U.S. Department of Transportation

Executive Summary

ITS Benefits, Costs, and Lessons Learned: 2014 Update Report

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Executive Summary

Intelligent transportation systems (ITS) provide a proven set of strategies for advancing transportation safety, mobility, and environmental sustainability by integrating communication and information technology applications into the management and operation of the transportation system across all modes. In the future, ITS technologies will transform surface transportation by offering a connected environment among vehicles, the infrastructure and passengers' wireless devices, allowing drivers to send and receive real-time information about potential hazards and road conditions.

The U.S. Department of Transportation's (U.S. DOT) ITS research program focuses on the overall advancement of ITS through investments in emerging ITS technologies, as well as supporting the evaluation of deployed ITS. This report presents information on the benefits, costs, and lessons learned regarding ITS planning, deployment, and operations obtained from almost twenty years of evaluation data.

The report is based upon three related Web-based databases, known collectively as the ITS Knowledge Resources (KRs). The Knowledge Resources were developed by the U.S. DOT's ITS Joint Program Office (JPO) evaluation program to support informed decision making regarding ITS investments by tracking the effectiveness of deployed ITS. The Knowledge Resources contain over eighteen years of summaries of the benefits, costs, and lessons learned of specific ITS implementations, drawn primarily from written sources such as ITS evaluation studies, research syntheses, handbooks, journal articles, and conference papers. They can be accessed online at www.itskrs.its.dot.gov.

The report has been developed as a collection of factsheets presenting information on the performance of deployed ITS, as well as information on the costs and lessons learned regarding ITS deployment and operations. The report has been designed to be flexible for the user. The purpose is to make the information readily available, whether by accessing it through the web, a mobile device or tablet, or by printing sections on one or more application areas. There are a total of 20 factsheets representing the 16 taxonomy areas. Four of the taxonomy areas (arterial management, freeway management, transit management, and driver assistance) have enough data to require more than one factsheet.

Findings

As of April 2, 2014, there were a total of 1,668 summaries of ITS benefits, costs, and lessons learned in the ITS Knowledge Resources databases from the United States and around the world, as shown in Table 1. Of the 1,668 summaries, 325 summaries have been added since the last report was completed in late 2011.

Table 1: Summaries in the Knowledge Resources Databases.

Summary Type	Number of Summaries
Benefits	804
Costs	282
Lessons Learned	582
Total	1,668

Table 2: Summaries by Taxonomy/Application Area.

Taxonomy/Application Area	Number of Benefit Summaries	Number of Cost Summaries	Number of Lesson Summaries
Arterial Management	147	54	67
Freeway Management	104	48	100
Roadway Operations & Maintenance	63	29	36
Crash Prevention & Safety	83	37	16
Road Weather Management	61	47	37
Transportation Management Centers	17	47	67
Alternative Fuels	1	0	0
Traffic Incident Management	71	40	66
Transit Management	106	45	74
Emergency Management	16	17	39
Traveler Information	85	39	73
Driver Assistance	85	22	18
Information Management	10	8	28
Commercial Vehicle Operations	63	21	18
Intermodal Freight	20	3	13
Electronic Payment & Pricing	81	36	73

An important addition to the Knowledge Resources in the last three years is the inclusion of benefit, cost, and lessons learned summaries for the Connected Vehicle Program, the Urban Partnership Agreement Program and the Integrated Corridor Management (ICM) Program. As these programs continue to evolve and become deployed across the country, the number of summaries will continue to increase, providing timely data to those interested in deploying similar technologies. Table 3 below shows the number of summaries in each of these areas.

Table 3: Summaries by Program Area.

Program Area	Number of Benefit Summaries	Number of Cost Summaries	Number of Lesson Summaries
Connected Vehicle	16	0	0
Urban Partnerships	4	0	7
ICM	6	3	13

Geographic Location of Summaries

Figure 1 shows the distribution of the summaries across the United States. There are also 214 international summaries located outside the United States. The relative size of the circle in each state corresponds to the total number of summaries in that state, with the section of the circle shown as blue, red, or tan representing the proportion of benefits, costs, and lessons learned summaries. In general, the number of summaries in the Knowledge Resources closely aligns with the level of deployed ITS, with some of the larger states providing the higher number of summaries (for example, California, followed by Florida, Washington, Texas, Minnesota, New York, Michigan, Virginia, Maryland, Illinois). As shown in the bottom left of the figure, 229 summaries are classified as nationwide rather than attributed to a specific state or states. Nationwide summaries are often based upon the experiences of several states, such as from a crosscutting study, or are based on average values from survey results across the U.S.

