Roadway Safety Data Program

UTAH DEPARTMENT OF TRANSPORTATION

SAFETY DATA PROCESSES AND GOVERNANCE PRACTICES

CASE STUDY

FHWA-SA-15-060

Prepared for
Federal Highway Administration
Office of Safety
Roadway Safety Data Program
http://safety.fhwa.dot.gov/rsdp/

November 2015

U.S. Department of Transportation
Federal Highway Administration

Safe Roads for a Safer Future
Investment in roadway safety saves lives
http://safety.fhwa.dot.gov

(Page intentionally left blank)

ACKNOWLEDGEMENTS

The FHWA Office of Safety Data Management Systems and Processes Project team would like to thank the following individuals who graciously provided information needed to develop this case study.

Name	Title	Department	Email/Phone #
Michael Butler	Contract Administrator Consultant Services	Utah Department of Transportation	michaelbutler@utah.gov 801-965-4419
W. Scott Jones	Safety Programs Engineer	Utah Department of Transportation	wsjones@utah.gov 801-965-4285
Stan Burns	Director for Asset Management	Utah Department of Transportation	sburns@utah.gov 801-965-4150
Chris Meredith	Cartography and GIS	Utah Department of Transportation	cmeredith@utah.gov (801) 965-4915
Steve Quinn	Engineering Technology Services Manager	Utah Department of Transportation	squinn@utah.gov 801-887-3631
Becky Hjelm	GIS Manager	Utah Department of Transportation	bhjelm@utah.gov 801-964-4456

ACRONYMS

Table 1. Acronyms

Acronym	Description
AASHTO	American Association of State Highway and Transportation Officials
AGRC	Automatic Geographic Reference Center
CDIP	Crash Data Improvement Program
DBP	Data Business Plan
DOT	Department of Transportation
FHWA	Federal Highway Administration
GIS	Geographic Information System
LRS	Linear Reference System
UDOT	Utah Department of Transportation
UGate	UDOT's Geospatial Data Portal
UMIP	Utah Mapping and Information Partnership
UPlan	UDOT's data sharing portal

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

The purpose of this case study is to highlight innovative data management strategies at Utah Department of Transportation (UDOT) that support the use of technology to benefit safety programs. In addition to highlighting forward-thinking strategies for safety data management, data analysis, and reporting, the case study documents the need for a formal data business plan and data governance. Exploring data management practices and the use of innovative tools within UDOT provides safety data management examples of:

- The importance and usefulness of a robust and well-managed data collection program.
- Providing access to integrated data for a variety of purposes.
- How to use integrated data to develop advanced safety analysis capabilities and at the same time support tools for planning, performance measures, and target-setting processes.
- The importance of collaboration and sharing current data strategies and challenges with data stakeholders.

UDOT has recognized the need for quality data to support planning, performance measures and decision making for many years and has emerged as a leader in data collection, data sharing, and development of innovative tools for data analysis and reporting. Through the annual Strategic Direction reports and complimenting Efficiencies and Accomplishments reports, UDOT updates their goals and strategies based on current needs while supporting the overall vision, mission, and goals of the Department. UDOT staff and management do not hesitate to try new ideas and invest in data-driven tools to make the best use of available funding for safety, asset management and other program areas. Their accomplishments in data collection methods and development of tools and reports have inspired many other state DOT's to try similar strategies.

One of the prominent research projects recently completed pertaining to the topic of enhancing data management/data governance practices is NCHRP 666: *Target-Setting Methods and Data Management to Support Performance-Based Resource Allocation by Transportation Agencies (2010).* NCHRP 666 provides systematic guidance for establishing data management (and data governance) programs within an organization. The following six steps from NCHRP 666 can be adapted for safety data programs[1]:

[1] NCHRP Report 666: Target-Setting Methods and Data Management to Support Performance-Based Resource Allocation by Transportation Agencies (2010), http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_666.pdf.

1. Establishing a need for safety data management/governance
2. Establishing goals for safety data management
3. Assessing the current state of safety data program systems
4. Establishing safety data governance programs
5. Leverage Technology for safety data management
6. Linking safety data to planning, performance measures, and target processes

This case study demonstrates how UDOT excels in two of those steps: leveraging technology for safety data management; and linking safety data to planning, performance measures, and target processes.

