology.

In hindsight, the camera density could be reduced. The possibility of supplementing cameras with more advanced detection or other technologies should be considered. Currently, the detection equipment is spaced every 300 ft, which is excessive for monitoring traffic flow. The proposed spacing, shown in Figure 3.4, would locate the detector stations 600 ft before the gantries and 600 ft after the gantries. Gantry spacing is at 2,400-ft intervals, which means the detector stations would be located every 1,200 ft.

Second, HA has an interest in more advanced technologies, such as artificial intelligence or millimetric radar detection. Millimetric detection provides a more refined monitoring of the roadway and could recognize debris or stalled vehicles. This advanced detection would help the control center determine when it is safe to reopen the roadway after an incident.

Finally, it may be possible to reduce the overall size of an ERA. Decreasing the size of the ERAs could provide the same services and safety factors as the larger space at a lower cost.

Analysis and Research Observations

The UK implementation of ATM was initiated differently from those of other countries within Europe. They began by completing an in-depth safety analysis of the corridor. HA focused on determining the problem areas, the influences, and the impacts that these areas make on an average daily trip along one of the UK's busiest corridors. Once those hazards were identified, a risk assessment was completed. ATM was identified through a compilation of solutions focused on mitigating the safety issues that had been identified. The solution was decided to be the best choice for the cost, safety, and mobility of the motorists along M42.

The ATM solution was unprecedented in many ways. The Department for Transport is the first agency to use digital cameras for speed enforcement along a corridor with variable speeds. The cameras are connected with the variable speed limit data and have assisted in maintaining a compliance rate along the corridor that remains in the 90th percentile for speeds above 50 mph. The digitized images from the enforcement cameras are transmitted directly to the police for review and enforcement.

Information on VMS is informative and accurate, which also helps with user compliance. The detection subsystem on the corridor is motorist incident detection automation signal (MIDAS) sensor loops. The system uses algorithms to monitor traffic flow and automatically adjusts VSL signs when flow decreases. These algorithms have been used for years on other roadway sections and are well trusted by HA personnel. The automation between the detection and VSL signs allows the operators to focus on the issue that is causing slower speeds while also monitoring the back of the queue and approaching traffic.

ATM is successful in the UK because of user compliance, whether they are local, long distance, or freight. The stakeholder outreach performed during the early development of ATM has increased the buy-in and support for the solution. The corridor is clearly focused on the efficient and safe movement of goods and people.

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CHAPTER 4

Case Studies: Work Zone Management

Work zones in the United States account for approximately 10% of congestion, according to research from the FHWA (*1*). Work zones are defined as any construction activities that result in physical changes to the highway environment, such as reductions in the number or width of travel lanes, lane shifts, lane diversions, and temporary road closures. Work zones often reduce capacity and may experience higher crash rates than other segments of freeways, thereby contributing to a decrease in reliability. Furthermore, longer-term closures for major construction projects often have shifting impacts as traffic control strategies are modified to respond to changing schedules or unforeseen issues in the field.

This section presents case studies that examine the processes that the North Carolina DOT (NCDOT) and Michigan DOT (MDOT) have used to better manage work zones. The NCDOT Traffic and Safety Operations Committee is tasked with evaluating work zones before any significant changes or when crash rates and speeds increase in the work zones. In Michigan, MDOT transportation planners have used microsimulation modeling to evaluate traffic control plans and select the plans based in part on their impact on the overall transportation network.

North Carolina: NCDOT Safety and Traffic Operations Committee

NCDOT has implemented an interagency coordination process for the planning and monitoring of major construction work zones. The coordination process begins before construction, ideally in the planning stage, and is continued throughout the project. The process is determined by the needs of each unique construction project. Initially, internal planning level meetings are conducted to establish the scope of a work zone. A project-specific Safety and Traffic Operations Committee is created to oversee the implementation of a work zone. This process is focused on addressing the work zone safety and mobility requirements provided by FHWA, 23 CFR Part 630, Subpart J.

In preparation for this case study, a discussion was held with Joseph Ishak, PE, Central Work Zone Traffic Control (WZTC) Section engineer, and Jennifer Portanova, PE, project design engineer, both with NCDOT. The following information represents their knowledge based on specific project experience.

Description

This case study was selected based on the proactive approach to managing the impacts of the project work zone and the continuous coordination between several involved agencies. The NCDOT Safety and Traffic Operations Committee is composed of representatives from the WZTC Section, the NCDOT field office, safety engineers, incident management personnel, public safety agencies, North Carolina State Highway Patrol (NCSHP), the public information representative, and the contractor. These representatives coordinate to ensure the safety of the workers and travelers, as well as the efficiency of the work zone and the transportation network.

The NCDOT Safety and Traffic Operations Committee focuses on significant projects as defined by the Work Zone Safety and Mobility Policy, where mobility and potential safety concerns exist. This allows the committee to provide better focus and attention to those construction projects, which will allow them to have the greatest positive impact. NCDOT guidelines clearly define four activity levels of significance. The criteria for determining the level of significance include lane closures, annual average daily traffic (AADT), truck traffic, additional travel times expected, level of adverse impacts to existing transportation infrastructure/high-volume traffic generators, duration of traffic impacts and user value or cost. The coordination process and committee involvement are then based on the determined level and specific needs of the project.

Coordination for the concept, design, implementation, and monitoring of work zones occurs throughout the life of a construction project, with varying levels of participation. The early planning stages for the traffic management concept of a project only involve units internal to NCDOT. As the project continues to later phases of the design, through implementation and monitoring, a committee is established with stakeholders specific to the project area. The committee has an active role in implementing and monitoring safety and traffic operations in conjunction with each major lane shift or when increases in crash rates or speeds are observed. As an extension of this collaboration process, the NCDOT Work Zone Traffic Control Section, which is part of the Mobility and Safety Division, has initiated an effort to continually monitor and evaluate the effectiveness and safety of work zones. Based on observed conditions, the committee can initiate speed or safety studies to validate concerns in the vicinity of the construction project. The resulting information is available to guide decisions aimed at revising and improving the existing traffic management plan.

The Safety and Traffic Operations Committee also considers the impacts of the project work zone on the surrounding network and seeks to efficiently plan for and minimize those impacts where possible. Lane and ramp closures are carefully considered because of their impact on the surrounding network. In addition, modifications or improvements to specific segments of the network may be recommended to handle the additional traffic resulting from the construction project.

Since the inception of this coordination process, the committee has been responsible for managing the planning and monitoring of work zones for several significant projects. Some construction projects have been completed with no major crashes or fatalities.

Background of Agency

The NCDOT Traffic Management Unit is one of six technical units within the Transportation Mobility and Safety Branch. The Traffic Management Unit consists of the Congestion Management Section, the Municipal and School Transportation Assistance Section, and the WZTC. Based on the NCDOT's mission statement and goals, the WZTC Section is primarily tasked with making the infrastructure safer and more efficient in and around work zones.

The WZTC Section regularly coordinates with municipalities, highway patrol, emergency responders, other department branches, and other agencies. The WZTC Section is responsible for developing traffic management plans that maintain mobility and safety through a work zone. In addition, the performance evaluations for each staff member within the department are directly connected with the department's goals; staff members are encouraged to evaluate current operations and implement strategies that directly seek to reach these goals. The focus of the Safety and Traffic Operations Committee is in line with the established goals as it works to safely and efficiently plan, implement, and monitor the work zones of significant projects.

Process Development

The impetus for the Safety and Traffic Operations Committee meetings was a fatality that occurred within a construction project work zone. Because of the fatality, a coordination meeting with key stakeholders was conducted. These meetings continued throughout the remainder of the project. The collaboration was useful and productive; therefore, when the US-70 Clayton Bypass project was nearing construction, it was decided to hold similar coordination meetings before construction, during construction, and before major traffic shifts. The meetings were held to address upcoming traffic shifts, enforcement, speed limits, incidents, public information, and a construction update on the project. The meetings were again successful, and NCDOT created the Safety and Traffic Operations Committee, which is now involved in significant projects and seeks to address the work zone safety and mobility requirements provided by FHWA, 23 CFR Part 630, Subpart J.

Detailed Process

NCDOT has published *Guidelines for Implementation of the Work Zone Safety and Mobility Policy*, which outlines the goals, objectives, and strategies for all projects and identifies key stakeholders who are responsible for the implementation of each objective (*2*). The document also provides a method of determining the project level of significance, which, in turn, determines the required management practice. Projects that are determined to be significant within the guidelines require the establishment of a Safety and Traffic Operations Committee composed of representatives from the agencies outlined above.

The Safety and Traffic Operations Committee meetings are conducted to evaluate the impact of the work zone on traffic on the major routes. Meetings are conducted before the implementation of the traffic management plan and continue throughout the life of the construction project. Corridors are designated as major routes based on the project location and the perceived regional impact of the work zone. Instead of conducting monthly scheduled meetings, the meetings are established based on key milestones of the project and when certain issues are identified within or in the vicinity of the work zone. The milestones include scheduled traffic shifts or changes in the work zone that can result in major impacts on traffic.

The work zone plans are reviewed for effectiveness based on observed conditions in the work zone. The field personnel, contractor, and law enforcement agencies provide input into the actual traffic conditions experienced in the work zone. Increases in speed, increases in crash rates, and other negative trends observed are discussed at the meetings and possible solutions are presented.

The committee coordinates to identify viable mitigation strategies in response to the issues observed in the work zone. Possible solutions include ramp closures, added presence of law enforcement, or restrictions in the contractor's available working hours. The strategies are implemented and continually monitored for effectiveness until other negative trends are identified or the construction project is complete. Successful implementation of effective strategies also can lead to policy-level changes to guide future traffic management plans and work zone implementations.

An example of the process used by the Safety and Traffic Operations Committee is shown in Figure 4.1.

Several key integration points were identified in the NCDOT Safety and Traffic Operations Committee process, including the following:

- Integration between the NCDOT Division Office, the NCDOT Work Zone Traffic Control Section, and the contractor to review work zone traffic control plans;
- Integration between NCDOT, the contractor, and the NCSHP to review final plans before implementation;
- Integration between NCDOT and the contractor for revised work zone plans before implementation;
- Integration across all players to monitor performance of the work zone once implemented;
- Integration between agencies to review potential solutions when issues are identified and implemented; and
- Coordination with North Carolina's Information Management Public Affairs, Construction and Traffic Control

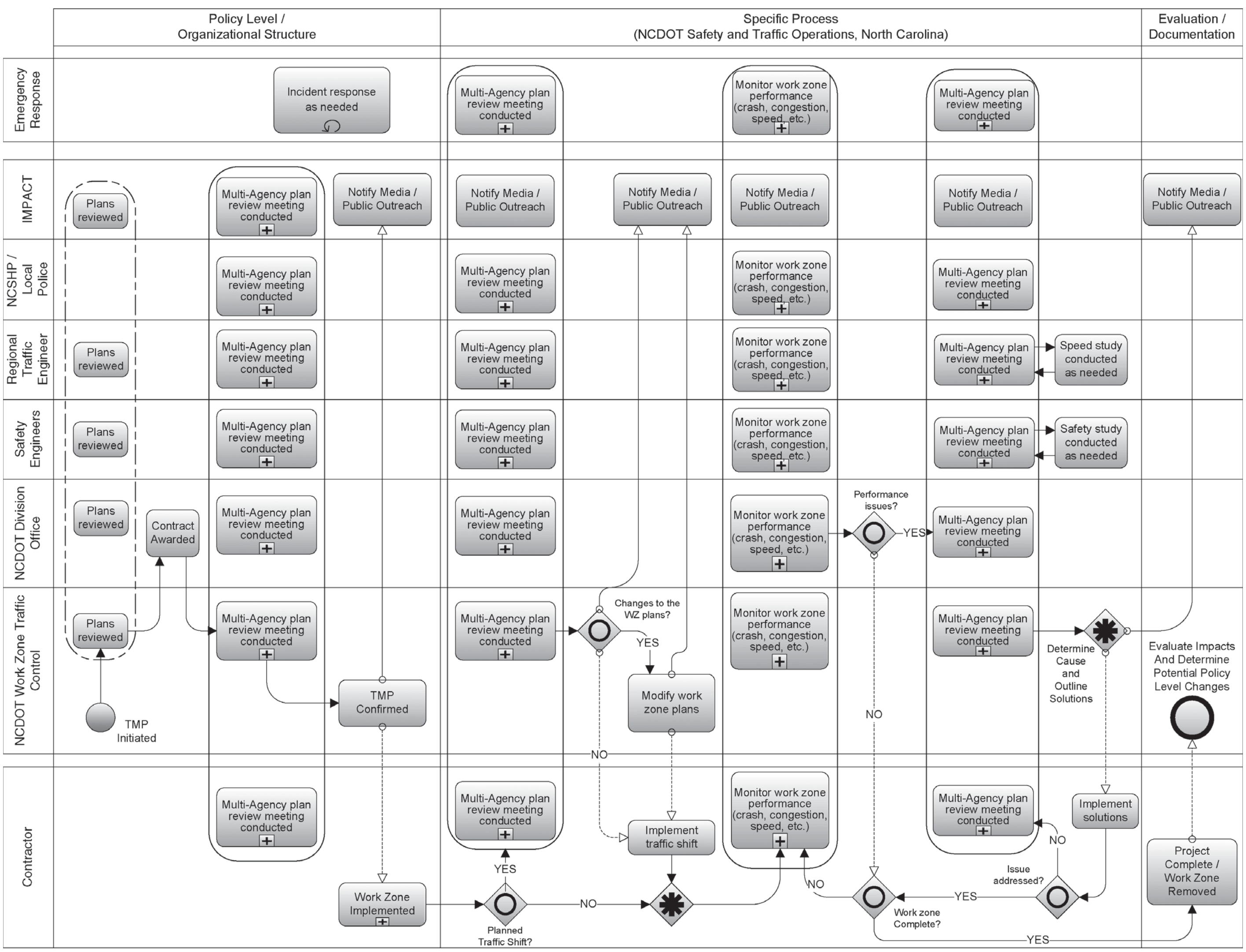

Figure 4.1. Detailed business process diagram of NCDOT Safety and Traffic Operations Committee.

(IMPACT) group for public information assistance to provide outreach and information specific to the work zone.

Integration also is encouraged because of the required traffic management plan process. The WZTC Section must produce traffic management plans for every construction project on NCDOT-maintained roadways. Any modification to the work zone must be based on traffic control plans sealed by a professional engineer. Each time there is a change, a new set of plans are developed and sealed. As modifications are made in the field, it is important for the changes to be documented in the existing plans. It also is important that detailed meeting minutes are captured for each Safety and Traffic Operations Committee meeting. Since the work is occurring in an active work zone, the resident engineer should maintain these records through the construction life of the project and as long as state law requires.

Types of Agencies Involved

The Safety and Traffic Operations Committee includes participants with a vested interest in maintaining a safe and effective work zone. The NCDOT WZTC Section is responsible for the design and management of work zones for all roadway projects across North Carolina. The NCDOT Division is responsible for the construction of the roadway projects and works closely with the WZTC Section on issues or questions regarding the work zone traffic control plans. Additional stakeholders include local agencies that can be affected by rerouted traffic, emergency management services and emergency responders who need uninterrupted access to the work zone during incidents, the Traffic Systems Operations Unit that oversees public information for larger construction projects and manages the statewide incident management and traveler information systems for 511 and the web, Traffic Safety Unit, and the NCSHP that is responsible for law enforcement on North Carolina's highways.

These stakeholders collaborate through the Safety and Traffic Operations Committee, which provides opportunities to develop relationships and trust. The committee establishes a network of informed individuals who seek to provide the public with safe and reliable transportation throughout North Carolina. The relationships and networks that are established carry over into other aspects of the transportation network as well. For example, through efforts to successfully implement tougher penalties for speeding through work zones, the NCDOT has developed a strong relationship with the NCSHP. This relationship and foundation of trust has carried over into the Safety and Traffic Operations Committee.

The committee also provides the contractor with another avenue to seek direction and communicate concerns. The contractor is driven by a need to construct the roadway project on schedule and under budget while maintaining a safe work environment for its employees. Since larger construction projects can include daily liquidated damages for delayed completions, the contractor is always focused on efficient and safe operations within the work zone. The contractor is aware of daily experiences in the work zone and can identify unsafe scenarios within the work zone and when traffic patterns, such as increased speeds, begin to change. The contractor coordinates with field personnel on a daily basis, but the Safety and Traffic Operations Committee provides a means for the contractor to communicate concerns with the WZTC Section, NCSHP, incident management, and public information personnel.

The committee establishes relationships and networks of informed individuals that build trust with their partners to reach a common goal. These partnerships increase the safety and mobility of work zones for significant projects throughout North Carolina. They also influence coordination among the same agencies that may communicate on other transportation projects.

Types of Nonrecurring Congestion Addressed

As stated, work zones are categorized as planned events, but can generate long-term effects on traffic. Work zones modify the roadway operations for specific time periods, and these modifications must be evaluated to minimize impacts to mobility, safety, and travel time reliability. The NCDOT Safety and Traffic Operations Committee is focused on continually monitoring the effect of a work zone on the roadway capacity. The committee also plans for secondary incidents and considers how emergency responders can efficiently respond within the work zone. Additionally, construction contracts specify that the contractor will be required to clear incidents in a set amount of time and requires that a towing company be identified within the contract as a subcontractor.

Not only does the committee consider potential incidents, but it also attempts to minimize the incidents that occur by carefully establishing the appropriate speed limits within the work zone. Higher work zone speeds increase the safety risks for the motorists and workers in both quantity and severity. Higher speeds, increased crash rates, and ineffective lane shifts have a direct impact on travel time reliability within the work zone. The committee has established a process to identify, evaluate, and implement mitigation strategies to offset negative impacts on travel time reliability and these strategies have proven successful in recent projects.

Performance Measures

The committee has identified specific performance measures, such as speed and crash rates, to continually evaluate the safety and mobility of the work zone. When these measures demonstrate negative trends, the committee works to address issues that promote the variation in driver behavior. The changes in trends can be identified by any of the committee participants, including the resident engineer, contractor, and even the NCSHP. Once a mitigation strategy has been implemented, the safety and mobility of the area are monitored to ensure that the strategy has been effective and does not generate more problems, such as an increase in congestion.

As an example, the committee recently managed an I-40 project that had no fatalities in the work zone throughout the construction project and a decrease in the crash rate on the corridor during the project. The committee feels that the reduction in the crash rate can be attributed, in part, to a combination of the proactive management of the work zone, a higher level of law enforcement, and extensive outreach to inform the public of the project.

Benefits

The Safety and Traffic Operations Committee has developed greater trust and partnership between contractors, NCDOT, and the NCSHP. Working toward a common interest of improving safety for workers and motorists has strengthened the trust developed between the multiple agencies. The committee provides a means to evaluate traffic management plans before implementation and during construction. The continuous monitoring of the work zone provides a safer work environment and roadway. Modifications to the traffic management plan can be easily implemented because everyone is continually involved. Additional benefits and increased efficiencies are experienced through targeted enforcement on areas within the work zone where safety issues and a higher rate of violations are observed.

Lessons Learned

The committee has seen great success on the few projects where a traffic management plan has been implemented. The success is based on established trust between the partners and documenting the safety and mobility of work zones. This trust is established through targeted meetings that are held only when needed and involve the correct stakeholders. Documenting the impacts of work zones will provide reference points for decisions made on future traffic management plans based on well-documented successful practices.

Analysis and Research Observations

The process has provided a means by which all affected stakeholders can provide continuous feedback concerning the effectiveness of a traffic management plan. On typical construction projects, stakeholders are involved to a certain degree during the plan development, but implementation and monitoring of the work zone is handled by the division and contractor with some coordination from the WZTC Section. The establishment of the Safety and Traffic Operations Committee allows any affected stakeholder to voice concerns about the work zone and traffic control plan at any point during the construction project.

Committee meetings allow identified issues to be presented and resolutions to be discussed because each of the stakeholders provides a specific focus for the work zone. Having a discussion about potential solutions with all the stakeholders allows each partner to voice concerns that could affect their particular focus area. For example, a full ramp closure could eliminate dangerous weave conditions on the mainline but also may eliminate a key access point for emergency responders to access the roadway. The ramp closure also may eliminate key access to the local municipality. The committee approach to addressing issues yields the most effective and supported solutions.

The continuous evaluation of the work zone evaluates the average speed and crash rates so that problem locations can be identified early and addressed. The attention to observed issues results in greater mobility and safety within the project limits and better travel time reliability on the network. The ability to quickly assemble stakeholders, discuss options, and implement solutions demonstrates an effective approach to mitigating identified issues. The specific focus of meetings also establishes trust with the stakeholders that meetings will be successful and results will be produced.

Michigan: MDOT Work Zone Traffic Control Modeling

The Michigan DOT I-75 Ambassador Bridge Gateway Project includes the reconstruction of the I-75 and I-96 freeways, a new interchange for the Ambassador Bridge, a redesign of the Ambassador Bridge Plaza, and a pedestrian bridge across I-75 and I-96 to connect east and west Mexicantown in southwest Detroit. The Ambassador Bridge, which connects Detroit, Michigan, and Windsor, Ontario, Canada, is one of the busiest commercial bridges in the world and the largest commercial border crossing in North America, with approximately 11 million vehicles crossing the bridge each year. It is a vital international trade route and access to the bridge needed to be maintained at all times during the reconstruction. I-75 also serves as a critical link for trade and manufacturing in the Midwest. For Michigan's large manufacturing industry and their many suppliers along the corridor from Ohio to Tennessee, I-75 is a necessary lifeline.