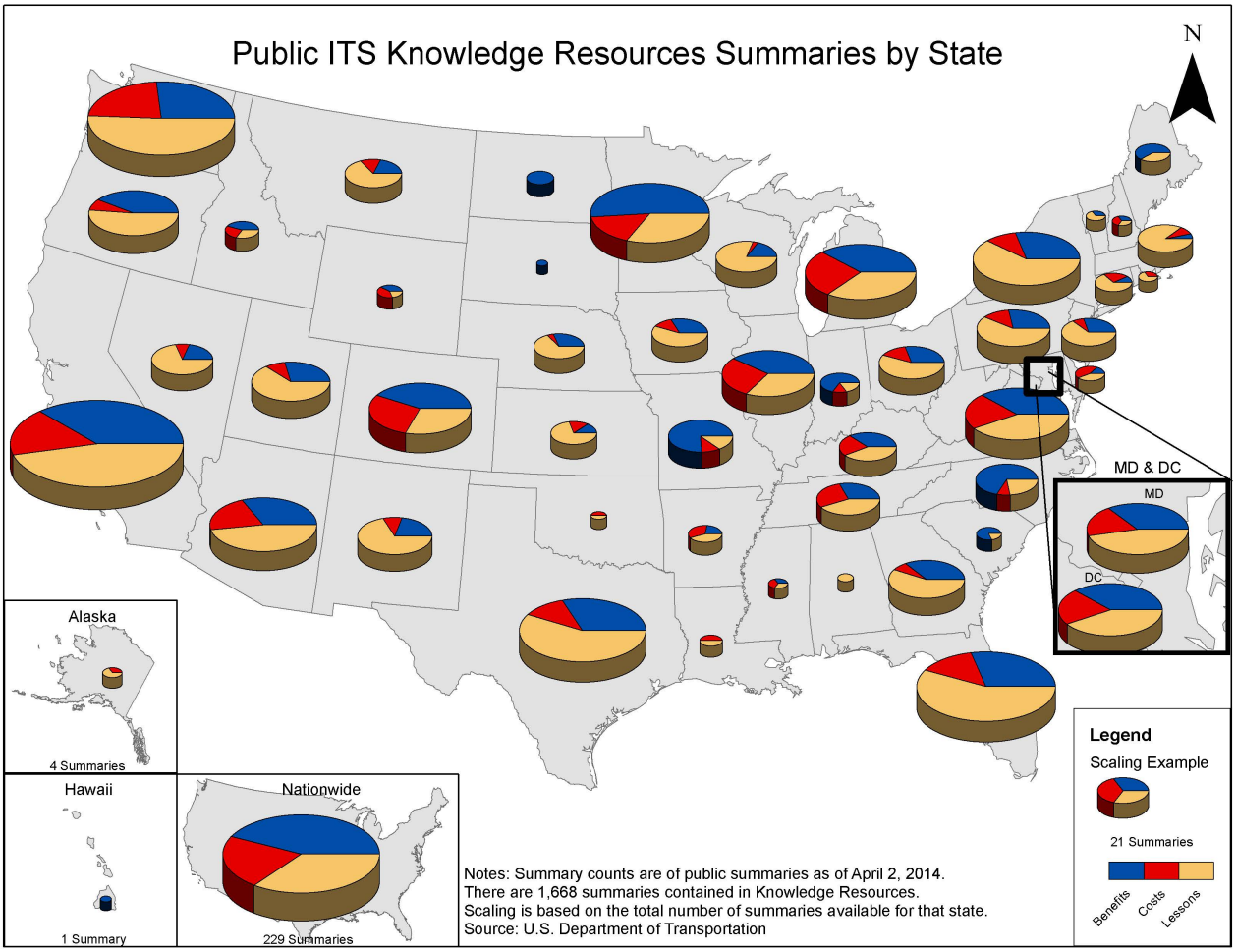

Figure 1: ITS Knowledge Resource Summaries by State.