STATE SAFETY DATA PROCESSES AND GOVERNANCE PRACTICES

DATA MANAGEMENT AND GOVERNANCE

UDOT has an innovative data collection program that has vastly improved procedures for managing assets and roadway inventory. As a result, they have been the focus of several case studies and have earned recognition from transportation organizations such as AASHTO. UDOT has developed a geospatial data portal called "UGate" that supports many data-driven tools for project prioritization, planning, analysis, and reporting. Currently, there is no formal data business plan for safety or enterprise data, but UDOT staff takes initiative on data management projects by applying innovative ideas. The resulting products and tools such as UPlan, Linear Bench, and Report Auto Generator that are highlighted in this case study demonstrate the value in quality data and confirm the need for investment in improved data management practices such as an enterprise data business plan.

UDOT is very good at understanding user needs and providing the data and tools needed to manage programs that support the Department's initiatives. They readily share information and coordinate with other business areas (including Information Technology (IT)) in data management issues and potential projects. Data management, IT, asset management, safety, and planning staff work together to be strategic, collaborative, and innovative.

Data Collection

Utah's data collection project (featured in the FHWA-SA-14-078 Case Study: "Collection and Use of Roadway Asset Data in Utah Roadway Safety Data and Analysis") expands UDOT's asset and roadway feature inventory, allows for better planning and budgeting, improves coordination among divisions, and greatly improves the traffic and safety division's data analysis capabilities. The Request for Proposal (RFP) they used to solicit the contract is available, and lessons learned and successes from that project have been well documented and presented at various conferences and webinars. The data collection effort was coordinated with several business areas in the organization to meet as many needs as possible. These include incorporating advanced imagery (hi-resolution photo and LiDAR), data extraction of specified inventory, and pavement data imaging and tools for analysis.

Data Management and Governance

UDOT manages and shares data in a centralized data system that supports many innovative tools and applications for planning, safety data analysis, target-setting processes, and tracking performance measures. They consolidate all of their main systems (including those that

specifically support safety programs) in a centralized data portal known as UGate. Data in UGate is integrated, downloadable, and accessible. Most information is available to the public. At UDOT, data is available for viewing and analysis using web based applications and online maps (UPlan) or available for download in various formats such as Shapefile (ArcGIS), Excel or KMZ (for display in Google Earth). UGate also supports several analysis tools used by traffic and safety engineers for project prioritization, planning and reporting.

UDOT exposes data in tools, applications, and reports to improve quality. This in turn demonstrates the need for data governance and data management improvements. For example, when developing a tool, a systems engineering process occurs to evaluate data needs and linkages to ensure it meets end-user needs. If a problem arises during development that will be an obstacle for the functionality desired of the tool, UDOT finds a way to troubleshoot the problem and is able to obtain support for that work. Web applications (i.e., an online map) also help with data quality because maps and visual web tools make poor data quality and other data management issues easier for business owners to see. This often triggers support for activities and projects to improve quality.

The expansion of technology at UDOT has made data governance and data business planning a higher priority need for the Department. They are currently developing UGate 2.0, which will allow for more in-depth analysis of data to support safety and other program areas. The process of developing UGate 2.0 resembles a data governance framework because Utah is taking a close look at all priority systems and data and evaluating how they will fit into the UGate framework. UDOT is also in the process of organizing a data governance board to review technology expenditures, stewardship roles and other data governance matters.

Specific to safety data, UDOT evaluated their process for the Crash Data Improvement Program (CDIP) in 2011 to assess their current situation and develop recommendations for improvement. Since then, UDOT's Highway Safety Office has implemented specific performance measures for safety, which they track and report to National Highway Traffic Safety Administration (NHTSA) every year as part of the Highway Safety Plan (HSP). One example of an area where they have made significant progress is electronic reporting of crashes. UDOT reports that they submit all of their crashes electronically and they are receiving 60% of all crash reports within a week of the incident. The electronic submission of crash data greatly improves accessibility to the data and allows for automated quality checks and tracking for performance measures.