Construction started on the I-75 Ambassador Bridge Gateway Project in February 2008 and was scheduled for completion in fall 2009. As part of the construction, I-75 was scheduled to be closed for 18 months through downtown Detroit and a complete closure of the I-75/I-96 interchange was scheduled for three months. To determine the impacts of the closure and plan detours and traffic management strategies, MDOT used large-network microsimulation.

The microsimulation model was created on the Paramics model software platform by a consultant. MDOT Metro Region Planning staff and Traffic and Safety staff closely coordinated with the consultant to develop and implement work zone mobility mitigation plans. This case study was based on interviews with MDOT Metro Region staff.

Description

This case study examines the modeling process that MDOT used to evaluate the impacts and to develop work zone traffic control plan alternatives. The ability of MDOT to develop network microsimulation models of work zones around the project began years before construction started, with the development of the Southeast Michigan Freeway Simulation (SEMSIM) model on the Paramics platform. SEMSIM was originally developed as a tool for helping facilitate MDOT project funding decisions for Southeast Michigan. MDOT Metro Region Planning repurposed the SEMSIM model and applied it to work zone modeling of the I-75 Ambassador Bridge Gateway Project. This marked the first time that network microsimulation had been used in an operations analysis, as opposed to planning applications. The model also had to take into account numerous other planned closures of I-75 and surrounding roads partly because of the I-75 Ambassador Bridge Gateway Project and partly because of other planned freeway and local construction projects (*3*).

The MDOT consultants modeled several scenarios corresponding to various project stages. The scenario for the summer of 2008 was most critical because, in addition to the I-75 mainline closure, it included the complete closure of the I-75/I-96 interchange, as well as other scheduled project closures within the Gateway simulation network. The MDOT consultants worked closely with MDOT Metro Region Engineering staff, Construction staff, and Traffic and Safety staff, including the Michigan Intelligent Transportation System (MITS) Center, to evaluate various alternatives for construction closures. They eventually came up with a plan that demonstrated congestion would be high, but that the plan would work and could handle the projected traffic volumes.

Construction began in February 2008, with the most critical phase occurring in summer 2008, which entailed the complete closure of the I-75/I-96 interchange. During the three months modeled for summer 2008, MDOT found that the traffic and congestion predicted by the model was close to what MDOT was observing in the actual construction work zones.

Field conditions on this complex and interdependent freeway network often unexpectedly changed, upending even the best laid plans. For example, MDOT found that a bridge on another segment of I-75—part of the detour route and a critical evacuation route from downtown Detroit—had only been scheduled for resurfacing but actually needed to be completely reconstructed. This required freeway lane closures on a detour route for 3 months. What was planned to be a short-term closure of this bridge ended up being a long-term closure and took a critical link out of the system during summer 2008. In addition, each time a new lane closure was required, it was critical to maintain access for emergency vehicles and key evacuation routes. Although the network simulation model was capable of modeling each of the many possible scenarios, the process was not adapted to the time-consuming coordination requirements. Operations applications, in contrast to planning applications, have shorter time horizons and require faster turnover and shorter information feedback loops. In order for the model to accommodate changes in the field, a contract amendment for the model would need to be updated, funding would need to be allocated, results would need to be analyzed, and work zone mitigation measures would need to be updated. Additional coordination would be needed with project staff and managers to develop, review, approve, and implement mitigation measures. Large-scale network microsimulation is a new technology, and time and effort will be needed for the business processes to adapt to this new technology.

The microsimulation model proved to be effective in modeling impacts of major freeway closures and in evaluating a number of work zone traffic control strategies. MDOT was able to quantitatively evaluate the impacts in terms of delay on motorists and commercial vehicles and assign costs to that delay to measure the economic impacts of construction closures and the various work zone traffic control strategies. An evaluation of the Gateway simulation model results showed that the work zone mobility plan for the 90-day period during the complete closure of the I-75/I-96 interchange would save about $1.63 million a day in user costs in just the a.m. and p.m. peak periods alone. This was an extremely conservative estimate based on an assumption of $16 per hour in user costs. However, as effective as the microsimulation model was in this project, without a process in place to continually update the model based on actual conditions during construction in the field, the model will likely become out of date on large projects during the construction phase.

Concurrent with the modeling effort, three major efforts were developed and implemented. These included incident management under the direction of Metro Region Traffic and Safety and the MITS Center; the addition of real-time sensors and travel advisories brought into operation under the MITS Center; and a public involvement and stakeholder outreach effort involving meetings, presentations, and the generation of feedback from major corporations in the auto, auto supplier, and logistics industries. A comprehensive public involvement program was maintained with Detroit's Mexicantown community as well. Coordination with MDOT's Detroit Transportation Service Center (TSC) was also critical to the work zone mobility effort. The Detroit TSC is responsible for all the other projects on the Detroit network and for responding to events and other contingencies.

Background of Agency

Four groups within MDOT Metro Region worked together in the work zone modeling for the I-75 Ambassador Bridge Gateway Project: Planning, Traffic and Safety, Construction, and the Detroit TSC. Once an initial model of the closure was developed, MDOT Metro Region Planning, Traffic and Safety, and Construction worked together to evaluate different construction scenarios and, where possible, adjusted closure schedules or construction staging to minimize the impacts of the project.

The MITS Center also participated in planning for the construction. Although the MITS Center was not directly involved in work zone mobility modeling and planning, they were integral to the effort through their operation of the real-time and incident management programs. The MITS Center serves as MDOT's TMC for southeast Michigan and monitors over 200 mi of freeway. The MITS Center manages real-time operations and, under the direction of Traffic and Safety, runs the Incident Management Program. In addition to the permanent traffic detectors, CCTV cameras, and DMS that the MITS Center regularly operates, numerous portable devices were brought in to assist with monitoring traffic and providing traveler information throughout the work zone.

Process Development

The process used for the work zone modeling of the I-75 Ambassador Bridge Gateway Project can be attributed to three factors. First was the great likelihood that shutting down I-75 would adversely affect the mobility of residents in southeast Michigan, manufacturing along the I-75 corridor, and international trade with Canada. It was critical for MDOT to understand the impacts of shutting down I-75 and to determine how to set up traffic control and detour routes in a manner that would have the least impact on the transportation network.

The second factor that drove the process was the existence of the SEMSIM model that allowed MDOT to build on the existing network model and to develop detailed models of the work zone traffic control strategies. Unlike other planning and design applications, work zone mobility requires a system perspective. Closing a part of an interstate freeway would have systemic impacts on other freeways, system interchanges, and major arterial roads. The SEMSIM model, as enhanced for the Gateway Project, included the core freeway network in the City of Detroit and the major state trunkline roads, thus providing this capability.

Finally, the U.S. Department of Transportation (USDOT) Final Rule on Work Zone Safety and Mobility requires that the impacts of work zones be determined and that transportation management plans be developed to mitigate those impacts. These new rules require that planning for work zone mobility should start as early as possible, even in the project concept stage. These requirements and the technology for large-scale microsimulation were not available until just before construction of the Gateway Project. However, this same SEMSIM/Gateway model is being repurposed for two other mega projects, which are presently in predesign. Thus, for the first time ever, MDOT will be employing advanced traffic modeling techniques to perform construction staging and work zone mobility planning before design. Microsimulation will allow MDOT to effectively determine the impacts of the work zones and test various strategies to mitigate those impacts in the most effective ways.

Detailed Process and Integration Points

Figure 4.2 presents an overview of the process that was used to develop the work zone traffic control model for the I-75 Ambassador Bridge Gateway Project. MDOT Metro Region Planning, Construction, and Traffic and Safety reviewed the models that were developed of the alternatives for construction closures for each phase of construction and selected the closure plans based in part on the impact of the closures on motorist delay and mobility. The selected plans were shared with the MITS Center before the start of construction to allow the MITS Center time to develop strategies for the operation of the system, including how to handle incident management and provide real-time information. One of the challenges of the process was that, when conditions changed in the field, there was not a process available that allowed for quick updates to the model. A process that could adjust the model for changes in the field and assist MDOT in selecting new alternatives for construction closures would be valuable and assist MDOT in minimizing delay and maintaining mobility.

This process is considerably different from the process used in planning applications. Traditionally, MDOT has used microsimulation for environmental clearance for large capacity improvement or expansion projects. This process involves a much wider cross-section of the department and is much more integrated into ongoing MDOT business processes. Timelines and information feedback loops are much longer. In addition, these planning applications were focused on individual projects and did not involve modeling the whole network. A CORSIM simulation model of the Gateway Project was originally created in the Environmental Clearance stage of the project, but this was project-specific and did not involve the

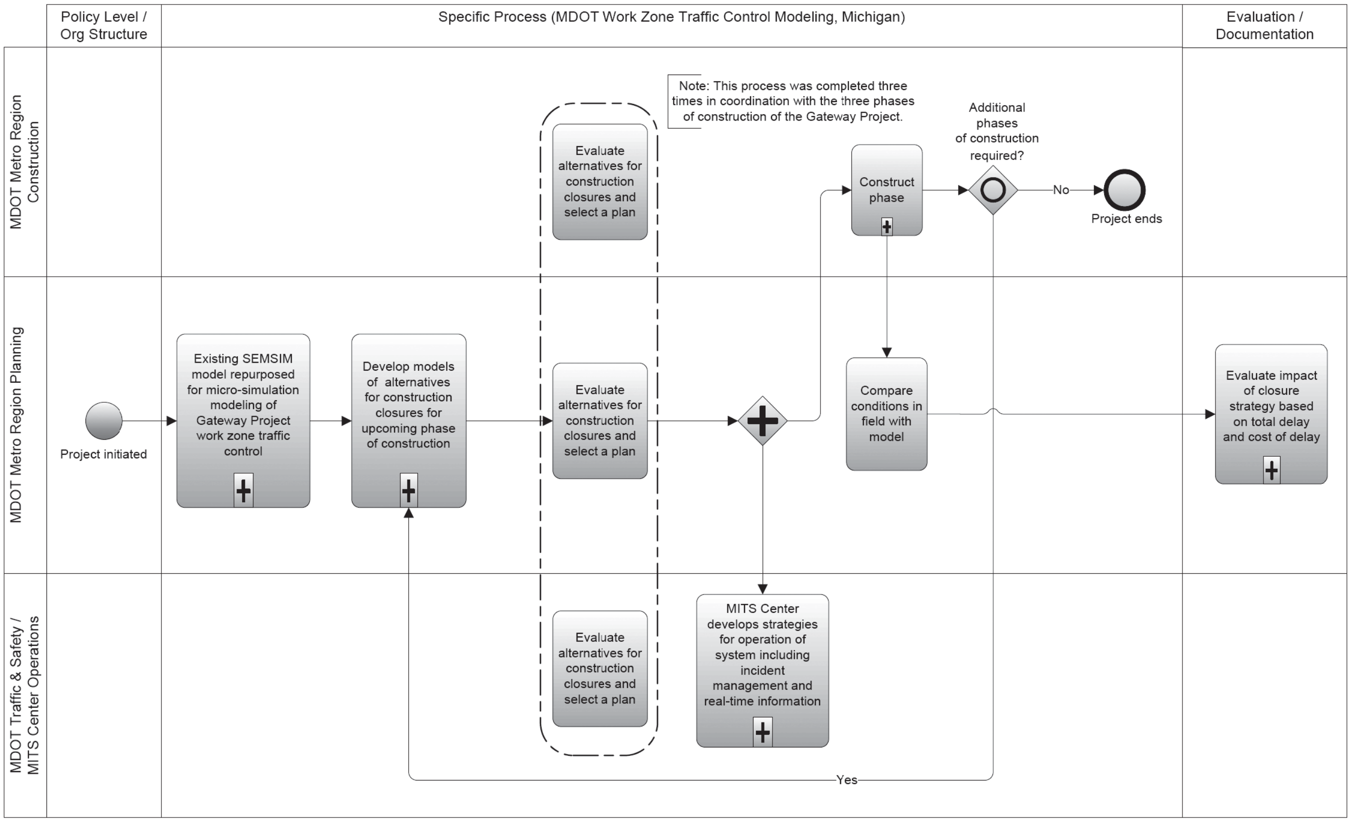

Figure 4.2. Detailed business process diagram of MDOT work zone traffic control modeling.

network. The technological innovations of programs such as Paramics and VISSIM opened up new opportunities for network traffic analysis.

Several key integration points were identified in the MDOT work zone traffic control modeling process, including the following:

- Integration between MDOT Metro Region Planning, Construction, and Traffic and Safety to model impacts of construction, select the best work zone traffic control strategies, and develop operational strategies;
- Coordination and integration with the Detroit TSC, which is responsible for other Detroit projects. Some of these were included in the simulation for the Gateway. All required coordination of traffic plans;
- Continual integration during construction between MDOT engineers responsible for construction and MDOT planners responsible for modeling to incorporate construction changes into the model and develop new work zone traffic control strategies; and
- Use of existing SEMSIM Paramics network model of southeastern Michigan to repurpose it for microsimulation of freeway closures.

Types of Agencies Involved

In addition to MDOT Metro Region Planning, Traffic and Safety, Construction, Detroit TSC, and the MITS Center, the process also relied on the work completed by the consulting team selected to do the modeling and the contractor doing the construction. These groups all worked well in the initial planning stages for construction. However, the real challenge was during construction, when changes to the actual construction schedule were occurring daily because of another project in the Gateway Project's influence area and it was not feasible to update the Paramics model. In reviewing the process, MDOT recognized that it will be important in the future to develop a tool that will allow field engineers and technicians to change the model and to try different work zone traffic control scenarios. While the microsimulation model was effective for this high-budget, high-impact project, which also had a long planning horizon, other projects with smaller budgets and shorter planning horizons will require a more flexible approach. Specifically, general project scheduling and work zone mobility for the annual program, which has multiple simultaneous projects, will require a more flexible process and technology that will shorten the planning and implementation cycle. Presently, the MDOT Metro Region is looking at developing an in-house mesoscopic model that can be used for routine scheduling and staging.

Organizational changes also might be considered, such as bringing modeling under the direct control of the users, including the MDOT Metro Region Traffic and Safety engineers responsible for operational decisions.

Types of Nonrecurring Congestion Addressed

This process addressed nonrecurring congestion caused by work zones for a major project like that of the 18-month closure of I-75. As noted, for projects of lesser impact, a more flexible approach is needed. By using microsimulation to develop detailed models of work zone traffic control, MDOT's Metro Region was able to objectively evaluate scenarios and work with MDOT Traffic and Safety staff and Construction staff to select strategies that provided the most effective mobility.

Performance Measures

The primary performance measure that MDOT used was to determine the overall cost to motorists based on total delay of the various scenarios. The cost savings provided an effective way to compare different work zone traffic control strategies against each other, and the potential for monetary savings clearly demonstrated the benefits of careful modeling and selecting the best work zone traffic control strategies. The Gateway Project did not have many alternatives for detour routes, so the task was to make the only available alternative work. The simulation model helped MDOT devise ways to ensure that traffic would flow on the detour routes. For example, through the simulation model, MDOT found that selective closing of system interchange ramps would allow them to maintain throughput on the main detour route, which was a freeway that ran through the heart of Detroit. In addition, auto and truck delay along a set of 35 specific routes was assessed to identify mobility issues along specific pathways. The focus was on maintaining regional and international truck mobility.

Benefits

The MDOT work zone traffic control modeling provided several benefits. It provided MDOT with a quantitative measure of total delay based on a project design, as well as the ability to compare work zone traffic control strategies and determine options with the least delay. By associating cost with delay, MDOT was able to measure the monetary impact of different scenarios. The process also allowed the MITS Center to coordinate incident and real-time management along the detour routes, giving them advance notice of closures and projected traffic volumes so that they could develop operational strategies.

Lessons Learned

The existence of the SEMSIM microsimulation model was critical in allowing MDOT to perform a detailed microsimulation of the entire network around the I-75 Ambassador Bridge Gateway Project. By repurposing the Paramics' SEMSIM model, MDOT was able to accurately and cost-effectively develop and evaluate work zone traffic control strategies around the project.

The rapidly changing conditions in the field during construction led to changes from the initial mitigation plans. Because field engineers and technicians could not access the model used for developing work zone traffic control strategies, there were a few instances when construction plans changed but were not incorporated into the model. Problems arose when other projects whose closures were in the area of influence of the Gateway Project encountered changes. To address this challenge, MDOT Metro Region plans to test a one-county mesoscopic model using DYNASMART for modeling on a future project. Although DYNASMART does not provide as many capabilities as Paramics, it is an easier tool to use and more suitable for in-house use by engineers and technicians that will not have the time to do detailed modeling. The hope is that an engineer or technician in a field office can use DYNASMART to keep up with changing conditions and continue to refer to the model to select the best work zone traffic control strategies.

Analysis and Research Observations

Use of microsimulation models to evaluate the impact of work zone traffic control strategies proved to be effective for the initial construction. However, this project revealed some weaknesses in the process. These primarily concerned the lack of flexibility that limited the use of the Gateway Model to respond to unexpected developments. This flexibility relates to both the technology and the process. The modeling work was performed by consultants, and the MDOT contracting process in effect on this project did not allow quick enough response to sudden changes. While a large-network microsimulation model is very useful for high-impact projects such as the Gateway, there is a need for a more flexible tool for other, lower-impact closures, as well as for staging multiple projects on the system. The problem that emerged during the Gateway closures was related to another project that was on the Gateway detour route. The planning horizon and budget for such projects do not permit large-scale microsimulation. An alternative approach might be a network mesoscopic model that can be run in-house and be under the control of the operations engineers who are responsible for making decisions.

The Ambassador Bridge Gateway Project marks the first time that network microsimulation has been used in an operations application. This provided a valuable learning experience on the use not only of microsimulation but also of any advanced traffic modeling in the operations environment.

First, it taught that advanced network traffic analysis is direly needed to support high-impact operational decisions on a congested urban freeway network. The cost of delay and of travel time unreliability to users, especially commercial users, is estimated in the hundreds of millions of dollars. Given that multiple concurrent construction-related closures are an ongoing or annual occurrence, a scientifically sophisticated, systematic approach must be implemented to plan for such disruptions.

Second, the interdependent nature of a congested urban freeway network means that an incident or closure at one location will usually have wide-ranging ramifications. Typically, there are dozens of simultaneous projects in each other's influence areas whose closures need to be coordinated. Presently, network simulation is the only tool that can provide the traffic analysis needed to stage, coordinate, and mitigate multiple interacting projects.

Third, the business processes in an operations environment are radically different from those in a planning environment: conditions are extremely dynamic, construction schedules and staging schedules change daily, and events and incidents and unforeseen contingencies, like the discovery of a bridge deck in need of emergency replacement, will upend the best laid plans.

It can be expected that technology will continue to change. Someday, there may even be real-time simulation. The challenge to DOT business processes will be ongoing. For the present, however, new, more dynamic processes will be needed if the full potential of the new traffic simulation technology is to be realized.

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CHAPTER 5

Case Studies: Special-Event Management

Special events present a unique case of demand fluctuation that causes traffic flow in the vicinity of the event to be radically different from typical patterns. Special events can severely affect reliability of the transportation network, but because the events are often scheduled months or even years in advance, they offer an opportunity for planning to mitigate the impacts. Because large-scale events are recurring at event venues, it gives an opportunity for agencies to continually evaluate and refine strategies, impacts, and overall process improvements over time.

In this section, case studies are presented that examine the processes developed for special-event management at the Kansas Speedway in Kansas City, Kans., and the Palace of Auburn Hills near Detroit, Mich.

Kansas: Kansas Speedway

In 2001, the Kansas Speedway opened for its first major NASCAR race. With attendance exceeding 110,000 people, it set a record as the largest single-day sporting event in the history of Kansas. Attendance has continued to grow and now exceeds 135,000 for most major races. The traffic control strategies that were put into place to handle these major events were the result of years of planning between the Kansas Speedway, Kansas Highway Patrol (KHP), Kansas Department of Transportation (KDOT), and the Kansas City Police Department. The process was successful in part because of the clear lines of responsibility that were defined for each agency and the strong spirit of cooperation and trust that was established before the first race was held.

In preparation for this case study, representatives from KHP and KDOT were interviewed. Lt. Brian Basore and Lt. Paul Behm represented the KHP Troop A and were able to share their experience from many years of actively managing special events at the Kansas Speedway. The primary responsibilities of KHP are to operate the KHP Command Center that was established for the Kansas Speedway race events and to manage traffic on the freeways around the event. Representatives of KDOT who were interviewed included Leslie Spencer Fowler, ITS program manager, and Mick Halter, PE, who was formerly with KDOT as the District One metro engineer during the design and implementation of the Kansas Speedway. Fowler and Halter provided an excellent history of the development of the project, as well as a description of KDOT's current operational procedures used during races at the Kansas Speedway. KDOT maintains the CCTV cameras and portable DMS around the Speedway and assists KHP with traffic control on the freeways.

Description

This case study examines the development of the special-event management procedures for races at the Kansas Speedway. Particular focus is given to the roles and responsibilities of the KHP and KDOT in developing the initial infrastructure and strategies that led to a successful special-event management process that has been used and refined for 8 years. One of the strongest recurring themes in development of this case study was the outstanding cooperation and partnerships that were developed between the agencies involved. Each agency has clearly defined responsibilities before and on race day, though no agency is considered in charge. They cooperate to safely and efficiently move vehicles from the freeways to city streets to the Kansas Speedway parking lots and then do the same process in reverse.

