U.S. Department of Transportation

Arterial Management: Surveillance, Lane Management, Parking Management, Information Dissemination, and Enforcement

ITS Benefits, Costs, and Lessons Learned: 2017 Update Report

Arterial Management

Surveillance
Traffic Control
Lane Management
Parking Management
Information Dissemination
Enforcement

Highlights

- A Bay Area Rapid Transit (BART) smart parking system found that more efficient management of transit station parking lots improved parking space utilization rates and increased BART ridership.
- Automated enforcement continues to demonstrate that it is a successful, cost-effective means of reducing traffic accidents, injuries, and deaths.

Introduction

This factsheet is based on past evaluation data contained in the ITS Knowledge Resources database at: www.itskrs.its.dot.gov. The database is maintained by the U.S. DOT's ITS JPO Evaluation Program to support informed decision making regarding ITS investments by tracking the effectiveness of deployed ITS. The factsheet presents benefits, costs and lessons learned from past evaluations of ITS projects.

Arterial management systems manage traffic along arterial roadways, employing vehicle detectors, traffic signals, and various means of communicating information to travelers. These systems make use of information collected by traffic surveillance and detection technologies such as microwave or video imaging detector systems (VIDS) to smooth the flow of traffic along travel corridors. They also disseminate important information about travel conditions to travelers via technologies such as dynamic message signs (DMS), highway advisory radio (HAR), or mobile devices. Traffic sensors and surveillance devices may also be used to monitor critical transportation infrastructure for security purposes.

A variety of techniques are available to manage the travel lanes available on arterial roadways, and ITS applications can support many of these strategies. Examples include dynamic posting of high-occupancy vehicle restrictions and the use of reversible flow lanes allowing more lanes of travel in the peak direction of travel during peak periods. Variable speed limits (VSL) can be used to adjust speed limits in real-time based on changing traffic conditions, adverse weather, and work zone activities. Parking management systems, most commonly deployed in urban centers or at modal transfer points such as airports and outlying transit stations, monitor the availability of parking and disseminate the information to drivers, reducing traveler frustration and congestion associated with searching for parking spaces. Transportation agencies can share information collected by arterial management systems with road users through technologies within the arterial network, such as DMS and HAR. They may also share this information with travelers via broader traveler information programs such as 511, the Internet, and most recently with smartphone applications. Arterial management systems may also include automated

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enforcement programs that increase compliance with speed limits, traffic signals, or other traffic control devices. Arterial management systems can also apply unique operating schemes for traffic signals, portable or dedicated DMS, and other ITS components to smooth traffic flow during special events.

Information sharing between agencies operating arterial roadways and those operating other portions of the transportation network can also have a positive impact on the operation of the transportation system. Examples include coordinating operations with a freeway management system, or providing arterial information to a traveler information system covering multiple roadways and public transit facilities.

The most prevalent ITS technologies used along arterials are traffic signal systems. There are many different applications for traffic signals including advanced systems, adaptive systems, and different types of preemption and priority. The arterial management taxonomy has been divided into two chapters: one addressing the benefits, costs and lessons of traffic control technologies and this chapter addressing other technologies such as parking management, variable speed limits, automated enforcement and information dissemination.

In addition, regional operations can provide coordinated strategies and applications that tie arterial management systems with other applications such as freeway management, transit management and transportation management centers. An example of this coordination is the Integrated Corridor Management (ICM) program. Additional information on the interaction of arterial management systems with these other technologies is further explored in other chapters within this report.

Benefits

Parking Management

Parking management systems with information dissemination capabilities, most commonly deployed in urban centers or at modal transfer points such as airports, monitor the availability of parking and disseminate the information to drivers, reducing traveler frustration and congestion associated with searching for parking.

Variable Speed Limits

Variable speed limits are speed limits that change relative to road, traffic, and environmental conditions. Traffic managers use variable speed limits to warn the driver that driving conditions are not conducive to the normal posted speed and speeds should be adjusted accordingly. Variable speed limit systems use sensors and/or vehicle probe data to monitor prevailing traffic, weather, and environmental conditions to determine the most efficient speed limits. Speed limits may be communicated to drivers via in-vehicle systems or DMS. These speed limits may or may not be enforced the same as normal speed limit signs, depending on the policies of state and local jurisdictions.