Interagency Partnerships and Collaboration

UDOT uses an external department for technology delivery that (for a fee) handles technical details such as data item definitions or physical database locations, storage and structures. Although these services come at a cost, it is helpful to have information technology

professionals handle the system architecture and database functionality so UDOT staff can focus on improving or developing data collection and analysis capabilities to support program areas.

UDOT creates and manages a common Linear Referencing System (LRS) from centerline data compiled by an outside agency called the Automatic Geographic Reference Center (AGRC). AGRC aggregates all geospatial data from state and local governments and provides UDOT with the centerline and associated data. UDOT then creates and manages the LRS which they share back to AGRC. The partnership between UDOT and AGRC is part of the Utah Mapping and Information Partnership (UMIP), which includes several agencies that coordinate to consolidate, improve, and provide access to common datasets.

An important partnership project between UDOT and AGRC is a pooled fund study to update the LRS to meet the FHWA requirement of establishing and maintaining an All Roads Network of Linear Referenced Data (ARNOLD) including a LRS that incorporates all public roads in the State. The pooled funds study supports data collection that leads to faster centerline updates using new imagery data. The LRS is a baseline for the data collection effort linking several data systems including: assets, roadway inventory, pavement, traffic, and crash data needed for safety analysis. Working with the AGRC is a successful partnership for UDOT that contributes to management and maintenance of the LRS, connections with other data and collaboration with outside agencies.

SAFETY DATA ANALYSIS TOOLS

UDOT's data management practices and data collection contracts have resulted in a single reliable source of integrated data (called UGate Data Portal) to support various tools and applications. Although there is no formal process or governance in place for the development and use of tools, the data portal was nevertheless developed as a result of collaboration among several business areas. UDOT staff leading the effort have focused on making sure there is ample current and reliable data available through the UGate Data Portal. Some of the ways they accomplish this are through promoting their comprehensive data collection program, finding the best ways to utilize all data they collect (mostly via innovative tools), and showing their executive and managers how the data and tools have created efficiencies or allowed for better management of safety program resources. Because data resources are centralized and there are many options for analysis and reporting, most staff at UDOT are aware of their options and support the data portal and its capabilities. Rather than using a formal process for developing tools, UDOT develops tools either in-house or in partnership with contractors designed meet specific needs identified for a business area. They recognize a need for a more formal process to ensure they meet all program area needs consistently and effectively with ample quality data to support them. UDOT is always exploring possibilities for optimal use of

their available data and tools and this section describes several tools that currently support safety analysis, planning, and decision-making processes.

UPlan

Utah was one of the lead states working with the AASHTO Innovation Initiative to develop a web based decision-support, mapping, and informational tool for completing complex planning and project development tasks. The purpose and goals of the program are available online at http://aii.transportation.org/Pages/UPlan.aspx. The main benefits of the program are data visibility and similar formats for sharing data through ArcGIS online (an ESRI Product) maps. This leads to better coordination between business areas and different agencies, and also improves data quality. The original UPlan design inspired the Geospatial Data Collaboration effort that was part of the Every Day Counts Accelerating Innovation initiative. Several states have adopted and deployed maps built in ArcGIS online for sharing state agency data in a web-based portal of collaborative information that supports a number of business areas.

UDOT uses an interactive map to accurately locate and link crash data to the LRS. The data is then available in UGate (the data portal) and shared via UPlan and other safety analysis tools. In the UPlan portal for Zero Fatalities, UDOT codes safety data by performance measures and roadway segments link to statistics such as severe crash rate, crash rate per mile, and safety ratings. A public use for this is to easily locate the safest routes in a simple but interactive web map application. Utah provides this information in UPlan and makes it available through public information requests. Data presented on the website is downloadable and if internal staff or other agencies need more detail, they can request access to use less limited crash data for their analyses. UPlan also provides open access to several other web based maps and applications that are of interest to the public and coordinating agencies. Figure 1 shows the Portal.