Several observations can be drawn from this geographic information:

- States with large numbers of summaries generally are those with larger metropolitan areas, where more ITS is likely to have been implemented, while predominately rural states, such as those in the Midwest and upper New England, tend to have fewer summaries in the Knowledge Resources.
- Some states can be identified as “early adopters” of ITS technologies, having been involved in model deployment projects and field operational tests. Many of these states continue to evaluate their systems on a yearly basis, see the benefits from their ITS investments, and continue to expand their systems. Florida and Washington, for example, consistently do yearly evaluations.
- Other states in the same region can benefit from these early ITS investments by using the evaluation data summarized in the Knowledge Resources to choose cost effective technologies, which provide substantial impact, while avoiding common pitfalls in implementation.

ITS Evaluation Highlights

In the eighteen years that the ITS JPO has been tracking the evaluation of ITS technologies, there has been steady growth in the number of studies documenting the benefits, costs and lessons learned of ITS. Looking back over the last three years, the most recent additions to the ITS knowledge resources indicate the following evaluation highlights from each of the Application Areas:

Arterial Management

- 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 (2011-00695).
- Local traffic measures such as controlling traffic demand, banning heavy duty vehicles or restricting speeds during periods of peak pollution can contribute to significant reductions in air quality measures (2011-00754).
- SPaT applications, used in the connected vehicle environment, have the potential to increase safety, mobility, and reduce environmental impact at traffic signals.
- Improved traffic signal control continues to be one of the most cost effective ways to improve safety and mobility in most jurisdictions.

Freeway Management

- Technologies such as adaptive ramp metering, variable speed limits, dynamic merging, dynamic pricing, and information dissemination can influence traveler behavior in real-time to improve safety, reduce emissions, and improve system efficiency and reliability.
- Variable Speed Limit (VSL) systems have been shown to reduce crash occurrence and can also reduce system travel time and vehicle emissions through increased uniformity in traffic speeds.
- With Integrated Corridor Management (ICM), transportation professionals can manage the transportation corridor as a multimodal system rather than a fragmented network of individual assets. ICM solutions projected benefit-cost ratios range from 10:1 to 25:1 over 10 years.

Roadway Operations & Maintenance

- Mitigation strategies for roadway operations have shifted from a capacity-oriented approach that relies on increasing capacity to reduce travel times, to a reliability-oriented approach that focuses on maintaining existing capacity while minimizing disruptions to improve travel time reliability.
- Portable Traffic Management Systems (PTMS) can be rapidly deployed to improve safety and mobility regardless of work zone location. These systems can automatically monitor traffic conditions and communicate with vehicles and drivers to improve situational awareness, harmonize traffic flow, and lessen the impacts of reduced capacity at work zones.

Crash Prevention & Safety

- Crash avoidance technologies have been shown to decrease crashes and can reduce occurrences of driver injury and fatalities by up to 57 percent.
- The new wave of crash prevention and safety strategies includes the integration of vehicle and infrastructure safety systems and implementation of connected vehicle technologies for safety applications.

Road Weather Management

- Three types of mitigation measures may be employed in response to environmental threats: advisory, control, and treatment strategies. Advisory strategies provide information on prevailing and predicted conditions to both transportation managers and motorists. Control strategies alter the state of roadway devices to permit or restrict traffic flow and regulate roadway capacity. Treatment strategies supply resources to roadways to minimize or eliminate weather impacts.
- Weather-Responsive Traffic Management systems have the potential to reduce rear-end conflicts by approximately 22 percent for moderate volume levels and 43 percent for high volume.

Alternative Fuels

- Wireless charging technologies will allow drivers to charge their electric vehicles in small amounts on a more frequent basis. Dynamic charging may complement local stationary charging, removing range anxiety. As a result, electric batteries could be smaller, with the resulting reduction in electric vehicle cost and weight.
- The potential benefits of a catenary-accessible hybrid truck platform may be significant. Trucks, when connected to the catenary system, will have zero-emissions which can significantly reduce overall emissions along a corridor.