Background of Agency

The Kansas Speedway is a 1.5-mi oval race track suitable for many types of races, including Indy and NASCAR. Seating capacity is currently being expanded to 150,000 people, and parking capacity allows for 65,000 vehicles. The Speedway is located approximately 15 mi west of downtown Kansas City, near the intersection of I-70 and I-435, which serve as the primary routes used by spectators attending the races. Events are held throughout the year, and there are typically two major race events each year when crowds reach capacity. The majority of parking is on Kansas Speedway property and is free for spectators. The Kansas Speedway provides attendants and directs vehicles into the parking areas.

The primary agencies involved in traffic management for the Kansas Speedway include KHP Troop A in Kansas City, KDOT District One, and the Kansas City Police Department. KHP is responsible for traffic management on the freeways and for operation of the KHP Command Center, which is activated several days before major events and serves as the central communications center for all public agencies on race day. The full resources of Troop A (over 40 troopers) are used on race day, along with over 20 other troopers from around the state. KHP also deploys a helicopter to monitor traffic from the air and roving motorcycle units on race day. KDOT District One is responsible for maintaining five CCTV cameras and deploying 12 portable DMSs on roads used to access the Speedway. The Kansas City Police Department provides officers for the city street network that links the freeways to the Kansas Speedway (*1*).

Other participants in the process include Wyandotte County and the Kansas Turnpike Authority (KTA). Wyandotte County currently owns the WebEOC software used by all participating agencies to share information and request assistance on race day (*2*). The KTA maintains I-70 near the Speedway. It is responsible for such maintenance tasks on this section of I-70 as snow and ice removal, guardrail, and signing and striping, although the section is not tolled.

Process Development

The Kansas Speedway opened for its first major event in summer 2001. However, development of the process for special-event traffic management began long before Kansas City was even selected as the site for the racetrack.

In the early 1990s the International Speedway Corporation was searching for a new location for a race track in the Midwest. The track was expected to host several large events per year, including at least one to two major races that were expected to attract more than 100,000 people. Given the potential positive economic benefit that such a facility could bring to an area, the International Speedway Corporation solicited proposal packages from several sites under consideration. Proposals needed to address criteria established by the International Speedway Corporation for site selection, including accessibility of the site to attendees. The effort to bring the race track to Kansas was led by Kansas City, with strong support from the governor and lieutenant governor of Kansas. Understanding the importance of accessibility, the governor directed KDOT to develop a plan and provide funding to make the necessary infrastructure improvements to handle race traffic for the Speedway. The priority placed on this project by the governor's office served as the first enabler to implementing the traffic management process.

KDOT developed an extensive plan to accommodate the large number of vehicles expected to attend events at the Kansas Speedway. I-70 needed to be widened and a new interchange was needed at 110th Street. US-24, which went through the proposed site of the track, needed to be completely realigned. Although not part of the original planning, CCTV cameras and portable DMS were also required to assist with traffic management. KDOT identified funding for each of their proposed infrastructure projects, and these projects were included in the package that was submitted to the International Speedway Corporation.

More than a year before the first race event at the Kansas Speedway, all the agencies involved in traffic management began planning for the event. Agencies that participated in the planning included KHP, KDOT, KTA, Kansas City Police, Wyandotte County, and the Kansas Speedway. The Missouri DOT and Missouri Highway Patrol were also initially involved because there was concern that traffic could be affected east of the track into Missouri. (Once the Speedway opened, it turned out that this concern was unfounded as race traffic had only minor impacts on I-70 near the Speedway and did not affect traffic on I-70 in Missouri.) To facilitate traffic management planning, a consultant also was brought on-board early in the process.

The success of the planning for traffic management was attributed to two primary factors. The first was the importance that the governor and Kansas City placed on the success of hosting major races at the Kansas Speedway. Millions of dollars were invested by the state and city to bring the race track to Kansas, and to recoup their investment they needed to successfully host large races. The visibility and importance of the first successful event was a great motivator for every agency involved. The second factor to which success was attributed was the personalities involved. Several of those interviewed for this case study noted that there were no egos in the room that got in the way. A sense of mutual respect among the agencies and for their work was a consistent factor in planning for traffic management. No single agency was designated as "in charge"; rather, each agency took responsibility for its piece and worked well with the other agencies to ensure overall success.

The result of the planning efforts was a multilayered traffic plan with different agencies leading the layers. The first layer dealt with interstate traffic, which was KHP's responsibility. The second layer dealt with traffic on local streets traveling between the interstates and the Kansas Speedway, this layer was the responsibility of the Kansas City Police Department. The third layer handled traffic entering or leaving the track property, which was the responsibility of the Kansas Speedway. KDOT provided support to all three layers through deployment of CCTV cameras, DMS, and cones. Each layer was critical to successfully manage traffic for events.

Detailed Process and Integration Points

Figure 5.1 shows the detailed process that was developed for special-event traffic management at the Kansas Speedway. Before a major event, all four agencies that are involved in managing traffic on race day come together for a meeting to discuss the upcoming event and changes or special circumstances that need to be considered in their planning. These agencies have worked closely together since the first event in 2001, and there is a clear understanding of the roles and responsibilities of each agency.

In the week before race day, KHP will activate the KHP Command Center. The KHP Command Center is the communications hub for the event and is where CCTV camera feeds are sent and portable DMS are controlled. On the day before race day, KHP conducts a briefing to review the setup and procedures for race day. During the race event, KHP, Kansas City Police Department, and the Kansas Speedway manage traffic on freeways, local streets, and in the parking lots. KHP deploys a helicopter to monitor traffic from the air and roving officers on monocycles to patrol the heavily congested areas around the Speedway that cannot be easily accessed by troopers in cruisers. All agencies continue to communicate primarily through WebEOC, a system owned by Wyandotte County that lets each agency monitor messages and communicate on a web-based system.

Once the race is completed, a follow-up meeting to review race day events may be held. This meeting was originally held after every event during the first few years the Kansas Speedway was in operation, but as traffic management has become more efficient, it is now only held as warranted.

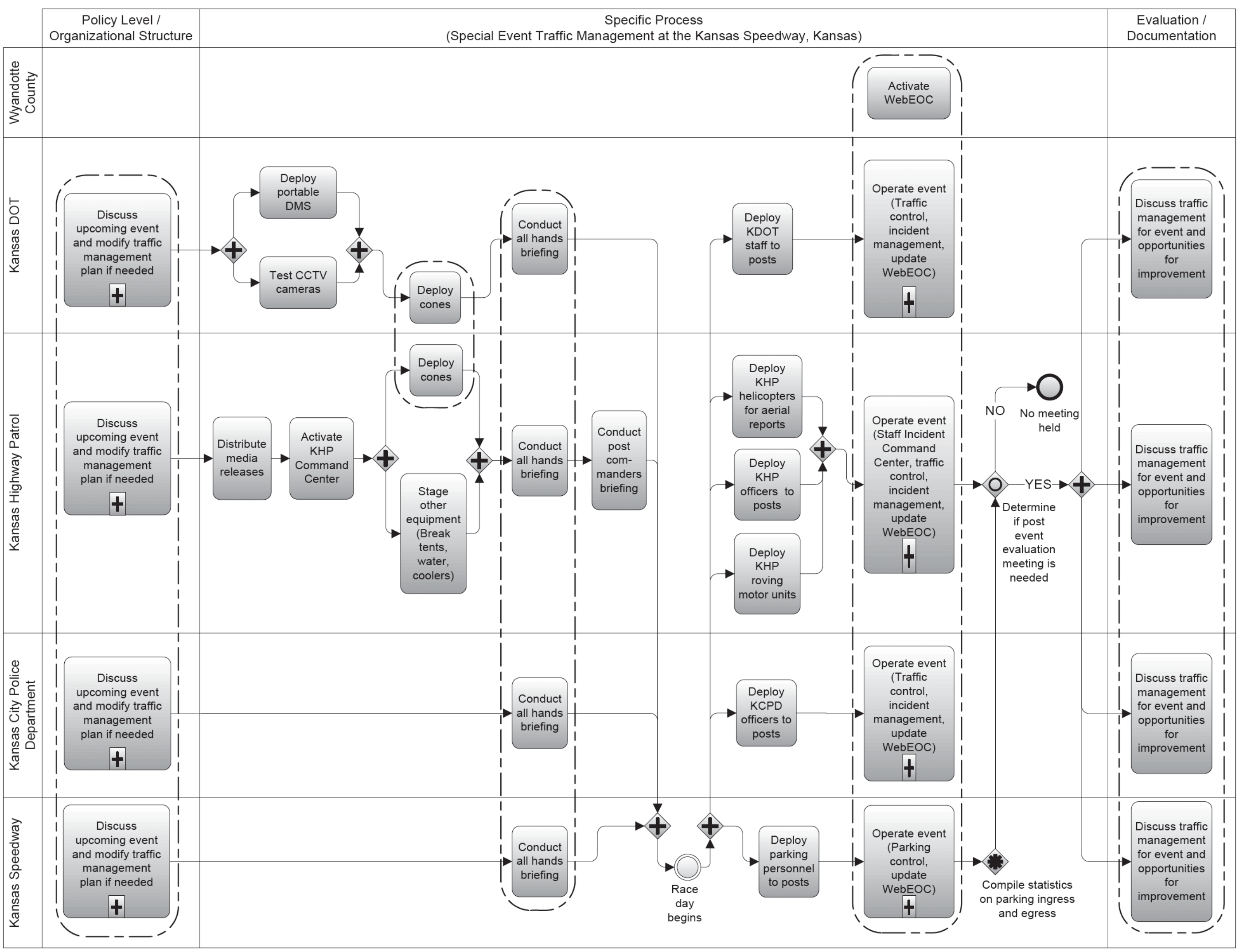

Figure 5.1. Detailed business process diagram of Kansas Speedway special event.

Several key integration points were identified in the Kansas Speedway special-event traffic management process, including the following:

- Integration between KHP and KDOT for deployment and operation of CCTV cameras and portable DMS;
- Integration between KHP, KDOT, Kansas City Police Department, and Kansas Speedway to develop traffic management plans for upcoming events and to discuss traffic management performance after operations; and
- Integration between KHP, KDOT, Kansas City Police Department, Kansas Speedway, and Wyandotte County for sharing of information through WebEOC during the special event.

Types of Agencies Involved

The primary agencies that are involved in the special-event traffic management are KHP, KDOT, Kansas City Police, and the Kansas Speedway. As described earlier, a three-layered approach is set up, with KHP responsible for traffic on the freeways, Kansas City Police responsible for traffic on local streets, and Kansas Speedway responsible for traffic in the parking areas. Numerous special teams have been established to facilitate the special-event traffic management on race day. These include the KHP Post Commanders Team, Logistics Team, and KDOT Team. The KHP Post Commanders Team is made up of the commanders from each traffic post where KHP will be directing traffic. The post commanders attend the post commanders briefing the evening before the race begins, direct the other troopers at their post, and communicate with the KHP Command Center. The Logistics Team is responsible for setting up the event, including staging and setting up of temporary traffic control, providing water and tents for troopers at traffic posts, and running errands during the event. The KDOT Team is responsible for maintaining the CCTV cameras, putting the portable DMS boards in place and changing messages on the board if the wireless communications fail, and assisting with temporary traffic control placement.

Types of Nonrecurring Congestion Addressed

The process for managing the Kansas Speedway traffic deals with nonrecurring congestion due to a special event. When the Kansas Speedway first opened in 2001, KHP set up 14 inbound posts and 11 outbound posts, with troopers stationed at each post to direct traffic. Since then, KHP has increased the efficiency of traffic management and has been able to reduce the number of posts down to seven inbound and seven outbound. Traffic is monitored from the KHP Command Center using CCTV cameras and a helicopter that provides updates on traffic conditions; portable DMSs with wireless communication can assist in directing traffic. The roving motorcycle units are used around the Kansas Speedway and can assist with managing any incident that blocks roadways. Over time, KHP and KDOT have refined temporary traffic control patterns and general traffic control to increase efficiency of the system as much as possible.

One of the primary concerns on race day is getting traffic off I-70 without significantly affecting through traffic. Because major races are held on weekends, the overall level of traffic on I-70 is generally lighter than what is experienced on a weekday. As part of the initial package that was proposed by Kansas City to bring the Speedway to Kansas, KDOT agreed to add one more lane to I-70 to accommodate overflow traffic for major races. KHP has been able to quickly move traffic off I-70 with only minor impacts on through traffic on the interstate. KDOT has not done a study of travel times for through traffic on race day, but they estimate that at peak periods before or after a race, motorists on I-70 will only experience minor slowdowns with perhaps 5 min of delay to their total trip.

Performance Measures

The Kansas Speedway tracks the time it takes to clear parking lots after races and has seen improvements in clearance times since the initial race in 2001. After races, if something went wrong or clearance times exceeded normal ranges, this information is shared with KHP and an evaluation meeting with all agencies involved in the traffic management may be held to review the traffic management. However, these instances are rare and in most events the parking lot clearance times can be accurately estimated based on race attendance.

KHP initially used troopers stationed at 14 inbound posts and 11 outbound posts to direct traffic. Although not a performance measure, the shift to seven inbound and seven outbound posts is seen by KHP as an indication of the improvement of their traffic management efficiency.

Benefits

The planning and cooperation between KHP, KDOT, Kansas City Police, and the Kansas Speedway allowed for efficient traffic management of more than 100,000 spectators from day one. The agencies involved in traffic management have been able to improve their efficiency and reduce the manpower needed to manage traffic over time and consider their traffic management effort a success from the start.

The popularity of racing in the United States and the efficient use of the Kansas Speedway have prompted an expansion of the seating capacity of the Speedway. Current expansion work will bring the total seating capacity of the Kansas Speedway to 150,000. Without an efficient plan to move spectators in and out of the Speedway, this expansion would not be possible.

The traffic management process developed for the Kansas Speedway goes beyond simple convenience to spectators. By minimizing the impacts to through traffic on I-70 and I-435, KHP can reduce freeway backups and minimize the chances of secondary incidents on freeways. Efficient and effective movement of vehicles off the race track is also critical for evacuation. On April 25, 2009, a tornado touched down in Kansas only a few miles from the Kansas Speedway. About 30 min earlier, a race that was in progress was suspended for the day due to rain, and many of the spectators were in the process of leaving the event. The tornado did not touch down close enough to the Kansas Speedway to cause any damage, but it was an important reminder of the need to be able to efficiently move traffic out of an area, especially in Kansas, which is particularly prone to tornadoes.

Lessons Learned

Each agency interviewed identified the single most important factor to the success of the special-event traffic management as the cooperation among all agencies in the planning and execution of traffic management. The importance placed on successfully bringing the Speedway to Kansas by the governor and Kansas City certainly contributed to that cooperation and coordination, but the personalities of the leaders from each agency and the existing relationships that had been established were identified as even more important factors.

KHP has learned that the development of a race-day protocol is particularly important, so that procedures for handling incidents or other unexpected events are well understood. KHP has worked with their partners to develop a tow policy to address abandoned vehicles, a traffic crash policy to quickly clear incidents, and a no-patrol zone to keep troopers and police officers in cruisers from adding to the congestion around the race track by limiting patrols to troopers on motorcycles.

Receiving information from the CCTV cameras and the ability to control the portable DMSs from the KHP Command Center have been valuable. However, CCTV cameras have failed in the past and communications to the portable DMSs are not always reliable, which sometimes necessitates the need for KDOT to manually change messages in the field. KHP and other agencies involved in traffic management have learned that technology is useful, but they need to be careful that they are not totally dependent on technology.

Analysis and Research Observations

Planning for the traffic management at the Kansas Speedway essentially began when Kansas was still being considered by the International Speedway Corporation and continued up until the first event. Political support for the Kansas Speedway gave those involved in traffic management a sense that they must succeed. Each agency took responsibility for their part of the plan, executed it well, and supported their partners. The sense of cooperation that started during the initial planning for traffic management of the race track has been carried into the continued operations. It is clear that each agency felt they had an important stake in the success of the Kansas Speedway and contributed the resources and staff required for that success.

One interesting note is that there are no formal agreements in place with any of the agencies regarding operations. When agencies were asked about this, they said they did not see a need to formalize what has worked well so far. There is confidence that they can continue to count on their partners, and that the strong relationships and years of experience working together will continue to add to that confidence.

Michigan: The Palace of Auburn Hills

The Palace of Auburn Hills (the Palace) is an arena located northwest of Detroit that hosts events such as concerts, basketball games, circuses, and graduations for eight months of the year. Because of the volume of traffic generated by these types of events, an increase in traffic congestion is typical in the vicinity of the Palace. Focused traffic management plans at these locations can help mitigate the effects of the increased congestion before and after the event. The Palace is located in Auburn Hills, a suburb of the greater Detroit, Michigan, area, in the north-central section of Oakland County. The Auburn Hills Police Department (AHPD) has been involved with traffic management strategies at the Palace since it opened in 1988 and has played an integral part in the development of the traffic management plan currently in place.

To acquire details regarding the traffic management plans implemented for events hosted at the Palace, an initial interview was conducted with Danielle Deneau, PE, of the Road Commission for Oakland County (RCOC). After that conversation, a more in-depth interview was conducted with Capt. Jim Mynesberge of the Auburn Hills Police Department.

Description

In terms of traffic operations and management, a special event can be categorized as a scheduled interruption to normal traffic flow. The Palace special event case study provides an analysis for a multiagency, public–private partnership focused on managing traffic for planned events of varying sizes. The traffic management plan includes traffic control strategies managed through the RCOC FAST-TRAC signal system, which is programmable and detects actual traffic counts (the original timing was based on recording traffic flow as officers manually directed traffic); traffic monitoring capabilities through the MDOT CCTV cameras; and traveler information using the

MDOT DMS and MiDrive website. The current traffic management plan includes a partnership between the Palace, the Police, RCOC, and MDOT and has resulted in memoranda of understanding (MOUs) and formal agreements between some of these agencies. The plan provides a direct connection between the Police dispatch and the RCOC TOC. The effectiveness of the traffic management plan allows fewer officers to be used for managing traffic at special events and reduces the time required to load-in and load-out for each Palace event. Load-in and load-out are two performance measures that have been defined to measure the success of traffic control before and after events.

Background of Agency

The Palace is located within Auburn Hills, adjacent to I-75, and is within the jurisdiction of the AHPD. The Palace is a multipurpose arena used for concerts, sporting events, and other events such as wrestling, circuses, or graduations. The arena has been operational for over 20 years and is the permanent home of the Detroit Pistons (NBA) and the Detroit Shock (WNBA). The arena is recognized for its large capacity for the NBA and can accommodate over 22,000 fans for basketball games and over 25,000 for concerts at center stage. The Palace also is the only arena that can hold the entire host city's population.

The AHPD provides security and traffic enforcement for the Palace during events. The Pistons typically attract a large attendance for their games, which has resulted in the arena expanding the parking capacity to keep pace with the attendance demands. AHPD manages the traffic before, during, and after each event, with a focus on providing efficient and safe access for motorists.

Process Development

The Palace partnered with AHPD and RCOC to develop a personalized traffic management plan for events at the Palace. The original traffic management plan used several police officers and manual traffic control to move vehicles through several intersections in the vicinity of the Palace. The original site plan included only three driveways, which created some capacity issues for event traffic ingress and egress. The traffic management plan recommended improvements to the site that included additional lanes, modified use of the existing driveways, and the construction of two additional access drives. One new access drive was constructed on the north side of the site, and one on the south side. The access drive located on the south side is called Direct Drive, and when clearing the parking lot, only allows right turns, providing drivers with direct access to I-75. The Palace also established a MOU with MDOT to temporarily close the access road just east of Direct Drive after events to provide exclusive use for Palace traffic when events commence.

The Palace had several motivations for an improved traffic management plan. The first was happier patrons attending events. The second was monetary. Since the Palace pays for the use of AHPD officers to manage traffic at events, there was vested interest in streamlining the personnel and the time required. The larger events would require a total of 15 officers to work an event and effectively manage traffic. Each intersection required two to three officers to safely direct traffic to and from the facility (15 officers total). With the revised plan, the larger events can be managed effectively by only one or two officers.

Initially, AHPD and the Palace met regularly to discuss improvements, issues, and traffic management strategies. AHPD now has the ability to implement the Event Manager (developed by RCOC) and activate predetermined signal timing plans through the RCOC TOC. With this closely integrated coordination, the issues have decreased and the coordination meetings have been reduced to only twice a year.

AHPD and the Palace used two specific measures of effectiveness initially to determine if pre-event traffic was being managed properly. These measures allowed the two agencies to assess operations and determine the appropriate area of concern, namely:

- If traffic was queuing on the public roadway but the Palace driveways had additional capacity, then traffic was not being managed effectively by the police.
- If traffic was stopped at the driveways and vehicles were queuing on the public roads, then the Palace personnel were not effectively managing the parking operations.

These observations were used to support the need to increase the access lanes and construct the additional driveway. The Palace parking process also was modified to establish longer stacking lanes approximately an hour and half before the event start time. This was necessary to accommodate the process for collecting parking fees from each vehicle.

For postevent traffic, the effectiveness measure was based on all the access drives clearing at the same time. The balance of exiting traffic was accomplished by sectioning the lots and directing all traffic to the specific exits. Since most events ended after 10:00 p.m., the Palace traffic could receive a higher preference in green time. It was determined that shorter cycle lengths resulted in extended clearance times for the Palace. Shorter cycle lengths create longer delays because of lost startup time and more clearance intervals per hour. In other words, the longer traffic was stopped, the longer it took to empty vehicles from the lot. The passing traffic was only inconvenienced by waiting through a single cycle length to accommodate the exiting Palace traffic. This impact was measured both visually and by using the FAST-TRAC system.