Figure 1. UPlan Map Portal

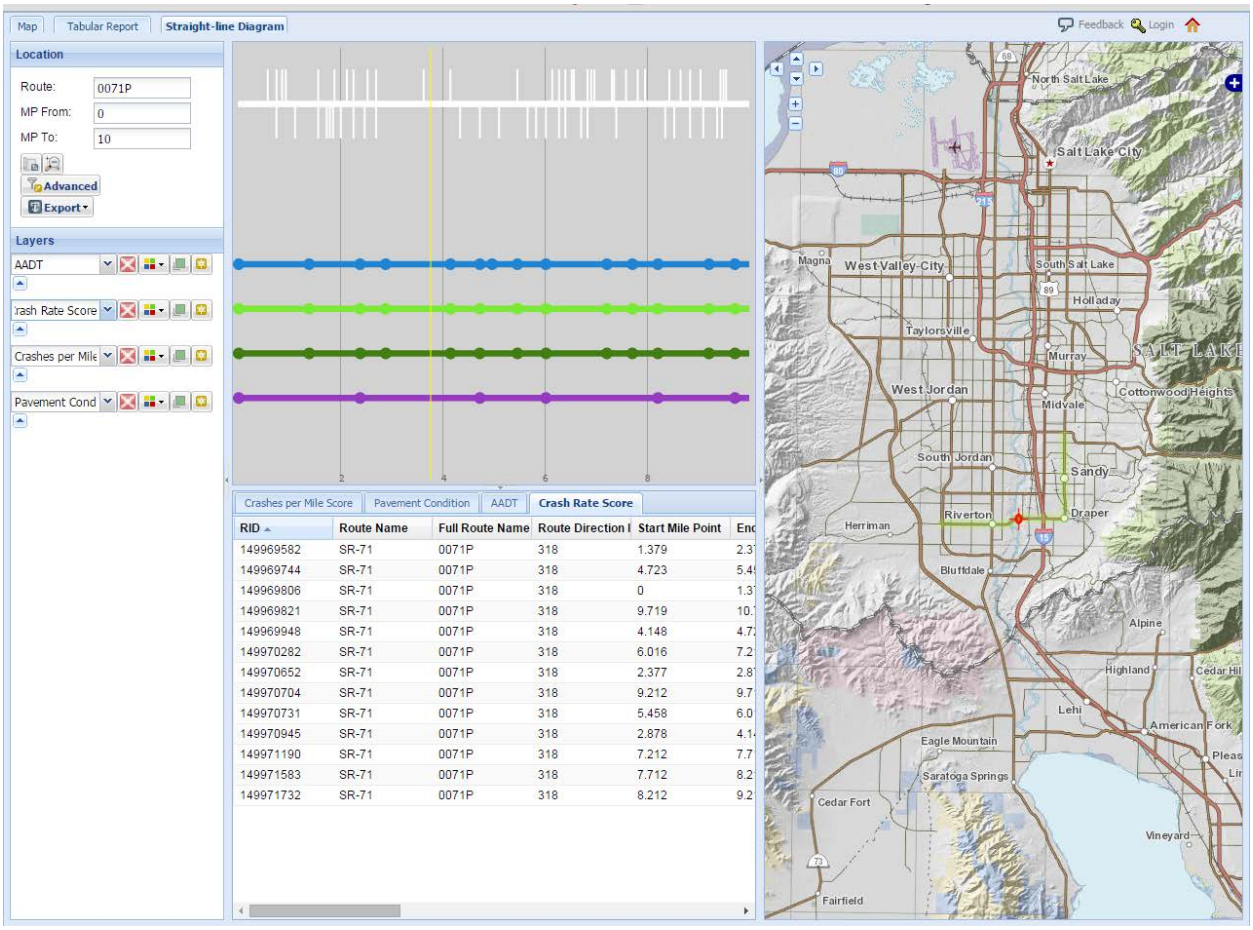
Source: http://uplan.maps.arcgis.com/home/

Linear Bench

Linear Bench is a tool used to view and analyze data that is accessible to UDOT staff. The too is designed for ease-of-use and allows the user to choose a road segment and data sets to generate a straight-line diagram, tabular report or map display with the selected characteristics. The data used in Linear Bench builds upon the data collection efforts and combines available data sources to allow for detailed analysis, decision making, and reporting capabilities that could support a number of different business area needs. The safety area can use this tool for detailed analyses of project areas or specific road segments because it can bring in any available assets or features and display them in a variety of formats.