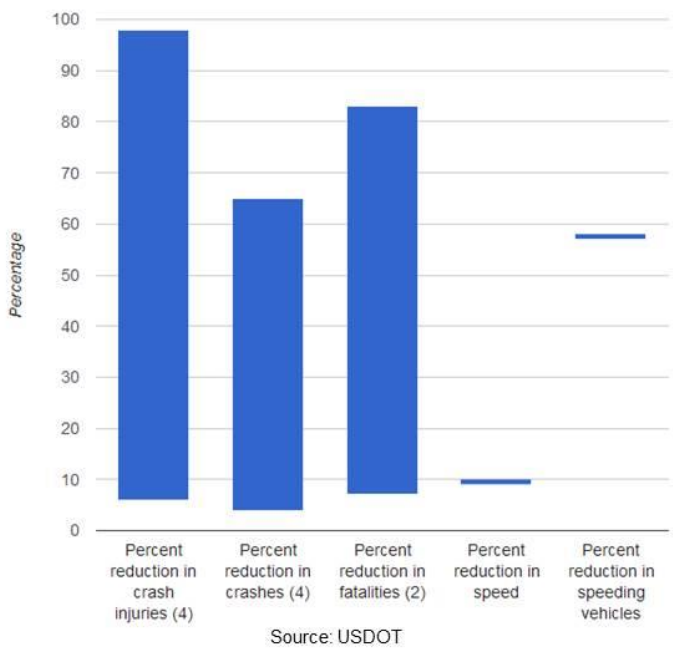

Figure 1: Safety Benefit Metrics Used in Studies of Speed Enforcement (Source: ITS Knowledge Resources).

The online versions of the factsheets feature interactive graphs that contain all the data points included in the ranges. Here, each metric has a number after the text, representing the number of data points used to create the range; no number means only there was only one data point.

Information Dissemination

Motorists are able to receive relevant information on location-specific traffic conditions in a number of ways, including DMS, HAR, and in-vehicle messages.

Transportation operations staff can share information collected by sensors or vehicles associated with arterial management systems with road users through technologies within the arterial network, such as DMS or HAR. Traffic management staff may also send information to in-vehicle devices capable of displaying traveler information. Coordination with regional or multimodal traveler information efforts, as well as freeway and incident management programs, can increase the availability of information on arterial travel conditions.

Table 1: Benefits of Arterial Management

Application	Selected Findings
Parking Management	In St. Paul, Minnesota, an advanced parking management system reduced travel times by nine percent. (2008-00508)
Parking Management	Thirty percent of commuters would like to see an expansion of the Automated Parking Information System (APIS) that provides heavy-rail commuters with station parking availability information at en-route roadside locations. (2011-00702)
Parking Management	A Bay Area Rapid Transit (BART) smart parking system encouraged 30 percent of surveyed travelers to use transit instead of driving alone to their place of work. The smart parking project found that more efficient management of transit station parking lots improved parking space utilization rates and increased BART ridership. (2011-00695)
Information Dissemination	An overheight warning system at a CSX bridge in Maryland decreased the number of tractor-trailer incidents by 75 percent. (2011-00750)
Information Dissemination	Simulation models show that real-time on-board driver assistance systems that recommend proper following distances can improve fuel economy by approximately 10 percent. (2010-00645)
Traffic Control/Variable Speed Limits	Local traffic measures such as controlling traffic demand, banning heavy duty vehicles or restricting speeds activated only during periods of peak pollution can contribute to significant reductions in air quality measures. (2011-00754)

Automated enforcement systems, such as speed enforcement and stop/yield enforcement, improve safety, reduce aggressive driving, and assist in the enforcement of traffic signals and speed limit compliance. Still or video cameras, activated by detectors or radar, can record vehicles traveling through a red signal or traveling faster than the speed limit. Speed enforcement cameras can also be portable and set up along the side of the roadway or even within a vehicle such as a van to enable more flexibility in the enforcement strategy.

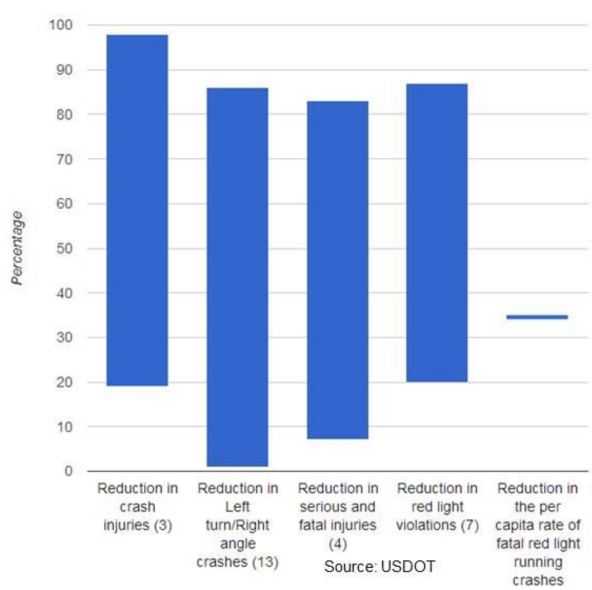

Figure 2: Range of Benefits for Automated Red Light Running Enforcement (Source: ITS Knowledge Resources).