Detailed Process and Integration Points

Figure 5.2 shows the process used by the Palace for special-event traffic management. The traffic management plan involves revised signal timing at 19 intersections in the vicinity of the Palace. Signal timing plans were developed for small, medium, and large events. The number of intersections included in the signal timing plan provides a larger footprint than AHPD was able to manage with only police officers. The plan allows a senior AHPD officer to select the appropriate timing plan based on input from the Palace concerning the size of an event. The senior officer also has the authority to instruct the dispatcher to activate the appropriate timing plans. The dispatcher then has the ability to activate the timing plans via the Event Manager from the AHPD facility.

The Palace has access to its own CCTV cameras around the facility and to MDOT-owned CCTV cameras on the trunk routes. The MDOT cameras provide information about traffic conditions on the roadways approaching the Palace. The Palace personnel also use radios to communicate continuously with AHPD. The Palace documents the load-in and load-out times for each event that occurs, and has observed that the load-out time has decreased from approximately 1 h to less than 25 min with the current traffic management plan.

Figure 5.3 displays the Palace and the surrounding transportation network for reference. I-75 runs north-south on the west side of the Palace, and M24 (Lapeer Road) runs north-south on the east side. The small connector on the south side of the Palace is the Direct Drive that is used exclusively for postevent traffic. AHPD responds to incidents in the vicinity of the Palace, including those that occur on I-75. During events, AHPD will coordinate for these incidents because they can affect traffic management at the Palace. Coordination is

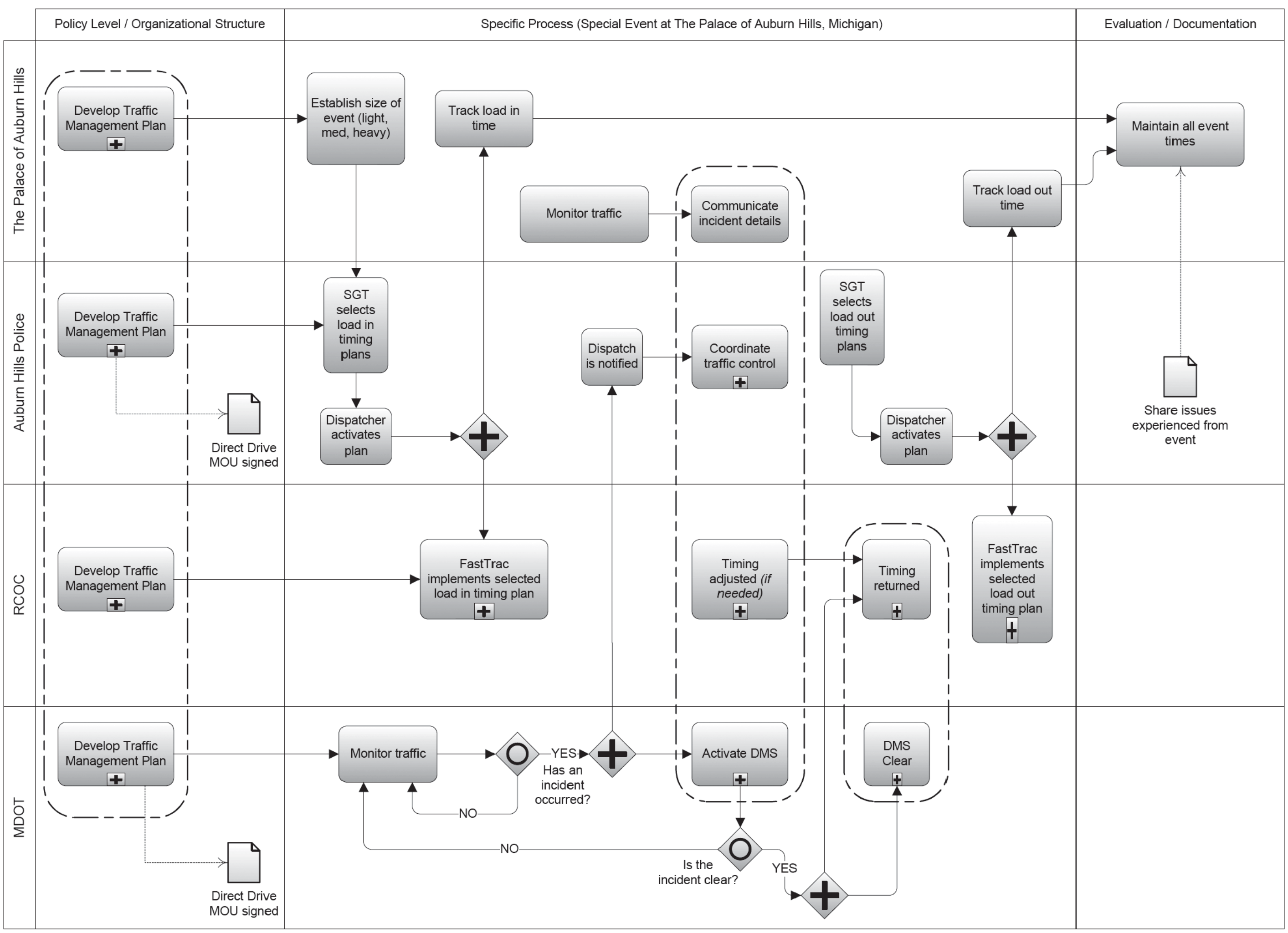

Figure 5.2. Detailed business process diagram for a special event at the Palace of Auburn Hills.

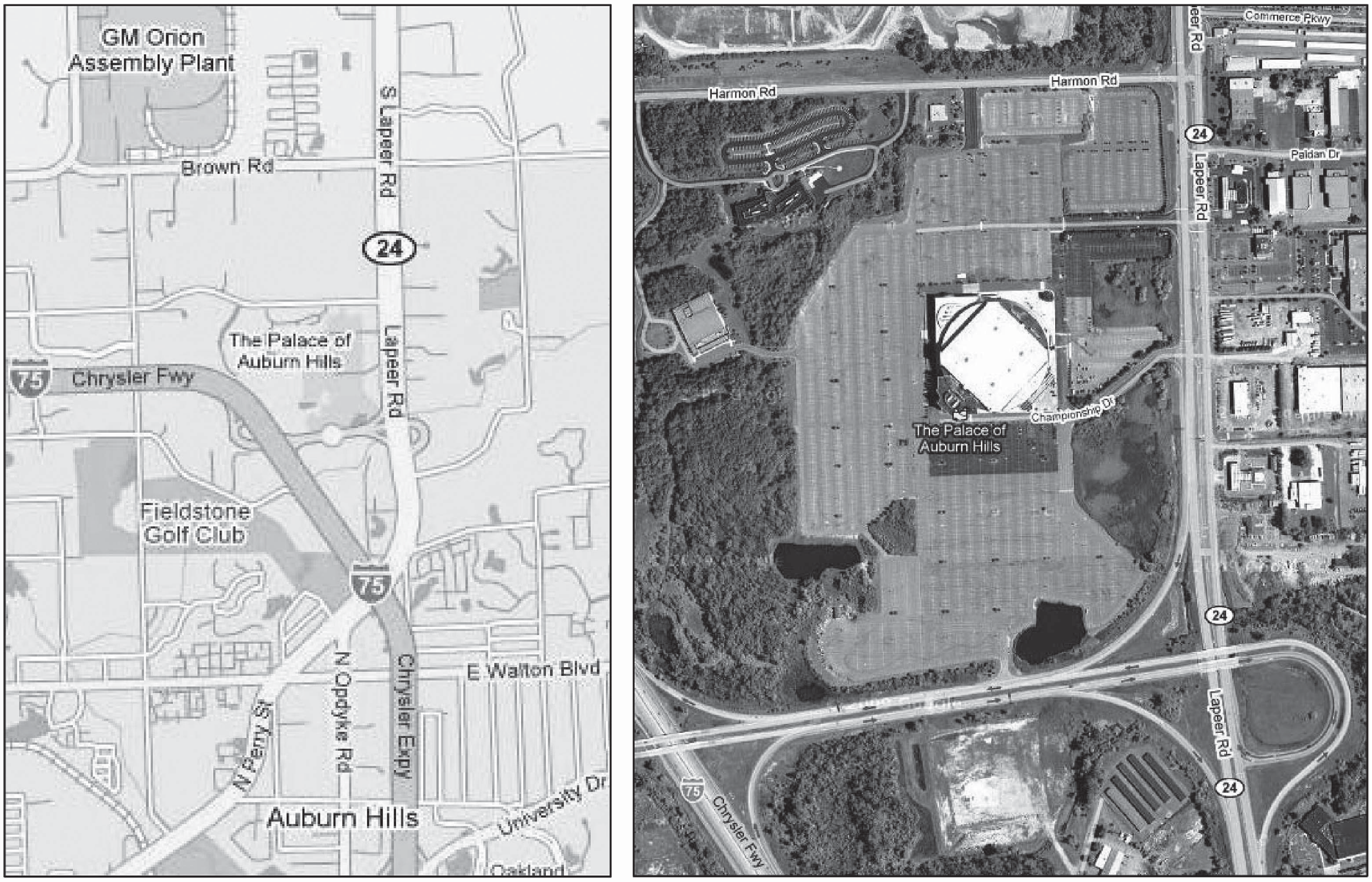

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Figure 5.3. The Palace of Auburn Hills and surrounding transportation network.

initiated by AHPD with MDOT and the Michigan Intelligent Transportation System Center (MITSC) to verify the incident, and MDOT will activate DMSs in the area to inform motorists of the incident if needed. In some cases, traffic is diverted to Opdyke Road through media and DMS communication.

During an incident, the Palace monitors the CCTV cameras and communicates traffic conditions with the AHPD officers. AHPD also coordinates with RCOC to determine possible adjustments to the signal timing. After the incident has cleared, AHPD will coordinate with MDOT and RCOC to clear DMS messages and reset signal timing, respectively.

Several key integration points were identified in the Palace of Auburn Hills special-event traffic management process, including the following:

- Coordination between the Palace and AHPD: Based on guidelines established in the traffic management plan, the Palace determines the size of an event (small, medium, or large) and informs AHPD.
- The AHPD Dispatcher has the ability to activate the predetermined signal timing plans within FAST-TRAC. The AHPD Sergeant has the authority to select the appropriate timing plan based on the size of the event and directs the Dispatcher as to which plan to activate. The AHPD dispatch has a direct connection with FAST-TRAC so RCOC personnel are not required during most events.
- The Palace has access to MDOT CCTV cameras so they can monitor traffic in the vicinity of the arena during an event. MDOT also monitors traffic, but the Palace's access to surveillance provides the ability to focus specifically on incidents that can affect typical traffic during an event.
- Coordination occurs via radio between Palace personnel and AHPD personnel to adjust the predetermined traffic management plan and mitigate potential impacts on traffic. The response to incidents during an event is coordinated among MDOT, the Palace, AHPD, and RCOC. Based on the impact of the incident, DMSs are activated with appropriate messages, timing plans can be adjusted, and additional resources can be implemented for modified traffic control solutions.

The Palace maintains records of all events, including the load-in and load-out times. Based on this documentation, the stakeholders have identified consistent results in the current traffic management plan. RCOC maintains the event signal timing plans respective to each event size. These timing plans can be revisited if issues or changing traffic patterns are identified. The MDOT MITS Center maintains incident records that can be referenced to determine impacts on the traffic during events. There is no central location for data related to events at the Palace, but it can be obtained from the individual partners.

Types of Agencies Involved

There are four main partners involved in the coordination of events at the Palace of Auburn Hills. The public–private partnership includes AHPD, the Palace, RCOC, and MDOT. The Palace is responsible for traffic on arena property, maintaining an arena-specific traffic management plan, and coordinating with AHPD for implementation. The Palace also has access to MDOT CCTV cameras so they can monitor traffic conditions on approaching routes. AHPD is the local police department responsible for traffic control within the city, including the local interstate routes. RCOC is responsible for county road maintenance and operations of the countywide signal system. RCOC has developed and programmed event-specific timing plans relative to the three categories of event sizes and allows AHPD to activate appropriate timing plans remotely. The MDOT MITS Center is responsible for monitoring the southeastern Michigan roadway network and uses CCTV cameras and detection for surveillance and DMS and the MiDrive website for sharing traveler information.

Types of Nonrecurring Congestion Addressed

The Palace's traffic management plan addresses nonrecurring traffic impacts classified as special events and crashes. When the Palace opened in 1988, AHPD manually controlled traffic in and around the arena. AHPD used approximately three to four traffic control police officers per intersection at several intersections (15 officers in all). In addition, the larger events required at least an hour to move traffic in and out of the parking facilities.

The signal timing plans available through FAST-TRAC and the agreement between RCOC and AHPD to activate signal timing plans remotely via the Event Manager make it possible to improve efficiency. The signal timing plans are predetermined based on the estimated level of traffic for scheduled events. The signal timing plans also incorporate additional intersections that were previously not managed during events. The revised signal timing plans allow AHPD to decrease the total number of officers required at any event to no more than two and reduced the time for emptying the lot to approximately 25 min.

Improved incident management is the result of an agreement between MDOT and the Palace to share camera images. The Palace personnel can access views of several cameras located on approaching roadways. When incidents occur in Auburn Hills, even on the interstate, AHPD typically are the first responders on scene. They will respond and coordinate with the Michigan State Police (MSP) and MDOT on the traffic management needs at the incident. They also coordinate with the Palace on any impacts to event-related traffic. MDOT will activate message signs to warn motorists and AHPD can modify the traffic management strategy to accommodate the changes in traffic patterns.

Performance Measures

Because the Palace tracks the load-in and load-out times during each event, those times can be compared to ensure the traffic management plan is working effectively. They meet with AHPD to discuss new issues and develop strategies that can mitigate these issues at the next scheduled event. The Palace maintains constant communication with AHPD to ensure that there is efficient and safe access for motorists. AHPD also communicates with RCOC on potential issues with the signal timing plans. The improved signal timing plans have allowed AHPD to reduce the number of required traffic control police officers from 15 to no more than two officers for each event. Emptying the parking lots of the Palace can now be achieved in less than 25 min. In addition, crash rates have remained consistent with the implementation of the Event Manager.

Benefits

The traffic management program at the Palace of Auburn Hills has proven to be successful. Benefits include improved traffic control efficiency; improved travel time; higher efficiency of motorist movement; and streamlined use of police resources. These benefits are achieved through strong relationships and trust between the stakeholders.

With the reduction in load-in and load-out times, the impact on motorists traveling in the vicinity of the arena also is reduced. In addition, spectators are able to reach the arena more quickly and spend more time at the event. This improved mobility translates into cost savings for the motorists by reducing fuel consumption and travel. The Palace also experiences a fiscal benefit by having spectators arrive earlier at events.

The improved signal timing plans allow for more intersections to be managed during an event with fewer officers, which frees up more officers for responding to emergencies, incidents, and other situations. Fewer officers for manual traffic control also has increased safety for personnel. Directing traffic in the dark and during poor weather conditions often created unsafe conditions for AHPD officers. The Palace's cost for police personnel also is reduced. The Palace indicated that the savings from the fewer officers required to control traffic can be redirected to other expenses, such as an extension of parking facilities or a reduction in ticket costs for events.

Lessons Learned

All the agencies involved with the special-event traffic management plan have acknowledged benefits, but there are still some elements that can be improved. Some simple modifications could be achieved more quickly, while others are more extensive and would require several years. The partners stated that the traffic management plan should be developed as the site is designed. This approach would identify deficiencies in driveway access and potential capacity issues related to moving the maximum capacity of the parking lots. The site development also should limit the amount of traffic movement occurring closer to the buildings to minimize conflicts between vehicles and pedestrians. This additional conflict can generate congestion within the parking lot. Lastly, sufficient lighting throughout the parking lot should be implemented. Better lighting increases safety by improving visibility for drivers navigating among pedestrians, especially during inclement weather.

Analysis and Research Observations

The Palace traffic management plan has been developed through input from the Palace of Auburn Hills, AHPD, and RCOC and has improved the efficiency, reliability, and safety of traffic management during special events hosted by the Palace. During arena events, such as games and concerts, the traffic flow in and out of the Palace has improved considerably while limiting the resource needs of AHPD. Coordination between the Palace and AHPD also has increased the reliability of loading and unloading the Palace parking lots.

The Palace records and evaluates the load-in and load-out times to determine possible signal timing adjustments. The Palace personnel discuss improvements to the traffic management plan with AHPD on a continuous basis. The continued communication between the Palace, AHPD, and RCOC has improved operations and resulted in improved mobility for the motorists going to the Palace, as well as for motorists within the area.

Agreements have been established between AHPD, the Palace, and MDOT to share CCTV camera video images for improved incident management. The police can coordinate and respond to incidents more quickly. Based on monitoring an incident, real-time information is provided and coordinated between all stakeholders to improve traffic coordination during and after each event.

References

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CHAPTER 6

Case Study: Weather Management

According to the FHWA, weather is the second most common cause of nonrecurring congestion, accounting for approximately 15% of all congestion in the United States (*1*). Strategies for road weather management include focusing on improving safety and traveler information, which can reduce the number of weather-related crashes, and providing advance notice to travelers so that they can delay their trips or use alternate routes if possible. These strategies can improve reliability by reducing incidents that can block roadways and reducing the number of vehicles on the road that may be affected by severe weather. This section presents a case study that examines the process that the Nevada DOT (NDOT) has developed and implemented for notifying freight travelers of freeway conditions on I-80 during hazardous winter weather.

California and Nevada: I-80 Winter State Line Closures

Heavy freight traffic heading westbound on I-80 toward the Nevada/California state line needs advance warning about closures at Donner Summit, which frequently occur during hazardous winter storms. This segment of I-80 has an elevation of 7,000 ft. Extreme winter snowstorms are a significant hazard to freight and passenger vehicles on this segment, and Caltrans will often close I-80 to westbound traffic if weather conditions warrant. Although closures of the state line and closure notifications are initiated through Caltrans, if notifications are not made early enough to allow freight and other traffic time to find suitable and safe parking or change their route, the impacts on NDOT roadway facilities and local streets in Nevada cities and towns can be significant. Freight parking on I-80 during winter weather events causes several problems not only to the freight drivers who are trying to maintain their schedules but also to NDOT's winter plowing operations; moreover, it restricts lane usage by emergency vehicles and creates hazardous driving conditions for passenger vehicles.

The need to notify westbound travelers (particularly freight) on I-80 of potential hazards and road closures has been the impetus for NDOT to develop important internal processes that involve two NDOT districts, state law enforcement, media, local agencies (including cities and law enforcement), and key freight stakeholders. The notification process has been expanded further east to include Utah and Wyoming; this provides westbound freight travelers with advance notification of closures and parking restrictions to allow them to make alternate route choices well in before of the closure.

NDOT has established policies and processes to notify traffic (with a particular emphasis on freight) heading west on I-80 that the state line and pass are closed. These notifications are strategically issued to allow for traffic to divert in advance. ITS infrastructure, including DMS, flashing beacons, and highway advisory radio, has been placed along the I-80 corridor to notify motorists in advance of an alternate route.

To prepare for this case study, interviews were conducted with Denise Inda, PE, PTOE, Mike Fuess, PE, PTOE, and John Talbott from NDOT. Inda is the assistant chief operations engineer of NDOT Maintenance and Operations. Fuess is the District 2 traffic engineer, and Talbott is in the District 2 Road Operations Center. District 2 has its headquarters in Sparks, Nevada, and covers the northwestern part of the state, including Reno and Carson City.

Description

This case study describes the processes that NDOT and other agencies have developed and implemented to address freight traffic issues on I-80 during hazardous winter weather conditions. Nevada DOT Districts 2 and 3 and Nevada DOT Headquarters staff provided input to this description.

Managing traffic on I-80 during winter conditions has also been the impetus for NDOT to install traveler information infrastructure (including DMS, warning beacons, and highway advisory radio) in advance of key decision points to allow travelers to choose an alternate route. Freight drivers can either decide to find allowable parking at suitable off-highway facilities further east on I-80 or use alternate routes to reach their westbound destinations.

Truck traffic can receive these alerts and notifications several ways: NDOT DMS and highway advisory radio, DOT flashing beacons (warning that state line is closed), 511 and NDOT's traveler information web page, commercial broadcast media, and truck stop announcements and notices.

Operational processes (at NDOT) link back to closure stages identified during the multiagency coordination meetings. What NDOT needs to do, from an operations perspective, is then integrated into their established operational processes.

Background of Agency

NDOT is divided into three operational districts that cover the entire state. District 1 focuses primarily on southern Nevada (including the Las Vegas metropolitan area); Districts 2 and 3 are situated in the northern part of the state. Interstate 80 traverses in an east-west direction across northern Nevada through both District 2 (Reno/Sparks) and District 3 (Elko), and each district has operations and maintenance responsibility for this significant interstate corridor.

NDOT has implemented Road Operations Centers (ROC) in both districts along this interstate corridor. Key functions of these centers include monitoring road weather information sensors and CCTV cameras at key locations; initiating traveler information and notifications through DMS, highway advisory radio, Nevada's 511 phone and web traveler information tools; coordinating with other agencies (including state law enforcement, counties, emergency responders, and neighboring states); and coordinating with NDOT district maintenance. The operations centers in Districts 2 and 3 are near the I-80 corridor. The functional capabilities at each of these centers have been specifically designed to monitor and respond to incidents and emergencies along the I-80 corridor. Staffs at these district centers routinely coordinate with one another to support more effective corridor-wide strategies. Capabilities have been designed in each center so that they can serve as backup for those in other centers.