Transportation Management Centers

- Recent initiatives and concepts such as Integrated Corridor Management (ICM) and Active Traffic and Demand Management (ATDM) integrate more functionality into a single center for more responsive or even predictive traffic operation strategies.
- TMCs are collecting more and more data with the potential to collect data directly from vehicles in the near future. Social media is being used to disseminate traveler information, while crowdsourced data is being used to gather data from drivers to get travel times, incidents, and other roadway information from driver reports.

Traffic Incident Management

- Benefit-cost analysis of Incident Management Systems show that these systems have a high return on investment with B/C ratios ranging from more than 4:1 to over 38:1.
- Incident management programs have the ability to significantly reduce the duration and clearance time of traffic incidents, resulting in significant reductions in vehicle delay, fuel consumption and secondary crashes.

Transit Management

- Providing transit travel times and departure information on highways can lead to a 1.6 to 7.9 percent mode shift from automobile to transit.
- The use of traveler information tools such as trip planners and station parking information encourages individuals who have never tried transit options to take them at least once and encourages existing riders to use the transit system more frequently.
- Deploying ITS technologies for transit operations and fleet management can help improve service reliability; decrease running time; reduce bus delays at intersections, missed trips, and emissions; and allow for increased service without additional staff or vehicles.

Emergency Management

- Tools and operational strategies that help manage traffic operations can be used in emergency operations for the purpose of increasing traffic capacity on evacuation routes and responding to traffic incidents that hinder the evacuation effort.
- Research shows that the effects of transit signal priority on emergency evacuation clearance times for transit vehicles can provide significant time savings without having a significant impact on evacuation clearance times or evacuee travel times for non-transit vehicles.

Traveler Information

- The next generation of en-route traveler information is in-vehicle traveler information through connected vehicle technologies and other “infotainment” applications.
- Researchers indicate that a well-designed trip planning website should be more than just an itinerary-trip planner; it should be able to effectively capture and convey real-world factors that make transit an increasingly attractive option.

Driver Assistance

- Connected Eco-Driving shows potential for reduction in fuel consumption and emissions for individual drivers as well as fleets.
- Vehicle platooning has great potential to combine several technologies for safety, mobility, and environmental benefits for drivers and the transportation system.
- Cooperative Adaptive Cruise Control (CACC) Systems have the potential to be in every vehicle in the future, are very easy for drivers to use, and have the potential for up to a 37 percent reduction in fuel consumption in some scenarios.
- Costs for Dedicated Short Range Communication (DSRC) based On-Board Equipment for connected vehicle technology are expected to be priced in the $200-233 range in 2017 for aftermarket devices.
- Following on the success of in-vehicle navigation, driver assistance technologies are now moving into the marketplace.

Commercial Vehicle Operations

- With sufficient economies-of-scale, a network wide deployment of Smart Roadside applications can yield benefit-cost ratios ranging from 3.5:1 to 6.2:1 over 10 years.
- Dynamic mobility applications that improve data sharing among commercial vehicle drivers can improve freight travel times up to 20 percent.

Intermodal Freight

- Using wireless communications with GPS vehicle positioning systems can improve commercial vehicle utilization by reducing empty container miles.
- Intermodal terminal gate appointment systems have the potential to dramatically improve operations inside the terminal and at the gate, resulting in reduced congestion on the roadway system and reduced harmful emissions in neighboring communities.

Electronic Payment & Pricing

- Recent lessons learned show that educating the public about the benefits of congestion pricing and engaging political champions early in the process lead to successful congestion pricing projects.
- The benefits of HOV to HOT conversions and expansion have been maintained over time with lower operating costs.

Information Management

- The 2012 transportation reauthorization law Moving Ahead for Progress in the 21st Century (MAP-21) will require greater use of real time and archived data to support development and monitoring of performance measures.
- Information management systems incorporate data fusion from multiple sources and/or agencies, integration of both real time and archived information, and in some cases, data visualization.
- Data archiving enhances ITS integration and allows for coordinated regional decision making.

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

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