The Governors Highway Safety Association strongly supports the use of automated enforcement to enforce red light running and speeding violations. Education and engineering solutions continue to be important in combatting red light running and reducing speeding; however, automated enforcement is another effective tool [1].

Automated enforcement continues to demonstrate that it is a successful, cost-effective means of reducing traffic accidents, injuries, and deaths.

Costs

A smart parking field test conducted for the California Department of Transportation and the Bay Area Rapid Transit estimated capital cost at $150 to $250 per space; O&M costs were estimated at $40 to $60 per space. The smart parking system permitted pre-trip as well as en-route trip planning. Motorists could reserve a parking space at the Rockridge BART station up to two weeks in advance. While en-route and faced with congestion on Highway 24, motorists could see the display of real-time parking availability at the station lot and decide to use transit. Key passenger-interface technologies used in the field test were:

- Two portable DMSs, located on Highway 24, which displayed parking availability information to motorists.
- A centralized intelligent reservation system that enabled commuters to check the availability of parking spaces and then to reserve a space via telephone, mobile phone, Internet, or personal digital assistant (PDA). The intelligent reservation system used the up-to-the-minute counts of parking availability obtained through the vehicle count data from the entrance and exit sensors at the BART station parking lot.

Fifty (50) parking spaces, of the 920 total, were made available for the smart parking field test – 15 for advance reservations and the remaining for same-day reservations by commuters who, upon seeing the DMSs on Highway 24, opted to take BART (2008-00134).

Lessons Learned

In planning for a demand-responsive pricing based parking management system, involve executive leadership, seek strong intellectual foundations, strike the right balance between complexity and simplicity, and emphasize data collection and project evaluation.

The SFpark pilot project of the San Francisco Municipal Transportation Agency (SFMTA) uses a demand-based approach to adjusting parking rates at metered parking spaces in the SFpark pilot areas and at SFpark garages. SFpark's combination of time-of-day demand-responsive pricing and off-peak discounts at garages is expected to reduce circling and double-parking, as well as influence when and how people choose to travel. Lessons learned from the project planning aspect of the SFpark pilot project are presented below:

- **Do not underestimate the scope of work.** It is easy to underestimate the scope, magnitude, and technological sophistication necessary to offer real-time parking data and provide demand responsive pricing. Agencies should develop the scope carefully incorporating expectations as well as challenges.
- **Involve executive leadership.** Many challenges accompanied planning and implementing a ground-breaking project with complex technology, significant policy changes, and a large amount of discovery and uncertainty. The support of a dedicated executive at the agency was critical, as was having appropriate financial resources.
- **Understand the parking supply.** Starting with the maxim that "you can't manage what you can't measure," the SFMTA collected comprehensive data about San Francisco's publicly available parking supply, both on and off-street, including existing parking regulations. Enabled by data, understanding the existing parking supply characteristics was a critical first step in the planning and implementation of the SFpark pilot project and will be just as important for its evaluation.

- **Seek strong and coherent intellectual foundations.** SFpark parking management approach was based on the pioneering academic work of Professor Donald Shoup from University of California, Los Angeles. Those foundations made it easier to develop policies, goals, and tools that were easily communicated and understood by customers. An academic advisory team offered early guidance and support for the design of the SFpark demonstration and how it could offer valuable data for evaluation of outcome.
- **Strike the right balance between complexity and simplicity.** SFpark had to balance the potential complexity of managing parking effectively with the need to have something simple enough to be communicated clearly and quickly to customers. It had to strike a similar technological balance between what is desirable and what is feasible.
- **Emphasize data collection and project evaluation.** As a federally funded demonstration of a new approach to managing parking, the SFpark project is collecting an unprecedented data set to enable a thorough evaluation of its effectiveness. This improved the project's credibility among stakeholders.

The SFpark experience emphasizes the need for adequate planning when a demand-responsive pricing based parking management system is considered for implementation. Cities around the world are interested in the common and urgent goals of reducing traffic congestion and transportation related greenhouse gas emissions. To the extent that SFpark successfully manages parking supply and demand, rates, and reduces congestion and emissions, the project is relevant to other cities as well because it is easily replicable. SFpark is expected to improve traffic flow, reduce congestion and greenhouse gas emissions, increase safety for all road users, and enhance quality of life (2012-00621).

Install message signs at strategic locations to provide commuters en route with real-time information of the parking availability status at a major transit station.

An evaluation of automated parking information system in the vicinity of the WMATA Glenmont Metro parking facility shows that the signs displayed at Georgia Avenue, Norbeck Road, and Glenallen Avenue are an effective tool to inform commuters about the parking availability at the Glenmont Metro Station parking facility. The system helps reduce congestion and improve mobility around the parking facility, and increases customer satisfaction. The automated parking information system at Glenmont Metro Station is intended to provide real-time information to commuters about the availability of parking spaces at the Glenmont Metro Station parking facility. If spaces are not available at the Glenmont facility, commuters are directed to use other lots with available spaces, especially the underutilized Norbeck Road park-and-ride lot and the Wheaton Metro Station parking facility (2011-00597).