Coordination for I-80 operations and, in particular, for incident management or winter weather operations, extends beyond NDOT operations and maintenance to also include law enforcement and neighboring states. The Nevada Highway Patrol (NHP) is responsible for law enforcement and incident management coordination and response on the corridor and is a key partner in overall corridor operations. From a winter-operations perspective, law enforcement is a critical partner in restricting trucks from parking on I-80 because of a closure at the state line, and NHP will turn away trucks from the state line using truck turnarounds and not allow the trucks to obstruct the I-80 shoulders. Because of the significance of I-80 as a major east-west freight corridor, multistate coordination during major events is important. NDOT's efforts to notify state DOTs in Utah and even in Wyoming, both several hundred miles east of the Nevada/California state line, provide for even more advance notice to freight traffic about upcoming closures.

Process Development

Between 2002 and 2007, NDOT reported 23 closures on I-80 at the Nevada/California state line and 31 truck prohibitions because of severe winter weather (*2*). Nevada DOT has developed and implemented specific processes aimed at providing as much advance notification as possible to westbound freight traffic that the state line is closed and that there are limited to no parking options in Reno, which is just east of the California/Nevada state line. A recent closure of a 400-space truck stop has further exacerbated the parking shortage for freight vehicles near Reno. In some instances, NDOT indicated that trucks sometimes park on the shoulder or exit the freeway and park on arterials until they can cross the state line.

Caltrans, NDOT, and associated partner agencies (including state and local law enforcement) hold a meeting annually in September, before the snow season, to discuss strategies, roles and responsibilities, and extraneous circumstances that could affect strategies, and to establish overall lines of communication. This meeting is also an opportunity to fine-tune processes based on previous years' experiences during winter closures. Involving state DOTs in law enforcement, public information and communications, county and city operations, and enforcement, helps to introduce key stakeholders and obtain a broad range of perspectives into the planning process.

It was at one of these meetings that a hierarchy of closure activities was established and agreed on among the primary partners. This hierarchy is based on expected duration of the closure; depending on the duration, additional strategies may be implemented. These levels and their associated durations are as follows:

- Level 1: Assumed duration of less than 3 h;
- Level 2: Up to 6 h;
- Level 3: 6 to 12 h;
- Level 4: 12 to 24 h; and
- Level 5: 24 h or longer.

For the first three levels, controls are primarily implemented by Caltrans for the state line closure and NDOT will initiate its own notification processes, which includes agency and traveler notifications. For a Level 3 closure, District 2 or 3 will activate NDOT DMS further east on I-80. For Level 4 and Level 5 closures, NDOT and NHP will implement Nevada controls and will turn trucks away before they reach the Reno area, in addition to the Caltrans controls at the state line.

This process has been refined over time, and although most of the steps involve manual processes such as issuing notifications via phone or e-mail and text alerts, NDOT has incorporated important tools into the processes to support notifications along the I-80 corridor through roadside infrastructure and its 511 web and phone systems. The need to inform westbound travelers about these closures has influenced NDOT's planning and implementation of ITS infrastructure along the corridor. Road weather information sensors provide real-time information about weather, precipitation, and pavement conditions to the NDOT District Road Operations Centers in Reno/Sparks (District 2) and Elko (District 3). Traveler notification systems, including DMS and flashing beacons, have been strategically placed before decision points along I-80; although DMS are located on each side of the corridor, there has been more emphasis on placing infrastructure to notify westbound travelers of closures or other concerns.

Detailed Process and Integration Points

When weather conditions warrant closure of the Donner Summit pass on I-80 just west of the California/Nevada state line, Caltrans will make the decision to close the state line to trucks and maybe to all I-80 westbound traffic approaching the Nevada/California border. Once Caltrans decides to close the state line, it initiates notifications to NDOT's District 2 ROC in Reno/Sparks, which is staffed 24/7. As part of this notification, Caltrans will also indicate an estimated duration and will update NDOT if conditions warrant extending the estimated closure time. Caltrans also has remote access to be able to post messages on three DMS on I-80 in Nevada alerting westbound traffic that the state line is closed to trucks or that trucks are restricted.

When NDOT's ROC receives the notification from Caltrans, including the expected duration of the closure, it sets in motion a series of actions for NDOT to mobilize according to the stage level (predetermined by the duration or stage level). For a Level 1 closure, NDOT would notify its District 2 maintenance staff and District 3 office in Elko that a closure is in effect and that advisories are being issued, including NDOT's DMS on westbound I-80 (already activated by Caltrans); and input closure information into NDOT's statewide road condition database, which then makes the information available through Nevada's 511 system and www.nvroads.com traveler information website. Operators at the ROC will monitor road weather information systems and stay in contact with Caltrans to monitor the closure duration. As conditions warrant and if the closure duration is extended, NDOT will initiate additional operational procedures, including posting messages on DMS further east on I-80, activating additional flashers, and updating the information going to 511 and NDOT's website. NDOT District 3 also is notified to begin alerting trucks as they cross into Nevada on I-80 from Utah; a longer closure would also necessitate notifying Utah DOT and Wyoming DOT of the westbound I-80 closure at the Nevada/California state line, and these states would also initiate notifications using their respective systems and infrastructure. The objective is to minimize truck traffic approaching the Reno/Sparks area because there is limited to no available parking for trucks to wait out a lengthy closure at the state line.

Figure 6.1 shows a typical series of processes when Caltrans initiates a closure at the state line on I-80. This graphic assumes a Level 3 closure (6 to 12 h) and the external agency notifications that would be initiated by NDOT as a result of the predetermined strategies. As shown in this process diagram, there are several key integration points among NDOT and other agency processes to carry out winter operations on I-80. Process integration actually begins before a weather event affects I-80, in the form of preplanning for response strategies among agencies responsible for traffic management, maintenance, enforcement, and notification along I-80. At a higher level, there are overarching interstate coordination processes for winter maintenance and road closure operations that are also not necessarily specific to an event but provide the framework for which specific processes and activities are carried out and coordinated in response to winter closures in this region. Internally, NDOT has established operational procedures that have evolved with the addition of technologies and systems for traveler information and agency communications. One of the most critical processes in the I-80 winter operations strategies are the traveler notifications. NDOT will activate various traveler information systems, some of which are localized to the I-80 corridor (such as DMS or flashing beacons), while others provide information to travelers beyond I-80, including phone and web-based systems.

Several key integration points were identified in the I-80 winter state line closure process, including the following:

- NDOT initiating preplanned responses to state line closure by Caltrans once notified (Caltrans and NDOT process integration). This sets into motion several process activities, all of which result from agreed-upon strategies and protocols.
- Road closure database updating multiple notification channels of the closure and effects. This includes informing internal stakeholders (NDOT District Operations and Maintenance staff), as well as external stakeholders through its 511 and web-based systems. Media also use this information to provide updated alert information through radio and TV broadcasts.
- Extending notification to additional NDOT districts and other state DOTs (including Utah and Wyoming), who then initiate their own sets of planned strategies and approaches.

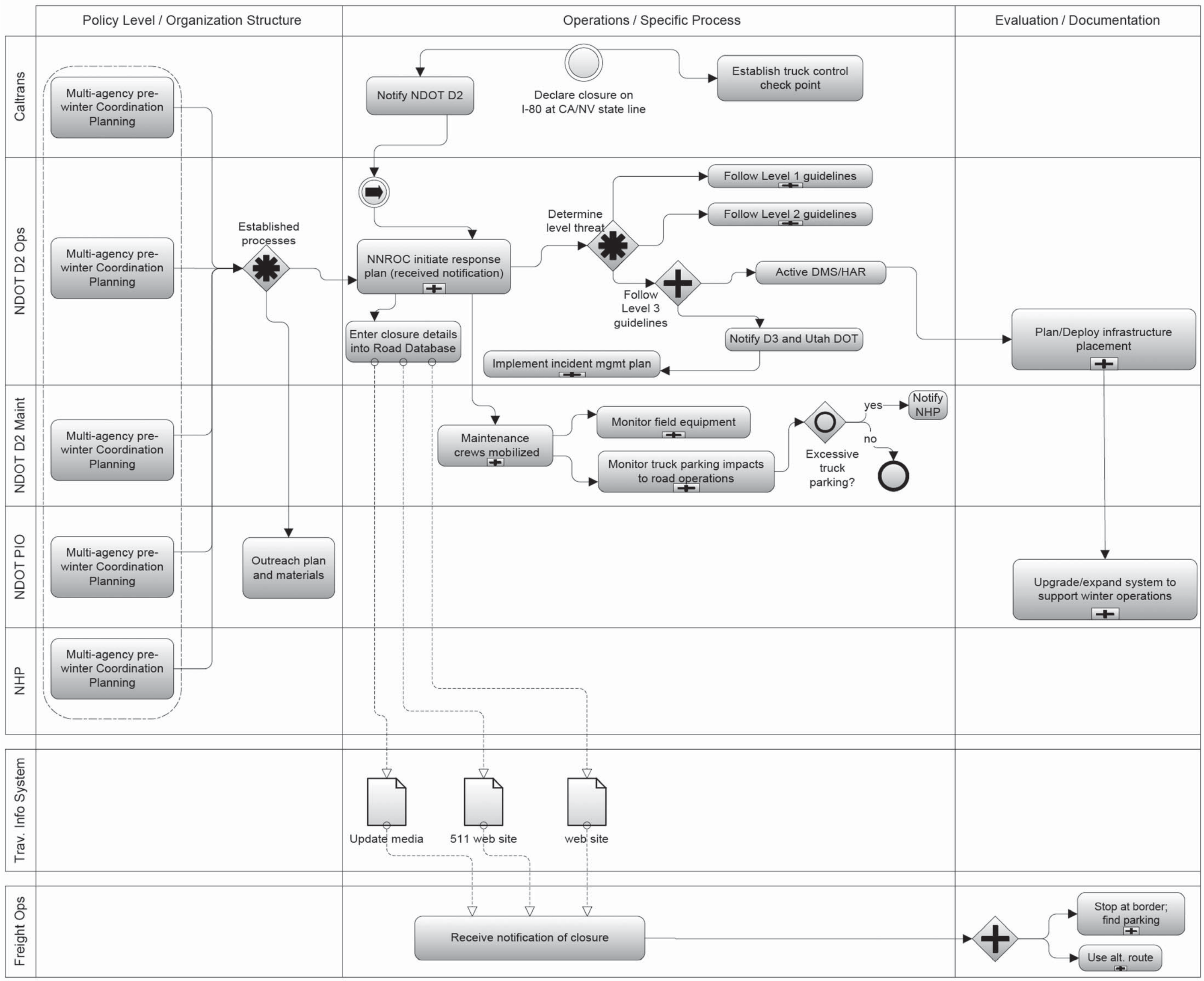

Figure 6.1. Detailed business process diagram of Nevada DOT I-80 winter closure.

There is a predetermination of specific coordination actions based on anticipated duration of the I-80 closure.

- Monitoring truck parking impacts to the road network (for safety of winter plowing and operations and emergency vehicle use) and coordination with state police for enforcement support. In some instances, law enforcement will initiate its own processes to implement truck turnarounds further east on I-80, thereby restricting trucks before they reach the Reno area.

Types of Agencies Involved

Primary partners for initiating and implementing winter response strategies on this segment of I-80 are Caltrans and Nevada DOT District 2 and, depending on the duration of the closure, NDOT District 3, further east on I-80, also will have a critical role. NDOT's internal processes have been established to effectively mobilize maintenance crews and equipment, update internal databases (which provide data to traveler information tools) and activate traveler information systems. Operators and Operations/Maintenance staff at the District 2 ROC in Reno/Sparks also are responsible for initiating other notifications, including neighboring states, cities, counties, and truck-stop facilities along the corridor.

Law enforcement for both California and Nevada are critical partners in I-80 winter operations. While DOTs can initiate closures of the roadways and implement processes for notifications and mobilization of DOT crews, enforcement of these closures is the responsibility of state police and highway patrol. NDOT indicated that the NHP also relies on trained volunteers to help staff established truck-turnaround points that NHP might establish along I-80 to prevent trucks from creating a bottleneck on I-80 while waiting out the closure.

There is an agreement in place that allows Caltrans to cross the state line to establish truck turnaround and checkpoints on the Nevada side of I-80. Caltrans will notify Nevada DOT before mobilizing in Nevada. NDOT did not indicate that there were other formal policies in place to support specific winter response strategies, but rather agencies partner as part of a collaborative process to do what is needed to minimize the impacts of closures on I-80 traffic.

Within NDOT, there are additional divisions and groups involved in executing operations strategies for winter events on I-80. NDOT's Public Information Office launched an outreach campaign to the freight community, notifying them of parking restrictions on I-80 during winter closures. They provided flyers and other information to each truck stop on I-80 and posted flyers at rest areas along the corridor (*3*). At some rest areas, NDOT has installed free wireless Internet, so travelers can access information about weather, closures, and parking alternatives.

Types of Nonrecurring Congestion Addressed

Although most of I-80 within Nevada and near the state line with California is considered rural (with the exception of the Reno/Sparks metropolitan area), winter-weather incidents can cause significant congestion if trucks and other vehicles are held in Nevada. NDOT estimates daily truck traffic of 2,500 vehicles per day on a typical winter day. There is the risk of crashes as a result of trucks parked illegally on the shoulder or in the outside travel lane on the highway. Parked trucks pose a significant hazard for maintenance crews trying to clear roadways or for emergency responders who need to get to an incident scene. Although the primary focus of the operations strategies and processes are to address the effects of winter weather, there are also definite links to incident-related congestion measures.

Performance Measures

There are few formal performance measures in place to monitor and track progress of the various business processes and integration strategies on I-80. Primary sources of information are visual observations from NDOT and NHP about numbers of trucks parked (potentially parked illegally) on I-80, or numbers of trucks that need to find an alternate route because of an enforced truck-turnaround point.

It is difficult to quantify how many trucks might have sought an alternate route as a result of information provided to them further east on the I-80 corridor. NDOT is implementing some enhancements to its 511 service to include truck control and restriction information, and NDOT will be able to track how often this information is accessed.

Benefits

NDOT continually refines strategies and approaches for winter management on I-80 to incorporate new systems or technologies and changes in land use as a result of development (such as removal of truck parking facilities or the addition of potential new parking areas or facilities), and incorporates lessons learned from previous winter events into its established operations processes. A strong partnership with NHP has been critical to successful development and execution of these winter operations strategies.

NDOT's processes are aimed at providing as much advance notification as possible to freight travelers that the state line is closed and parking on I-80 west of Reno is not available. Truck traffic can receive these alerts and notifications through several avenues: NDOT DMS and highway advisory radio, DOT flashing beacons (warning that state line is closed), 511 and NDOT's traveler information web page, commercial broadcast media, and truck stop announcements and notices. Freight drivers can choose either to find parking further east on I-80 or use an alternate route to reach their westbound destinations.

Recognizing the importance of providing advance notification, particularly to freight, has been the motivation for NDOT to plan and program specific enhancements and infrastructure. Corridor information needs along I-80 have resulted in NDOT Districts 2 and 3 installing permanent DMS and highway advisory radio on westbound I-80, with an increased number of flashing beacons that are activated during state line closures on the segment of I-80 in District 2 approaching the Reno metropolitan area. The need to provide more comprehensive and timely information to freight traffic has also been the driving force behind some key enhancements to NDOT's 511 and web traveler information system. This infrastructure is invaluable for helping to manage winter closure events on this corridor, but it also is used for construction restriction notifications, incident alerts, and AMBER alerts.

Lessons Learned

Prewinter meetings held before the snow season have been an effective strategy in bringing together key stakeholders from Nevada and California to manage I-80 closures during hazardous winter weather. These allow operations, maintenance, law enforcement, public information office, and others from both states to interact, establish contacts, and discuss roles and responsibilities during winter events.

The recent closure of a truck parking facility on I-80 in Verdi, Nevada, just east of the California/Nevada state line, eliminated 400 truck parking spaces. The impacts of truck parking and storage on I-80 during severe winter storm events do not just affect NDOT and I-80 operations but also local agencies when trucks seek parking alternatives in unsuitable locations. Cities are faced with trying to accommodate the need for truck parking during these events. There are currently only 750 available parking spaces at truck stops and other facilities along the I-80 corridor between the California/Nevada state line and Fernley, Nevada, a distance of approximately 50 mi (*4*). Truck stops are private developments that are subject to local zoning ordinances, which is often one of the biggest challenges in getting local approvals for building these kinds of facilities. Other concerns often expressed by local agencies or residents are enforcement, increase in traffic, and access issues; funding for access and potential interchanges also limits the development potential. NDOT does not have a role in land use planning or zoning, but is actively partnering with municipalities and local agencies to examine long-term solutions to the need for more truck parking along the corridor.

Because of the need to effectively manage freight traffic during winter events (as well as during other occurrences, such as an incident or wildfire evacuation), NDOT has mirrored capabilities between the ROCs in Districts 2 and 3. This allows operators from either center to execute predefined processes regardless of the center where they are based.

Analysis and Research Observations

The evolution of the I-80 processes and strategies has been driven by several factors. At the core, there is a high priority on traveler safety during hazardous winter conditions, particularly given the steep elevation changes on this segment of I-80. There is also a need to minimize (or eliminate) the number of trucks parking on I-80, which affects other traffic, poses a hazard to emergency access, as well as impedes NDOT's winter maintenance activities.

Most of the processes identified in this case study are the result of operations needs at the field operations levels; this includes field maintenance staff, highway patrol and law enforcement, and others. Relationships among DOT and public safety/law enforcement are essential for these kinds of operations. NDOT does not have the level of influence of the highway patrol for implementing en-route truck turnarounds; NHP's role for enforcement is critical. Both agencies recognize that current resource constraints limit their ability to adequately staff a long-term closure out in the field. This has translated into deploying traveler information infrastructure further east of the state line, coordinating with local agencies and truck stops about the closure and its potential impacts, and establishing lines of communication with neighboring states to provide even more advance warning to freight traffic.

A long-standing agreement between Caltrans and NDOT established the initial framework for cooperative management strategies and gave Caltrans the ability to implement checkpoints and truck-turnaround points in Nevada. A cooperative venture between Caltrans and NDOT installed three DMS on I-80 just east of the state line, and Caltrans has remote access to these signs to be able to post messages about state line closures or restrictions for westbound traffic.

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CHAPTER 7

Case Studies: Multiagency Operations

Improvements to travel time reliability, particularly in large urban areas, often rely on the integration and coordination of multiple agencies in order to achieve a common goal. This section presents two case studies that were considered because of the focus they place on multiagency integration. Often it is the institutional issues in a project, rather than the technical issues, that are the most challenging. These challenges only grow larger when multiple agencies are involved. The case study that is presented for AZTech examines the process used for multiple agencies in the Phoenix metropolitan area to view and exchange real-time traffic data from adjacent jurisdictions. The case study for the Metropolitan Transportation Commission (MTC) examines the multiagency approach to the development of corridor signal timing plans in the San Francisco Bay Area.

Arizona: AZTech Regional Archived Data Server

AZTech was established in Phoenix, Arizona, as part of the federally funded Metropolitan Model Deployment Initiatives in 1996 (*1*). There are several aspects to the AZTech program that are focused on improving travel time reliability in the Phoenix metropolitan area. From the state perspective, Arizona DOT operates a robust freeway management system that supports operations during recurring and nonrecurring congestion, including real-time detection, traveler information, incident management and response strategies, and planned event management. Coordinated and effective arterial operations are also a significant part of the region's transportation operations and management strategy. Many local agencies within the Phoenix metropolitan area operate independent traffic signal management systems; many also use CCTV cameras and DMS and operate web-based traveler information systems. Agencies within the AZTech partnership include Arizona DOT, Maricopa County DOT, the Maricopa Association of Governments, Valley Metro/Regional Public Transportation Authority, several cities, and state and local law enforcement and emergency response agencies.

One unique element to the AZTech program is the use of a regional database to support real-time information sharing among partner agencies. Agencies in the region determined it would not be financially feasible, nor would it be a viable option from an information technology security standpoint, to implement individual connections between agencies to share transportation data. A Regional Archived Data Server (RADS) was established to archive data generated by local and state agency transportation management systems. Initially, the RADS was intended to serve as a regional data archive, and to provide a repository for regional data that would be populated by local systems. Agencies in the region also could retrieve archived data from the server to support planning and analysis activities. The RADS has since evolved into a data engine that is supporting real-time information exchanges among agencies for transportation network operations data. As the region moves toward more center-to-center information-sharing strategies, the RADS has become a critical part of the overall approach. It has been developed through collaboration of local, county, and state agencies and continues to evolve and expand as new data sources and systems are deployed in the Phoenix metropolitan area.

As part of the development of this case study, an interview was conducted with Faisal Saleem, the Maricopa County DOT ITS program manager. He leads many of the operations initiatives within AZTech on behalf of Maricopa County.

Description

The AZTech RADS was selected as a case study to demonstrate how various agency processes and operations functions are enhanced through the ability to view and exchange real-time data from adjacent jurisdictions. This helps to support both recurring and nonrecurring congestion management on arterials and promotes a more coordinated operations approach among state and local agencies in the Phoenix metropolitan area. Of key importance is the interface that has been established by Phoenix Fire, which is a central dispatch for more than 20 fire and EMS response agencies (including cities other than Phoenix) in the metropolitan area (*2*). Arterial incident information had long been a significant data gap, and with the interface from the Phoenix Fire computer-aided dispatch (CAD) system, information about arterial incidents that have the potential to significantly affect transportation network operations are made available to the local TMCs in the region and to the state and county traffic management/operations centers.

Background of Agency

Maricopa County DOT and Arizona DOT are the two primary partner agencies for the RADS development, operations, and maintenance. Maricopa County is one of 14 counties in Arizona and includes the Phoenix metropolitan area. Maricopa has operated a TMC for more than 10 years and also operates traffic signals, DMS, and CCTV cameras on county-owned facilities. In addition to its own infrastructure, Maricopa County DOT often partners with local cities to address cross-jurisdictional traffic operations and incident management issues. These partnerships have collaboratively planned, deployed, and operated systems among multiple jurisdictions.

Maricopa County DOT initiated the development of the RADS database, and Arizona DOT is a key partner in operating, maintaining, and enhancing the capabilities of that system. Arizona DOT is responsible for operating and managing state-owned transportation facilities, which includes urban area freeways and rural interstate and highway corridors. Within the Phoenix metropolitan area, Arizona DOT operates a freeway management system, which generates a substantial amount of real-time data that is used by the Arizona DOT Traffic Operations Center to manage day-to-day network operations and respond to nonrecurring events, such as freeway incidents, road construction impacts, and planned special-event traffic.

Process Development

With the focus of the L01 research on nonrecurring congestion and its impacts on travel time reliability, this case study highlights the role of the RADS in supporting regional traffic operations and management strategies to respond to nontypical travel conditions on the region's freeways and highways.

A federal interoperability grant was awarded to the AZTech partnership, and Arizona DOT and Maricopa County DOT focused the grant funds on enhancements to information sharing between public safety and transportation management agencies in the region (*2*). Up-to-date and near-real-time information about incidents affecting arterials and freeways in the Phoenix metropolitan area represented a significant gap that needed to be addressed. Arizona DOT's freeway management system uses an algorithm that can detect major slowdowns in freeway speeds where there are detectors; however, this does not provide any information about the nature of the incident or potential impacts. From an arterial operations standpoint, information about arterial incidents and impacts was not readily available, and each city had varying levels of coordination between traffic operations staff and law enforcement and emergency response staff. There was a need to be able to capture data about incidents in a way that was automated and could provide broad coverage throughout the metropolitan area; many of the region's key arterials traverse more than one jurisdiction, so it is likely that a major incident could potentially affect multiple traffic management agencies. More comprehensive information would also support enhanced traveler information to the public.

In collaboration with Phoenix Fire, which dispatches for more than 20 fire and EMS agencies in the region, the AZTech partnership embarked on developing a concept of operations to transmit data from the Phoenix Fire CAD system to the Maricopa County TMC. Using national standards as a basis, a working group of the AZTech partnership identified specific requirements for what types of incident information would be valuable to support transportation operations and worked closely with Phoenix Fire to formalize these requirements and establish information exchange protocols. Data to be shared was mutually agreed on by AZTech partners and Phoenix Fire; Phoenix Fire agreed to provide a filtered data set from its CAD system so that information shared with transportation agencies did not compromise any sensitive data gathered during the incident response and on-scene management (*3*).

Through the requirements development process, several options were explored for how the CAD data would be shared. Factors such as firewall security (for Phoenix Fire, as well as for Maricopa County DOT and Arizona DOT), interface requirements, modifications to both Phoenix Fire and agency systems to share and accept data, and overall cost requirements were all considered. Through this iterative process, it was agreed that a filtered data set from the Phoenix Fire CAD system would be pushed to the RADS database, where it would be stored and made available to users who are able to access RADS. This approach capitalized on the existing functionality of RADS and also minimized the development effort and modifications that otherwise would have been required to support the data transfer.

Detailed Process

By establishing an automated connection between the Phoenix Fire CAD system and the RADS database, a significant amount of incident information is now made available to support transportation management and operations, response of transportation departments to incidents on freeways and arterials, as well as provide more accurate information for traveler information systems.

Dispatchers at the Phoenix Fire Communications Center receive and initiate responses to 911 calls. Initial information is entered into the CAD system, which includes several fields. As the dispatcher receives more information about incident details and what types of units are being dispatched to respond (fire engines, fire ladder trucks, chief, ambulance), they update the CAD to reflect the current status, severity, and impacts of the incident. The automated feed from the CAD system filters certain data before sending the data set to the RADS database; this minimizes issues with regard to victim privacy, and it minimizes any potential compromises to the response as a result of information about the incident being distributed.

The RADS database has been configured to produce a data set suitable to transmit to other systems, as well as to be viewed by operators at TMCs to ascertain potential impacts to street networks and initiate an appropriate response from the city and county crews, which could include maintenance support for incident cleanup or specialized response teams to support emergency traffic management near a major incident.

The RADS receives updated information from the CAD system every minute, and information that is sent to TMCs or traveler information systems is updated accordingly. There could be multiple incidents active within the CAD system; the data set is automatically updated with all active incidents and any changes in status.

Figure 7.1 shows a series of processes that result from agencies using data from the RADS database. Once transportation management centers are able to access the incident data from RADS, they can initiate a range of responses depending on the incident severity and location. Maricopa County DOT will also issue e-mail alerts for major incidents to subscribers, which primarily include agency staff, county-operated response teams, and the media. Data are also made available to other systems that push incident details to Arizona's 511 service and

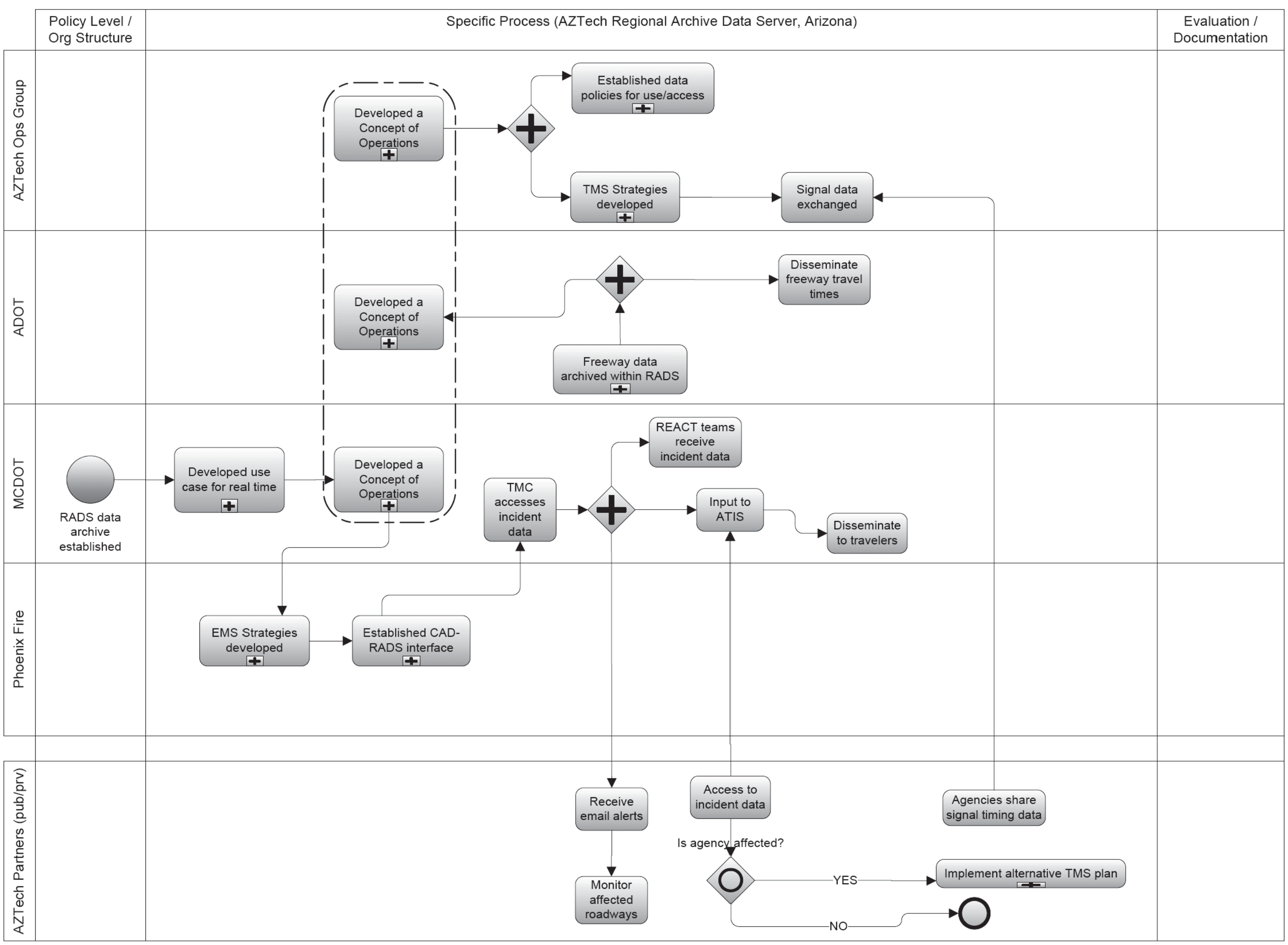

Figure 7.1. Detailed business process diagram of AZTech regional archived data server (incident data).

web-based traveler information system (www.az511.gov). These systems are updated as new information or details are received from the CAD data feed.

This figure also shows additional capabilities as a result of the RADS database. Arizona DOT is able to use RADS as the central data point to generate freeway travel times, which are then displayed on Phoenix metropolitan area DMS and also made available through www.az511.gov and through mobile devices. Traffic signal data is beginning to be stored on the RADS database, which allows agencies to share information about current traffic signal timing plans for better coordination on cross-jurisdictional corridors.

With the implementation of RADS and establishing automated data feeds between data providers and end users (including TMCs, media, and traveler information systems), Maricopa County DOT and Arizona DOT were able to automate several business processes, as well as provide for enhanced process integration as a result of having more comprehensive incident details on the region's transportation network. Important business process integration points within this strategy include the following:

- The collaborative operations of the RADS database represent an important integration point, because they involve ongoing development, updating, and enhancements to the system that are derived from AZTech partner needs. Maricopa County had the initial lead in developing and establishing this regional database, which is now housed at the Arizona DOT traffic operations center and maintained by Arizona DOT technology staff. As enhancements are identified and prioritized, partners collaborate on funding strategies, and have been able to apply a variety of funding sources (local, state, and federal) to the operations and enhancements of this regional data server.
- Establishing the data transfer from the Phoenix Fire CAD system to RADS represents a very key integration of multiple agency processes. The centralized database provides for a secure means of sharing critical information with additional public sector entities, as well as with private media and other subscribers. When TMCs have that data, they are able to initiate responses to incidents, which could include dispatching their own crews for incident clearance, modifying traffic management plans and signal timing plans to respond to increased congestion near the incident scene, and updating traveler information that is disseminated to the public.
- Multiple data types are stored in the RADS database that is then used to support traffic management, incident management and response, and traveler information alerts and notifications.

Design for the interface to the Phoenix Fire CAD data feed to RADS was documented as part of an April 2006 publication entitled *Emergency Management System Center-to-Center Interface Module, Phoenix Fire Dispatch System Design* (*4*). This document included a mapping for the CAD fields to International Traveler Information System (ITIS) codes that could then be supported by Arizona DOT and Maricopa County DOT systems.

A formal MOU was established between Phoenix Fire and Maricopa County DOT to share CAD data from Fire with the RADS database. As part of this MOU, data sharing parameters were outlined, including recognition by transportation agencies that they would be able to access a filtered data feed about arterial incidents, and recognition by Phoenix Fire that incident data provided to RADS would be shared with several external entities.

Types of Agencies Involved

Arizona DOT and Maricopa County DOT are the primary operating and maintaining agencies of the RADS database. Arizona DOT's Transportation Technology Group houses the RADS database and provides the IT expertise (internal and through consultant support) to update and maintain RADS, as well as establish additional interfaces with external agency systems. These agencies are also among the primary users of the RADS data, including the incident data feed, as well as the stored freeway management system data.

Phoenix Fire provides the data push of incident details to the RADS database. Operators at the Phoenix Fire Communications Center are responsible for entering and updating incident information as more details emerge from 911 callers and from fire and EMS responders. With the development work completed to establish the data feed, there is no impact on Phoenix Fire dispatcher operations to provide the data; an automated push is built into the system, which then populates the RADS database and makes that information available to outside entities to support a range of other operations and response processes.

Through the AZTech partnership, several public sector agencies within the Phoenix metropolitan area have or plan to have direct access to RADS. Some agencies are working with Maricopa County DOT and Arizona DOT to establish direct interfaces to be able to share their signal timing data. This also involves vendors of their respective traffic signal systems to make the necessary modifications to support the data feed. As part of being an AZTech partner, each agency agrees that data shared with the central system will be used on a regional level to support enhanced operations and traveler information. Specific data-sharing issues or needs are worked through on a case-by-case basis.

Types of Nonrecurring Congestion Addressed

The focus of this case study has been primarily on sharing incident data to support transportation management operations and response to incident conditions on roads in the Phoenix metropolitan area. When transportation management agencies have accurate and updated information about incidents affecting their road network, they can better respond to incident traffic conditions by modifying traffic signal timing plans or dispatching crews to support incident clearance or detour routing. Minimizing the impacts of incident-related congestion provides mobility and safety benefits.

From a recurring-congestion standpoint, RADS also supports more coordinated agency operations for day-to-day travel conditions. Having access to neighboring jurisdictions' traffic signal timing plans can support better cross-jurisdictional signal timing and coordination without compromising each agency's control of its signal management systems. This was an important parameter discussed and agreed on by AZTech partners.

Improved information for traveler information systems also supports both nonrecurring and recurring congestion management. Arizona DOT implemented a travel time program that uses RADS to calculate freeway travel times (using real-time data stored in RADS from the freeway management system) to display on urban area DMS during morning and evening peak travel hours.

Performance Measures

Maricopa County DOT tracks the number of incidents input to RADS from the Phoenix Fire CAD on a monthly basis. Incident inputs to RADS from this data feed average between 2,500 and 3,000 per month. The Maricopa County DOT has a broader performance monitoring program that also tracks the number of responses of its incident management crews and the number of incident e-mail alerts distributed to its mailing list, both of which are dependent on incident information received from the Phoenix Fire CAD data feed. Data are used to support faster mobilization and response of the Maricopa County REACT arterial incident-response teams.

The RADS serves as the region's data archive and is a key component of various performance-monitoring efforts through Maricopa County DOT and Arizona DOT. Arizona DOT tracks detector congestion data and travel times to be able to view mobility trends for urban freeways. Arizona also monitors its 511 phone and website activity, and RADS is a key data source for those traveler information systems. Arizona DOT estimates that there are 400 incident messages more per month broadcast on 511 and www.az511.gov with the addition of the Phoenix Fire data feed.

Benefits

Maricopa County DOT and Arizona DOT have indicated that the data links and information exchanges enabled through RADS provide for significantly more operations and traveler information data than was previously collected. In particular, the incident data feed from Phoenix Fire has addressed a significant data gap by providing arterial incident data that supports internal operations at the TMC, as well as external traveler information functions. In particular, Maricopa County DOT relies on incident data from Phoenix Fire to support faster mobilization and dispatch of their incident response teams.

More reliable information is provided to the traveler through established AZTech traveler information systems, including travel times on DMS, 511, web and media alerts, and mobile applications. RADS data also is included as part of the data set that is available to other private entities who aggregate data from available public sector systems and other data sources and then disseminate traveler information through a variety of technology applications.

The ability to expand RADS to include data beyond serving as a freeway detector data archive has been a direct result of the collaborative forum of the AZTech partnership. The open platform as a key requirement of RADS allows it to support multiple data formats, and does not require agencies to make drastic changes to their individual policies. Data that the agency selects are sent to RADS rather than to agencies having to establish physical connections directly to another agency, which could require significant development work and could be prohibitive because of agency information technology policies.

Integrating signal timing data into RADS and making these available to participating agencies allows agencies to share signal timing plan information without compromising network security, firewalls, or allowing operational control of signals by another entity. Agencies in the Phoenix metropolitan area operate various traffic control and management systems, and direct interfaces between agencies to share these data are not feasible nor are they an option that agencies are interested in exploring. RADS provides a neutral, centralized platform where agencies can access data.

Lessons Learned

RADS was able to successfully transition from a single agency data archive to serve as a regional archive for freeway, arterial, and incident data largely because of the strong partnerships between state, county, and city AZTech partners. The importance of pilot deployments also has been an important separator for AZTech programs. The benefits of how advanced systems can support a range of strategies need to be shared with agency staff and with regional decision makers.

System-to-system interfaces are often a roadblock for effective interagency data exchanges. Some AZTech partners were not supportive of a peer-to-peer system for exchanging real-time data because their respective internal IT and network security policies would not be able to implement the desired functionality. To address this, RADS was established as a neutral data repository, and allowed for agencies to share data without compromising individual networks and firewalls. This was an important issue for agencies to be able to communicate to their internal divisions about the security requirements that were being addressed. Because partners were brought together to discuss requirements and concerns from each agency's perspective, they were able to address these requirements and concerns during the concept of operations development, which ultimately became part of the AZTech partner agreement. From there, requirements were developed to address operational, functional, and security issues. Enabling agencies to interface with RADS would also require modifications to their existing systems, which required agencies to coordinate with their respective system vendors to complete the interface to RADS.

Representatives from National ITS Standards Committees were involved to ensure adherence to national standards. During the requirements development process, it was revealed that the current standards did not achieve a level of messaging security that was needed by the AZTech partners. Not only did the protocol developed for the RADS center-to-center information exchanges incorporate updated security requirements for web services security, but the effort for the RADS center-to-center project also provided input to the update of the NTCIP 2306 standard (Web Services Center-to-Center Communications Standard) (*5*).

Analysis and Research Observations

The institutional framework established by the AZTech partnership has been the key contributor to implementing systems such as the RADS and to advancing and elevating multiagency collaboration for traffic management and incident response in the Phoenix metro area. Involving important partner agencies in concept development—including state, county, and local agencies and law enforcement/public safety—has led to stronger awareness of the potential system capabilities, as well as buy-in at strategic points in the development process. The structure does not prescribe specific technologies or strategies that work well for some partners but not all; rather, it allows for collaborative decision making and provides for adjustments that are needed for specific requests or needs.

To date, not all agencies in the AZTech partnership have been able to participate in some of the information-sharing aspects of the regional operations strategy, largely because of the different levels of maturity of the individual agency systems. In some cases, minimal modifications are required for agency systems to interface with the centralized AZTech systems (such as the RADS); for others, more extensive development is needed. The region includes several growing cities, so not all agencies are at the same level of system implementation, which also limits some agencies' accessibility to RADS. Having some successful early adopters has helped to demonstrate the benefits that the RADS and center-to-center concepts can achieve.

Incremental build-out of system functionality has allowed for increasingly greater focus toward broader system improvements, such as corridor travel time reliability, multiagency incident response and management, and provision of more comprehensive and accurate traveler information through the public and private sector systems.

California: San Pablo Avenue Signal Retiming Project

The San Pablo Avenue Corridor is one of three main arterial corridors identified as part of the SMART Corridor Program. Retiming on the corridor was funded through the Metropolitan Transportation Commission (MTC) Regional Signal Timing Program (RSTP). This corridor was selected as a case study based on the multiple-agency support of the program and its successful integration across several jurisdictions along the corridor. The RSTP has been in place for more than 15 years and provides funding for local agencies to develop and implement timing plans with the help of RSTP consultants under contract with MTC. The SMART Corridor Program is a regional initiative to assemble stakeholders from several local agencies to focus on improving congestion along three major arterial corridors. The Alameda County Congestion Management Association (ACCMA) is closely involved with the SMART Corridor Program and led the application effort to retime the San Pablo Avenue Corridor using the RSTP as a funding mechanism. At the time of this publication, the RSTP program was ending at MTC and was to be replaced by the Program for Arterial System Synchronization (PASS). PASS functions in a similar manner to the RSTP by providing technical and financial assistance to local agencies to support signal timing and arterial corridor operations (*6*).

Representatives from MTC and their consultant firm were contacted to discuss project specifics and to better understand the process and procedures in place with the SMART Corridor Program and the RSTP. Jeff Georgevich and Vamsi Tabjulu were contacted from MTC. Georgevich was involved with the development of the original RSTP and has been involved throughout the program. Tabjulu has recently taken the responsibility of overseeing the RSTP. Brian Sowers, from MTC's consultant team, has been involved with the RSTP since its inception and was responsible for developing the signal timing plans on the San Pablo Avenue Corridor project. These three representatives provided firsthand knowledge about both San Pablo Avenue Corridor programs.

Description

The San Pablo Avenue Corridor case study focuses on a multiagency approach to the development of a corridor signal timing plan. The corridor runs through multiple jurisdictions, includes traffic signals on municipal and Caltrans roadways, and required coordination across 13 different agencies. The development of the signal timing plan was funded by the MTC RSTP and was led by ACCMA. The corridor also included transit signal priority for the Alameda Contra Costa Transit District and AC Transit.

The corridor consists of 13 mi of San Pablo Avenue from 17th Street in the city of Oakland to Highway 4 in the city of Hercules. A portion of the corridor is signed State Route 123 and is maintained by Caltrans. The other portions of the corridor traverse through 10 local-agency jurisdictions. Three of the agencies have Caltrans-maintained signals, and three have Contra Costa County–maintained signals. Caltrans and Contra Costa County also maintain signals under their respective jurisdictions. Other agencies involved include ACCMA and the West Contra Costa County Transportation Advisory Committee (WCCTAC).