Case Study – Utah DOT Weather Responsive Traffic Signal Timing

Utah DOT (UDOT) is among one of the first DOTs in the country to use real-time traffic signal performance metrics to optimize traffic signal coordination. In 2011, the Federal Highway Administration's (FHWA) Road Weather Management Program (RWMP) initiated a project to document existing strategies for Weather Responsive Traffic Management (WRTM), identify improvements to the strategies, and develop implementable Concepts of Operations (ConOps) for the improved strategies. UDOT was selected as the partner to implement a traffic signal timing strategy.

In this deployment, UDOT developed and tested an advanced concept for expanding operations of weather responsive signal operations to corridors outside of the Salt Lake City area. The intent of the project was to make UDOT's traffic signal systems more responsive to changes in traffic demands and travel speeds during severe winter conditions. UDOT examined how the weather responsive signal system, coupled with additional detection technology, could be used to better monitor and operate traffic signals during significant weather events in the Riverdale Road corridor. Riverdale Road is a northeast-southwest oriented road that carries traffic between I-84 and US-89 in Ogden, Utah. This segment is primarily a 6-lane road with 11 traffic signals [2]. It carries about 30,000 vehicles on an average weekday. Signal spacing ranges from 700 feet to over 3,000 feet.

UDOT tested the system through the corridor, allowing traffic signal operators to anticipate when weather conditions deteriorate to the point of impacting travel speeds in the corridor. Once aware of the impending deterioration, the system allows the operators to deploy traffic signal timing plans that best match the prevailing travel conditions in the corridor. For this, UDOT used a traffic signal performance monitoring system based on near real-time speed metrics and the Purdue Coordination Diagrams (PCD's) to measure and fine-tune the signal timing plans

An evaluation of the project found that UDOT was able to maintain near non-weather levels of progression, or higher, during inclement weather events by implementing weather responsive traffic signal timings along Riverdale Road [4]. The evaluation showed that total travel times and corridor-level travel times were less when the weather responsive timing plans were deployed in the corridor during inclement weather compared to normal time-of-day timing plans under the same weather and traffic conditions. A summary of the benefits is presented below, grouped by performance category:

Improving responsiveness to different inclement weather conditions:

- The UDOT Traffic Signal Manager rated the overall operation of the deployed signal plans during the weather events to be average or above average in eight of the thirteen events where weather responsive signal timing plans were implemented.
- UDOT operators commented that the system reduced the number of "stuck intersections" during adverse weather as maintenance personnel did not have to respond to malfunctioning detectors not detecting vehicles.

Maintaining a high quality of progression during inclement weather:

- When aggregated over all the intersections, implementing a weather responsive timing plan where recalls were not used provided the main-street the same level of performance (if not slightly better) as the normal, time-of-day control during non-weather events.
- Except in a few situations, the quality of progression provided by the weather responsive timing plans were similar or better than that provided by the normal (non-weather) traffic signal timing plans.

Maximizing signal system performance during different types of weather conditions:

- Cumulative travel time reduced 4.3 percent by deploying the weather responsive timing plans.
- Cumulative stopped time reduced 11.2 percent when compared to using the current time-of-day plans during the snow event.

Maintaining equitable service to the cross-streets during different weather conditions:

- While cross-street data was not collected as part of the observed data, Modeled results showed improvements for all impacted vehicles including cross-street traffic. Cumulative travel times improved by 3 percent and overall stopped times by 14.45 percent.

References

[1] *Speed and Red Light Cameras*. Governors Highway Safety Association. http://www.ghsa.org/html/issues/auto_enforce.html

[2] Taylor, M. (2014, August 14). Weather-Responsive Traffic Signal Control in Utah. Salt Lake City, Utah. Retrieved from http://www.its.dot.gov/presentations/Road_Weather2014/10A%20WRTM%20UDOT%20Weather%20Responsive%20Traffic%20Signal%20Management%20in%20Utah%208-14-14.pdf

[3] Haseman, R., Day, C., & Bullock, D. (2010). Using Performance Measures To Improve Signal System Performance. West Lafayette: Purdue University.

[4] Balke, K., & Gopalakrishna, D. (2013). Utah DOT Weather Responsive Traffic Signal Timing. Washington DC: Federal Highway Administration. Retrieved from http://ntl.bts.gov/lib/51000/51100/51165/C42F9252.pdf

All other data referenced is available through the ITS Knowledge Resources Database, which can be found at http://www.itsknowledgeresources.its.dot.gov/.