Background of Agency

MTC was created by the state legislature in 1970 to provide transportation planning for the nine-county San Francisco Bay Area. MTC is three agencies in one with a shared mission: to keep the Bay Area moving. MTC, along with Bay Area Toll Authority (BATA) and Service Authority for Freeways and Expressways (SAFE), is directed by a 19-member policy board. The RSTP developed by the Highway and Arterial Operations (HAO) section of MTC supports the efforts to improve the operations, safety, and management of the Bay Area's arterial network. Through the RSTP, MTC provides support to hire, fund, and manage performance monitoring on behalf of the local agencies. Through the application process, MTC encourages multiagency coordination for consistency among neighboring jurisdictions. MTC's primary goal through the RSTP is to optimize signal coordination through effective partnerships between multiple entities. MTC oversees the program and can act as a facilitator when needed, but primarily uses the expertise of consultants to address technical issues, develop, implement and fine-tune the new timing plans.

There are approximately 100 counties and cities within the MTC jurisdiction. Twelve jurisdictions have populations of more than 100,000, while approximately 37 of the jurisdictions have populations fewer than 25,000. Approximately two-thirds of the agencies have participated in the RSTP to gain funding for signal timing plans. Several of the agencies are smaller organizations with little or no engineering staff or resources. Several of the agencies have implemented emergency vehicle preemption and transit priority technologies. The MTC coverage area includes 24 transit agencies, eight of which are considered major players in the regional transportation system.

The East Bay SMART Corridor Program includes three major arterial corridors in the eastern portion of the San Francisco Bay area with various stakeholders, including ACCMA. ACCMA was established in 1995 and has been heavily involved with the San Pablo Avenue Corridor Retiming project. The relationships established through CMA have made the process of defining and implementing multiagency transportation projects more efficient and effective for all participants involved.

Process Development

The SMART Corridor Program identified San Pablo Avenue as a key corridor with the need for a revised signal timing plan. ACCMA successfully applied for the RSTP funds to revise the San Pablo Avenue signal timing plan.

As part of the RSTP, MTC advertises a call for projects from the local agencies in late summer to fall. Each of the local agencies coordinates and submits applications to the RSTP. To promote multiagency coordination, applications with multiple jurisdictions receive higher recognition. The application also requires data such as crash rates and integration with transit. Based on previous evaluations and information submitted from the applying agencies, MTC also strives to pair the most effective applicant and consultant partnership. Once selected, the applying agency also can declare consultants with whom they prefer or prefer not to work.

The corridor is selected and a consultant is assigned; the consultant then takes the lead in the development of the signal timing plan. The first step is a kickoff meeting with all the participating agencies. MTC remains involved only to the level needed for success of the project. If necessary, MTC can serve as a facilitator between the consultant and the applicant group or between local agencies participating in the retiming. MTC maintains a 2-year contract with all the consultants. All the firms receive the same total dollar amount of work during the first year of the contract; however, during the second year, the selection is based on past reviews and the preference of the local agencies.

In some cases, MTC will hire a second consultant to review the project if the local agency does not have an engineer on staff, such as with a smaller agency. MTC is often more involved in these projects than those reviewed by the local agency.

The consultant will work with each of the participating agencies through the development of the signal timing plans. Since the agencies follow various standards and guidelines for timing plans, MTC generally does not comment on the specifics of the timing plans. MTC believes that the primary responsibility for the operation of streets and roads and the retiming of traffic signals on arterials resides with the agency that owns them. Once the timing plans are developed, the consultant will continue to work with each of the agencies on the implementation of the plans. With more experienced consultants, the relationships and trust between the consultants and local agencies are well established. This trust is key when moving into the implementation phase of a project. Typically, the projects will last approximately 12 months but can extend longer. Projects also can be divided into groups for more complex projects involving a large number of signals and multiple agencies.

Detailed Process and Integration Points

Figure 7.2 shows the process used by MTC for corridor signal retiming. The SMART Corridor Program (SCP) is conducted through regularly scheduled meetings focused on developing and implementing projects that improve the major arterials identified in Phase I. The San Pablo Avenue project followed this established process.

The consultant organizes and conducts a kickoff meeting with all participating agencies. At the kickoff meeting, data collection, schedule, deliverables, and budget are discussed. All the specific project details are discussed using the RSTP program guidelines as the baseline. The consultant completes an in-depth analysis of the existing conditions on the project corridor. The development of the new signal timing plan begins after grouping the signals into logical segments. The consultant also coordinates with transit agencies that operate on the corridor for transit signal priority, if included in the project. The consultant develops recommendations for the revised signal timing plans and submits the timing plans to the project team for comments.

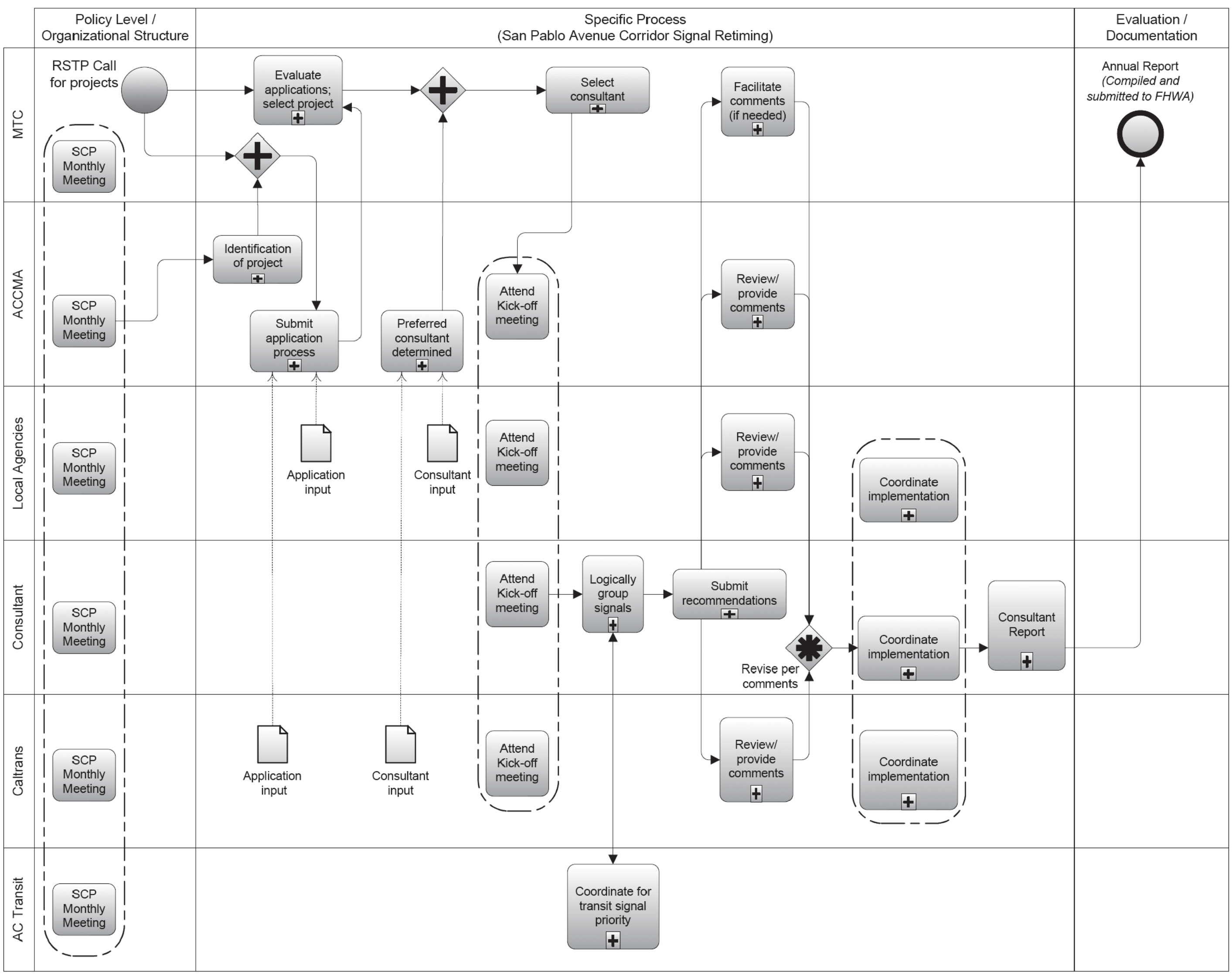

Figure 7.2. Detailed business process diagram of MTC corridor signal retiming.

Agencies located along each segment review the signal timing plans and provide comments to the consultant. If necessary, MTC facilitates discussions between the consultant and participating agencies. The consultant coordinates with each of the agencies to resolve comments and revise the recommendations. Once the signal timing plans are complete, the consultant works with each agency to implement the timing plans.

A final report is prepared including the recommendations, the implementation process, and measured improvements on the corridor. The final report is submitted to MTC, which compiles the benefit-cost analysis from all completed projects into an annual report. The annual report is then submitted to the Operations Committee of MTC and FHWA.

Several key integration points were identified in the MTC corridor signal retiming process, including the following:

- The SMART Corridor Program is the first integration point that fed into the success of the corridor timing project. The strong relationships developed through these regularly scheduled meetings paved the way for successful partnerships and well-developed timing plans for the San Pablo Avenue corridor that passes through various jurisdictions.
- The consultant submits the signal timing plans to each of the local agencies involved. If needed, MTC can facilitate comments on the signal timing plans. This integration between the consultant and every one of the local agencies further improves the final plan.
- The consultant coordinates directly with each agency to implement the final signal timing plans. The close coordination during the implementation further develops the trust between the consultant and every one of the agencies involved.
- At the conclusion of the signal timing plan implementation, a summary report of the process is required by MTC. MTC compiles all the final reports into an annual report documenting the impacts of the program on the arterials and regional network.

At the conclusion of each signal timing project, the consultants submit a final report stating the various benefits achieved by the implementation of the project. These reports are assembled into a single RSTP annual report. The report includes information regarding which projects were completed. It captures the improvements to travel times, fuel savings, and emissions reduction for the corridor and the region. The report captures the overall benefit-cost ratio of the implemented projects. Past evaluations of the RSTP indicate a 35:1 benefit-cost ratio (*7*).

Types of Agencies Involved

The types of agencies involved with the San Pablo Avenue Corridor Signal Retiming case study included the regional metropolitan planning organizations (MPO), local agencies (cities, municipalities, and towns), Caltrans, consultants, emergency responders, and transit agencies. The San Pablo Avenue case study involved 13 of these various agencies. Three multiagency organizations also were involved with the project: ACCMA, the SMART Corridor Program, and the MTC RSTP.

ACCMA took the lead through the application process with the RSTP. Through the relationships developed with the SMART Corridor Program, ACCMA was able to represent the interests of all the agencies involved with the identified section of San Pablo Avenue. ACCMA understood the application process and was able to provide relevant crash data, display existing multiagency partnerships, and speak to other key requirements of the funding program.

It was necessary to involve several local agencies with the San Pablo Avenue Corridor retiming project. The consultant took the lead in coordinating the interests of each agency during the development and implementation of the signal timing plan. Because all 13 mi of the corridor did not directly affect each agency, the consultant was able to segment the corridor into smaller sections and work closely with just the agencies affected by each segment. This minimized the time commitment from each agency and streamlined the review and implementation process for the whole corridor.

Upon completion of the signal timing plans, each agency was required to implement the plans within its jurisdiction. The agencies' involvement with the SMART Corridor Program and their review of the signal timing plans allowed them to trust the quality of the final plans. Moreover, the relationship established with the consultant during plan development formed a foundation of trust so the agency could feel comfortable relying on the consultant during implementation.

Types of Nonrecurring Congestion Addressed

The San Pablo Corridor project was directly focused on addressing recurring congestion but has indirect impacts on several nonrecurring congestion types. The improved corridor timing plans will maximize the corridor capacity during normal operating procedures. Phase I of the SMART Corridor Program focused on improving arterial mobility and safety; however, the current phase of the program is focused on interstates and will identify solutions for incident management strategies that use the complete transportation network. The relationships and improved signal timing plans on all the major arterials will improve the travel time reliability during those scenarios.

In addition, the emergency vehicle preemption will minimize impacts on travel times during major incidents that require emergency management or first responders to easily access all segments of the corridor. The quicker these vehicles arrive at the scene of an incident, the quicker they can clear the incident and return traffic operations to normal.

Finally, the use of transit signal priority improves the travel time reliability for the transit users along these corridors. Transit signal priority only elongates the green phase when transit vehicles are behind schedule. Therefore, it will improve the timeliness of the bus arrivals for delayed vehicles and minimize the interruption to normal signal operations by only affecting the green phase.

Performance Measures

Several performance measures are used to determine the success of the RSTP and the improvements experienced on the San Pablo Avenue corridor. As mentioned, a final report for each project is required and provides several performance measures that demonstrate project success. Travel time improvements, fuel savings, emissions reductions, and an overall benefit-cost ratio are recorded for each project funded by the RSTP. These measures indicate how the public will judge the project and, indirectly, how the public will support similar projects in the future.

The ultimate success of a project is directly related to the performance of the project team; therefore, how the team interacts and trusts each partner is important. As such, it is extremely important that the project team communicate and coordinate throughout the project. The method of selecting lead consultants based on the evaluation of their previous work has proven to be successful. This evaluation stage of the process is important for several reasons. From a technical standpoint, consultants who demonstrate minimal knowledge of signal timing can be excluded from future work. From a coordination standpoint, consultants who are difficult to work with also may not be engaged in future corridors. The ability of the agency to emphasize its preference for a particular consultant sets up each project for greater success and minimizes the cost to the program and users.

Benefits

The RSTP and SMART Corridor programs provide several benefits in addition to the 35:1 benefit-cost ratio previously stated. Several agencies with limited engineering staff have access to funds and proven consultants to assist in designing and implementing signal timing plans. The regional support also provides resources for applying for and managing the process. Some of the larger agencies actually use the RSTP as a consistent strategy for timing their arterials, thereby benefiting the region with improved throughput.

In addition to providing the funding for the plan development, MTC also coordinates with local agencies on their needs. They can recommend either a.m., midday, or p.m. timing plans instead of a single, all-day plan. Because the commute patterns are different during various times of the day, retiming all three scenarios has better benefits compared with a single, all-day plan. These three scenarios also encourage coordination across jurisdictional boundaries, most importantly with signals managed by Caltrans at the freeway ramps.

The largest impacts of the program are quantified at a regional level. Each of the corridors has shown increases in its capacity and travel time reliability, but assembling the regional benefits demonstrates the true impacts of the program. MTC has seen a 10% improvement in travel time for the region. From a regional view, the 10% improvement on travel time for a 60-min trip across the region for multiple vehicles is a greater impact than a 10% improvement for a single vehicle making a 10-min trip on one corridor. The 2004 annual report stated a 13% improvement in travel time and a 13% decrease in fuel consumption. The latest report shows an improvement of 10% in travel time and 10% increase in speed. These benefits take into account the 5-year life cycle of a signal timing project, with benefits accruing at 100% on the first day after implementation and gradually decreasing to an average of 90% of benefits for Year 1, 70% for Year 2, 50% for Year 3, 30% for Year 4, and 10% for Year 5. General methodology of the benefit-cost analysis, fuel consumption factors, and health costs of motor vehicle emissions are based on Caltrans's Life-Cycle Benefit-Cost Analysis Model (*8*).

Another benefit seen by MTC is an increase in the number of consultants with experience and expertise in signal timing. The consistent level of work generated in the region has increased the consultants' familiarity with regional traffic patterns and they are able to create and implement more effective timing plans. This increase in players from the consultants' aspect has provided a more competitive environment.

Lessons Learned

The region has faced several technological and institutional obstacles during the development and continued management of the RSTP and SMART Corridor program. All these difficulties can be linked to lack of effective communication. Effective communication fosters stronger relationships between organizations, which results in more efficient operations and project development. From a technical standpoint, effective communication improves trust in the field equipment and expands the capabilities of the overall system. Consistent results experienced from reliable communication between personnel to personnel; field equipment to field equipment; and personnel to field equipment has established a well-integrated regional timing plan.

The most effective means of coordinating traffic signals at intersections within several different jurisdictions is the installation of a GPS/time clock. The use of the time clock eliminates the need for interconnection between the signals. Despite the effectiveness gained by the installation of the time clock, however, interconnected communication between all the signals could further improve coordination strategies on several of the corridors. At the time this report was prepared, an estimated 50% of the 7,500 signals were interconnected. The cost to expand communication would be approximately $10,000 per project. One recommendation is to develop a program that would fund the installation of interconnected equipment. Until those funds are made available, the region will continue to pursue the use of GPS/time clocks to manage corridors within multiple jurisdictions.

MTC is constantly under political restraints and cost limitations for all their programs. One MTC strategy (*7*) is to analyze the regional needs for projects that meet the needs for multiple programs, such as "Safe Routes to School" or transit (*9*). Funding for each of the identified programs could be pooled to address regional needs and not just specific components.

Single–agency-operated corridors affecting multiple agencies need to further develop institutional and technical working environments. This coordination includes the involvement of transit agencies to improve the flow of transit vehicles on congested routes. Improved coordination also supports MTC's goal of elevating transit and light rail to a higher priority in the region.

Finally, if a region pursues the development of a program similar to the RSTP, it is important to develop clear guidelines on how to implement and manage the program. These guidelines will build credibility for the program because all parties will see consistent treatment of similar scenarios. These guidelines also will guide participants on how the program can support their operations.

Analysis and Research Observations

The MTC RSTP helped provide assistance and expertise for retiming traffic signals. MTC has retained a large pool of consultants for the signal timing projects. Because of the larger pool of candidate consultants, MTC is able to benefit from greater levels of expertise in the region and lower costs, which are a result of increased competition. The retiming projects have successfully reduced travel times, fuel consumption, and emissions, which has created a positive overall benefit-cost ratio for the region.

The local agencies are provided with opportunities for funding and engineering expertise that would not have been possible otherwise. With the approval of their project, MTC may hire additional consultants to help smaller communities with review of the signal plans. The project team typically has great communication between each other and clear goals for each project.

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CHAPTER 8

Analysis and Applicability to Other Agencies

When this project was initiated, the intent was to identify clearly defined integration points in successful business processes that demonstrate a link to improved travel time reliability. As the case studies evolved, two distinct aspects to process integration came to be identified as being critical to supporting reliability-focused operations: process integration at the operations level and at the institutional or programmatic level. Each poses different challenges in terms of process implementation, execution, and overall integration.

At the operations level, various processes and activities evolve and are coordinated among those who are responsible for overseeing or carrying out operational initiatives (such as steps a traffic management center operator takes to initiate notification to travelers). There is often a direct link between the process and the outcome (although it might take a collective set of processes to result in a significant outcome). Process integration at the programmatic level is a much more complex undertaking. Not only are there different constraints to be worked through at the institutional level, there is also a much less direct relationship between those programmatic processes and their contribution to travel time reliability. Yet, institutionalizing processes so that they influence training, staffing and resource management, planning, programming, and policy are essential enablers to effective business process integration.

This section is intended to aggregate the data collected through this research and present findings that can be applied by other agencies. The observations look at key players or stakeholders that are important to the effectiveness of a process, trends that are present within multiple agencies, gaps identified by the participants, and lessons learned from the agencies studied. The *Guide to Integrating Business Processes to Improve Travel Time Reliability* provides unique insights into how agencies can apply some of the findings from the research to examine their own process implementation and integration at both operations and institutional levels (*1*).

Influences to Process Initiation, Change, and Integration

Based on the analysis of the case studies and the feedback from participants at the L01 workshop (*2*), influences on business processes could be categorized into specific groups according to the event or directive that initiated the process change or process development. The categories were developed into three tiers, as follows:

- Major directive, or "top-down," approach: Includes legislative requirement or management-level goal or directive that requires implementing new processes or examining and revising existing approaches. Top-down directives can greatly accelerate the priority and pace of process change within an agency or among partners.
- Event-driven influence: There is a specific event or hazard that has prompted the need for improving operations, such as to support a large-scale event or breakdowns in operational processes during catastrophic events such as a hurricane evacuation or massive winter storm.
- Needs-based, or "bottom-up," approach: Processes that are initiated or coordinated at the operations level, often in response to specific activities or needs, such as day-to-day management of incidents, traffic signal operations, or enabling information exchanges for more effective real-time system management.

The range of influences makes it challenging to point to a specific catalyst or type of catalyst that is often the most successful in influencing processes and process change. Table 8.1 summarizes the three tiers and the types of influences that were identified as part of the case studies.

Table 8.1. Summary of Influences from Case Studies

Tier 1: Major Directive (Top Down)	
WSDOT/WSP Joint Operations Policy Statement	The executive leadership of WSDOT and WSP led the development of the Joint Operations Policy Statement (JOPS) Agreement. The leadership is responsible for review and signature of the JOPS Agreement each year. The JOPS Agreement also provided the basis for WSDOT and WSP to respond to the governor's request for top–down performance reporting on incident response and clearance times.
NCDOT Traffic and Safety Operations Committee	Based on the Federal Rule for Work Zones Traffic Control, DOTs are required to evaluate and manage work zones to minimize the impact on capacity and safety. This committee is one of the initiatives started in response to the rule.
Kansas Speedway Special-Event Traffic Management Plan	With the construction of a new raceway facility, there was a need to develop a coordinated strategy to effectively manage event traffic. KDOT received a directive from the governor of Kansas to develop a plan and provide funding for the necessary infrastructure improvements to support access to the Speedway location.
Tier 2: Event-Driven—Political, Public Relations	
Michigan DOT Work Zone Modeling	Michigan DOT needed a strategy to identify impacts on the Detroit-area freeway network resulting from a major reconstruction program on I-75.
I-80 State Line Closures	Periodic closures of I-80 at the California/Nevada state line and limited available truck parking and storage on the Nevada side has prompted a series of operational responses by Nevada DOT aimed at providing advance notification to freight traffic about the closures.
Tier 3: Needs Based/Opportunity Based/Grassroots	
FDOT Road Rangers	Expansion of a localized freeway service patrol program to a statewide program through public-private partnerships
The Palace of Auburn Hills Event Management Strategies	The Auburn Hills Police Department coordinated with the RCOC, MDOT, and the Palace to develop a comprehensive traffic management plan that decreased the required load-out time for the facility.
MTC Regional Signal Timing Program	The MTC RSTP was developed to provide funding for local agencies with limited traffic engineering resources with regionally significant corridors that cross through their jurisdiction.
AZTech Regional Data Server	With multiple traffic operations centers in the Phoenix metropolitan area managing several cross-jurisdictional corridors, a regional database was established to provide a central repository for agencies to provide and access information about real-time road network operations.
UK Active Traffic Management	The ATM was developed based on a safety analysis of key corridors in the UK and potential mitigation strategies to address those concerns.

Obstacles to Process Change

Whatever the influence, all agencies encounter varying obstacles when they begin to evaluate, implement, or modify a process. Some of these obstacles are common among agencies, whereas others are unique to individual agencies. Some of the obstacles can be conquered through modifications to the process; others may require institutional changes. The following obstacles were identified from the interviews and from conversations with the L01 workshop attendees. They represent a large sampling of the issues experienced by agencies across the country.

- Departments of transportation historically are focused on construction and maintenance and not on operations, although the operations focus is gaining more ground. Processes that tend to affect multiple divisions or groups within a DOT can often be difficult to change. Processes evolve differently among different divisions, even if they are part of the same overall organization. Communication among these groups varies; direct communication among divisions largely depends on their respective roles and how often they must interact in response to day-to-day operations needs. For instance, improvements to a process that involves traffic management center operational procedures and dispatching the DOT's in-house incident response team are likely to be much easier to achieve because the entities involved can collaborate on how to change or improve specific steps. When process change or improvement is dependent on upper-level divisions making modifications to resource management or allocation strategies in response to what the field response team needs to better support its operational activities, there are likely to be more justifications, research, or approvals required to implement process change. It is not a reflection of the change not being viewed as critical, but likely more attributed to the distance between these two divisions.

- Although reliability is emerging as an important metric among agencies, often it does not have an impact on process implementation or integration. Most, if not all, state DOTs have an overarching agency goal or directive to provide a system that supports mobility and provides safety for users, and these can translate into tangible operations improvements and programs. Travel time reliability and mitigating the effects of variability on the transportation network have not yet become engrained into the operations culture for many DOTs, although many of their activities for traffic management, traveler information, incident response, and weather hazard response all contribute to reliability. One exception identified within the case studies is WSDOT's 90-min incident clearance goal. The need to meet this goal has become such a critical part of both the DOT and the state police that tangible activities and processes have been implemented with the specific purpose of meeting this top-down directive.
- Because there are a range of agency stakeholders or partners that often contribute to reliability-focused strategies, it is important to consider that each will likely have a different motivation for process implementation or, more importantly, for process change. For a stakeholder to have a vested interest in modifying or changing operational processes, there needs to be a tangible benefit from the stakeholder's perspective. In some cases, broad objectives, such as reducing the time to clear a major event venue parking lot, can be a motivator, but often it will need to be an outcome that is closer to the division or agency, such as reducing the number of field staff by 75% to manage event venue parking lot clearance, which has a direct impact on resources, cost, overtime, training, and other factors. Understanding the unique language of the various stakeholder agencies can be important when trying to communicate the benefits of process change. WSDOT brought in a retired WSP district commander to serve as its incident response program manager. With his background in law enforcement, he was able to discuss incident management process change and implementation with WSP and communicate the benefits in a way that was more meaningful. Top-down directives also provide a certain level of motivation for process change, as there is typically a level of accountability associated with these directives.
- The process modeling that has been mapped out in the case studies may not be at a level that is typical of how a DOT, transportation agency, or other stakeholder would view individual operational processes. There is often a challenge in identifying critical gaps or breakdowns within specific processes because agencies might not typically approach assessing their operational activities with a supply-chain or business process perspective. In fact, a key challenge experienced by the research team was helping to align the concept of business processes to transportation operations during the interview process. Evaluations of operational programs, such as incident response and clearance times or before-and-after studies of throughput, will yield valuable information about whether processes are effective or not at a higher level, but might not provide enough information about specific steps that might need to be modified or about opportunities for more effective integration of processes.

Elements of Process Development and Integration

Process integration needs to occur at the operations level (in the field, in the center) and within the institution for it to extend to planning, programming, training, procurement, and other organization-level activities. Creating positive impacts to travel time reliability, or minimizing the negative impacts to variability in travel times, is rarely the result of operational processes from one source or one agency. As demonstrated through the case studies, there are multiple entities that carry out one or more steps in the process, and each individual step is an enabler to the success of the overall process.

Case studies presented in the research represent a range of potential processes and integration strategies. Each region or program profiled in the case studies has worked through unique institutional and operational factors, and processes have developed and evolved in response to different catalysts, many of them extremely localized. There are, however, benefits to be derived from these case studies that could be applied in other areas. Guidance from the workshop participants indicated that there would be more benefit in generalizing outcomes and deriving common elements from across the profiled processes. Figure 8.1 presents the generalized steps for mapping out business processes.

Influences: Each process description within the case studies was the result of a different catalyst or influence. There was either a top-down directive or a specific need that required the development of a solution.

Defining the Specific Reliability Goal: Feedback from the workshop stressed the importance of focusing on a specific problem that needs to be solved before focusing on the processes that would be required. Establishing a goal, such as incident clearance times, or identifying a need, such as mitigating truck queuing on an interstate, provides the benchmark by which specific stakeholders, actions, resources, and measures can then be derived. Reliability has not yet emerged as a common goal for transportation operations. There is a substantial focus on safety and mobility, as these can translate into much

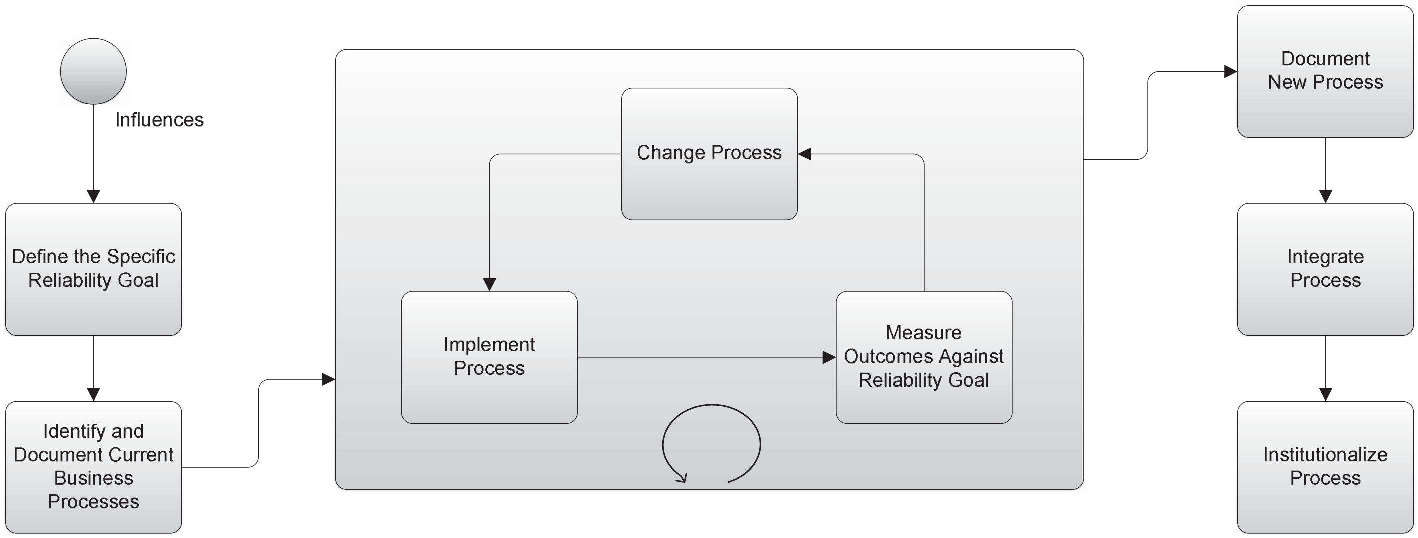

Figure 8.1. Business process mapping steps.

more tangible goals for departments of transportation and the public. Mobility can be difficult to capture in the context of a specific goal; supporting goals will often refer to improvements to travel time or reductions in delay, but even these may be difficult to convey to the public. The traveling public understands the big-picture concept of reliability because it directly affects their daily travel, but communicating system reliability and establishing reliability goals in a way that is meaningful to the public is a challenge.

Identify and Document Current Business Processes: This step is a gap in most current operational process assessments. Private-sector processes and industrial engineering often will focus on gathering information about current processes and flows and on identifying where the strengths and weaknesses are in the chain of events. Not completing this step risks overlooking roles, available resources, or operational activities that might be critical enablers to a more efficient process. Critical assessment can draw out important integration points (either existing integration points or potential integration strategies). It also provides a starting point for process documentation. Examples of BPMN have been included for each of the case studies profiled.

Implement Process: At the operations level, process development and implementation often occur as the result of grassroots efforts by staff and champions that are closest to the operational activities. Implementing or modifying current practices, coordinating with other agencies, and recommending more efficient systems to support operations, are all elements of process implementation. Often, as was demonstrated by the I-80 closures or the special-event management strategies, certain processes become engrained into a broader operations strategy. When processes need to be implemented upstream or are dependent on management from one or more divisions or agencies to support, a more formal approach to implementation will be needed.

It is important during process integration that all the appropriate stakeholders are involved. There needs to be buy-in from those who will provide inputs into the process and those who are affected by the process. In the MDOT case study, one of the challenges was coordinating changes that occurred in the field during construction with those responsible for doing the work zone traffic control modeling. The stakeholders in the field were critical and their input needed to be integrated into the overall process.

Measuring Outcomes Against Reliability Goals: Not all the case studies documented specific measures by which they evaluated their overall processes. Some have specific and formalized measures; others rely on less formal evaluations. Often, the directive or influence will have a direct impact on how the goal is measured. For operational processes, incremental or system measurements will indicate whether a process is working well or is not working at all. At the programmatic or institutional level, measuring process effectiveness in an incremental fashion might not translate into whether overall agency reliability goals are being achieved. Different measures might need to be applied at the programmatic or institutional level that consider trends, as well as the culmination of many subprocesses.

Measuring effectiveness or outcomes also provides an opportunity to periodically evaluate the effectiveness of various business processes and modify or change elements of the process if needed.

Document New Process: The case studies presented an option for how to take a critical look at modeling and assessing various processes for congestion management strategies. Not all agencies will want to make the investment in preparing detailed process models for all their operational activities, but documenting the key steps, relationships, information exchanges, and other factors can yield several benefits. This can be achieved through developing informal MOUs or more formal intergovernmental agreements to document roles, responsibilities, objectives, and expected outcomes. Operations manuals provide another mechanism for capturing details.

Integrate Process: Processes become integrated either through deliberate efforts or as a result of evolution over time. For a process to become part of day-to-day operations or to justify a change in current processes, there needs to be a demonstration of tangible benefits, both at the operations level (on the ground) and at the programmatic and institutional levels. Implementation can be a challenge but so is evolution and institutionalizing process change.

Once a process is developed, modifications may be needed to make it more tangible and meaningful to other entities that it could directly benefit. The MDOT Work Zone modeling case study provides an example of modifying a tool that was developed by the planning group into a tool that can be used by the construction engineer. Although the work zone model, developed using a microsimulation application, and the outputs are valuable and intuitive to planners and can provide important information to support better work zone scheduling, the tool is not in a format that the construction engineer can easily use to identify changing impacts in a work zone. MDOT has looked into how to translate the work zone model's planning product and outputs into a more usable tool for the construction engineering group, which would allow them to make modifications based on changing work zone configurations or schedules (at the time this report was prepared, this had not been completed). The ability to transfer that process demonstrates an important integration point and establishes a link between two divisions (planning and construction) that typically have limited coordination in the context of a large-scale reconstruction project.

Institutionalizing Business Processes: The final step to successful process integration is the ability to translate it into a core process within the organization. This requires more than adopting operational activities or processes and is dependent on buy-in and support by agency leaders. The next section describes the complexities of institutionalizing processes in more detail.

Institutionalizing Business Processes

The case studies suggest that implementing a process change and integrating various processes often occur at the operational level, but institutionalizing the process typically requires the participation and support from higher levels within an organization. Proven processes can benefit the organization and the participants for a few years, but institutionalizing a process is important to guarantee that it will sustain and evolve beyond the current players and champions. This section discusses the enablers used in many of the case studies to integrate successful business processes that affect travel time reliability.

The senior-level managers within an organization require certain motivators and incentives to implement a process change. Because DOT agencies are held accountable to the public, clearly identified performance measures and results can provide valuable tools for promoting the success of an agency. These performance measures also support the implementation of new processes by providing anticipated benefits to the public.

Evaluation methods and reporting abilities on the effectiveness of operations are critical. The ability to demonstrate that benefits are connected with specific actions or activities assists in building support and buy-in for the implementation of a process change. Access to documentation of proven processes and their associated performance measures allows management to more easily support new processes within an organization. Improved business processes can have high-level impacts for an organization, such as better resource management (including streamlining of staffing needs through partnering and automating of processes).

Many programs undergo an evolutionary process as they grow. They start small and with a limited scope and, over time, may expand in the services they offer and their geographic scope. Unlike processes that start on a large scale with wide-ranging objectives, programs that start small and evolve can sometimes be more easily institutionalized because there is not a great deal of mass to get moving and accepted into an institution. The FDOT Road Ranger case study provides a good example of a program that started locally and expanded over time. The program that was initially implemented in a single district has evolved into a statewide program that is now institutionalized at both the local and statewide levels.

It is noted that formal agreements may not directly contribute to the success of process integration, but the development of a formal agreement does provide strong support through documentation of the participating agencies' commitments. As personnel change, this documentation aids in maintaining the relationship between the players, thereby strengthening the relationships. WSDOT and AZTech both use formal agreements to document the commitment from the participating agencies. WSDOT requires an annual approval and signature from the directors of the DOT and state police for the JOPS Agreement. This reaffirms the commitment from the agencies and promotes consistency as directors change. AZTech uses agreements as agencies join the regional database to clearly state the expectations and requirements placed on each agency. Updates to the agreements are only required if the roles and responsibilities change. The MTC Regional Signal Timing Program requires the approval of the MTC board.

Since this program includes a funding mechanism for local agencies to access, it is understandable that the Board's approval is required. At the time this report was written, the program planned to sunset in late 2009 and the program would once again need to be supported by the MTC board members. Approval of the program demonstrates to the staff members that the organization is in support of the program.

Institutionalization is the final stage for implementing a process change. It should include clear documentation of the process, the roles and responsibilities of the players, and the performance metrics used to evaluate the effectiveness. The level of documentation will be unique to each organization, but should reflect the complexity of the business process and the level of commitment from senior management.

Benefits

As noted, process integration can be divided into two distinct aspects: the operational level and the institutional level. Through the case study development process, unique benefits were identified that result from process integration at both the operational level and the programmatic and institutional levels. Benefits can include increased efficiency, savings in financial and staff resources, increased scalability and flexibility of systems, and, ultimately, processes that are more integrated into an institution.

For any process to remain beneficial, the process should be developed in such a way that it allows for innovation to be integrated into the process. Processes that are not flexible and remain static may be effective initially in improving travel time reliability, but as travel conditions, travel patterns, and other factors that affect reliability change over time, a process that is static may lose its effectiveness.

Operational Level

Process integration can improve an agency's ability to effectively use its resources and provide financial savings as a result of improved cooperation, reduced capital expenditures, and efficient use of staff. For example, in Florida, the Road Ranger program's integration with private sector tow providers has reduced the need for FDOT to purchase towing equipment and bring on permanent staff to support the Road Ranger program. FDOT's use of private sponsors to support the Road Ranger program reduces their overall capital expenditures. In Kansas, the Highway Patrol relies on portable DMS that KDOT brings in from around the state to support major events. By using existing DMS, both agencies realize a cost savings and efficiency is increased because KDOT is more familiar with the operation of portable DMS than KHP. In Nevada, NDOT works closely with the Highway Patrol during winter closures of I-80 to set up truck-turnaround locations and ensure that trucks do not park on I-80 during closures of the Nevada/California border.

Process integration can allow agencies to plan for an integrated system that can be implemented in a scalable format that can grow commensurate with needs. By integrating agencies and processes early in the planning process, agencies are less likely to miss opportunities for integration and more likely to build systems that can expand to meet future needs. In Phoenix, the AZTech Regional Archived Data Server was designed using input gathered at the start of the process from the AZTech partner agencies. Not all agencies immediately used the server; however, because of its scalable design, it can grow and allow additional partners to join as needed.

The formal documentation of a process and any changes to the process will allow agencies to identify any correlation that might exist between changes to the process and performance metrics. As changes are made to a process, it is important to determine if those changes result in measurable differences in performance. By documenting a process and resulting changes, agencies can record the processes they follow and compare changes in the process with changes in performance metrics.

Programmatic/Institutional Level

By developing an integrated process, agencies can define clear responsibilities that can improve cooperation and trust, because each agency and department understands its role and its partner agency's role in effectively carrying out a process. If these roles and responsibilities are documented, an additional benefit can be provided because it keeps a record of roles and responsibilities that should not change even if personnel change. In the case study for the Kansas Speedway, both KDOT and the Highway Patrol noted that one of the reasons for the success of their special-event traffic management was that both agencies clearly understand their roles and responsibilities and how these affect all their partner agencies.

Buy-in from higher-level management at agencies is also a key to establishing a process that is effective and remains in place. Processes that have support from the upper levels of management are more likely to remain in place and be viewed as a high priority by all levels of staff within an agency. In Washington State, the JOPS Agreement between WSDOT and WSP formalizes roles of staff at the DOT and State Patrol and is signed each year by the WSDOT secretary of transportation and the chief of WSP. The agreement assigns individuals from WSDOT and WSP to lead each program covered by the agreement and makes them accountable for its success.

National Action

The interviews for the case study and discussion held during the L01 workshop clearly showed that there were many benefits to developing integrated processes (*2*). At both the operational and programmatic levels, agencies were able to improve process efficiency, decrease costs, and implement changes that resulted in measurable travel time reliability improvements.

The challenge that remains is to take the lessons learned from the case studies and workshop and use them to assist other agencies in examining their own business processes and looking for gaps (or opportunities) in process integration. It was evident through the case studies that there is no one-size-fits-all approach to business process integration. The influences that led to process changes varied among three categories: major directives, event-driven, or needs-based. The differences in the organizations of agencies throughout the country, institutional arrangements, political climate, and many other variables mean that process integration will happen in different ways and at different paces in different areas.

Greater focus should be placed on assisting agencies with integration of business processes at the institutional or programmatic level rather than at the operational level. At the operational level, processes vary and are usually coordinated among those who are responsible for carrying out operational initiatives. An example was provided earlier in this chapter of the steps a traffic management center operator takes to initiate notification to travelers. Changes to an operational process such as this typically involve fewer agencies and people and can be more easily evaluated to determine if a change that has been made is effective and of value.

Institutional- or programmatic-level changes to processes tend to be more challenging to implement, as well as more challenging to institutionalize. In the L01 workshop in Phoenix, the participants were particularly interested in how agencies made the transformation of implementing and institutionalizing programmatic-level changes (*2*). The actual process itself was not as useful, because processes will vary throughout the country based on specific needs and goals for travel time reliability. But how a process was implemented and institutionalized can provide valuable information to other agencies and enable them to more successfully implement and institutionalize their own programmatic changes.

A training course or workshop based on case studies across the country with a focus on the elements that led an agency to implement and institutionalize a programmatic change could be one forum to help elevate process integration within agencies. The workshops could be designed to provide both general case study reviews and focus on specific needs in a region. Action plans for implementing and institutionalizing specific business processes for better travel time reliability could be the result of the workshops. As part of the workshops, a method of documenting business processes, such as the BPMN presented in Chapter 2 could be taught. Use of BPMN is certainly not required to implement processes, but it does provide a useful method of documenting existing processes and developing future processes that provide the level of integration necessary to improve travel time reliability.

A training course or workshop should also emphasize the enablers that led to the institutionalization of business processes that are presented in this chapter (Institutionalizing Business Processes). Enablers included evaluation methods that allow an agency to determine the impact of a process change, performance measurement programs that allow an agency to track the benefits of a change, and formal agreements that document a process change and specify the role of each agency's involvement. The course can also emphasize the role of business processes in developing regional ITS architectures and systems engineering analysis. Both the architecture and the system engineering analysis efforts can be effective methods of assisting agencies in developing more efficient and integrated processes.

Ultimately, the successful integration of business processes will depend on the staffs of various agencies at all levels working together toward a common goal of improved travel time reliability. Presenting examples of successfully integrated business processes, as well as providing assistance through workshops to develop action plans for agencies, may serve as a catalyst for a region. These types of workshops will not provide instant results but could help agencies throughout the country to move further along on their own path toward optimizing their systems and providing improved travel time reliability.

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