Viewing data sets together using the Linear Bench tool (Figure 2) can trigger response and action. For instance, analyzing crash scores, Annual Average Daily Traffic (AADT), and pavement data together could uncover the need for a site visit to check pavement surface condition. Linear Bench is a useful way to inventory roadway assets before visiting a project site, which saves time and resources as well as improving safety for UDOT employees.

Figure 2. Linear Bench Application



Source: https://www.udot.utah.gov/ugate/f?p=111:2:0::NO:::

Report Auto Generator

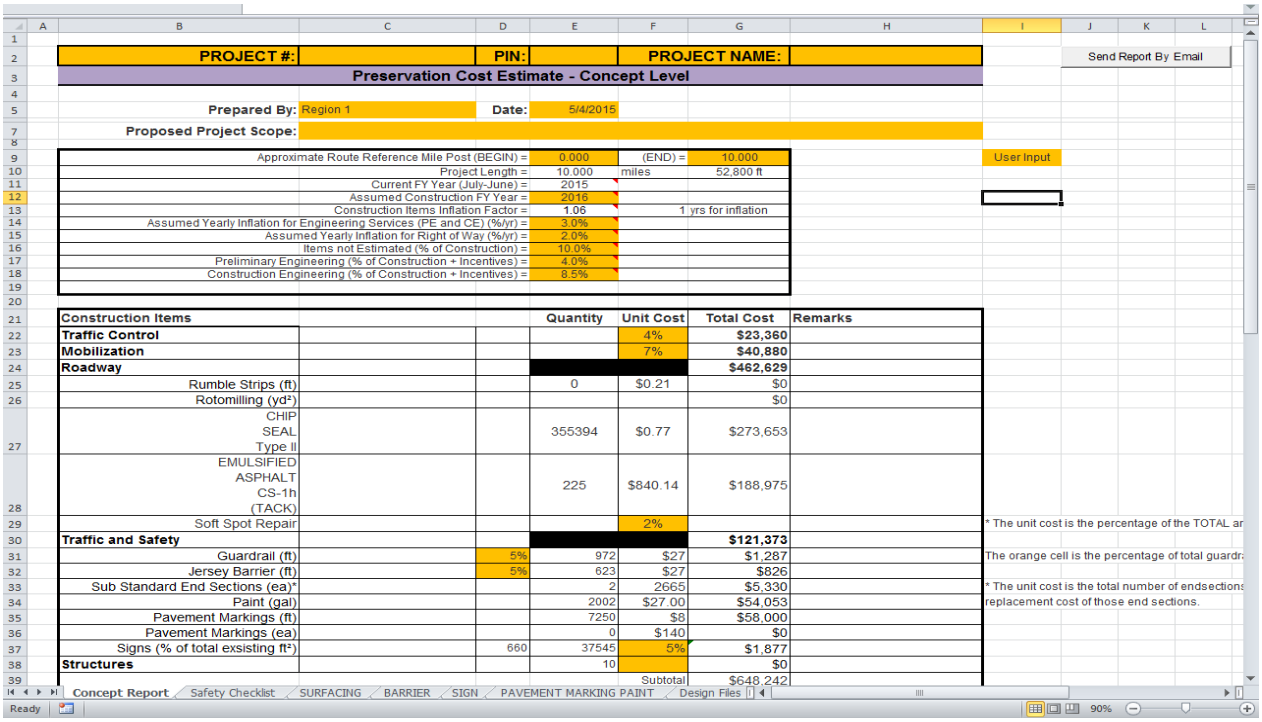
The Report Auto Generator uses a download parameter in Linear Bench to set up a bid estimate (Figure 3) using Excel and connections to an export of data for a given segment of road. The tool saves time and effort and increases accuracy. One benefit of the Report Auto Generator is that it utilizes information accessed through the Data Portal to populate most parts of the form, so users do not have to look for and compile data to create a bid estimate. Another benefit is a notification feature that encourages coordination on projects across departments. When a bid estimate is created using this tool, there is an option to notify one or more interested parties either within or outside the department by email. The email notification provides enough detail to make sure interested parties don't overlap work in the same area and allows for coordination of work efforts.

Systematic instructions allow any user to generate a cost estimate as long as they know how to identify a few details associated with the project. Prompts will guide a user to:

- Name the project file,
- Decide if they want to include guardrail data,
- Identify a region,
- Identify project as an Overlay or Mill and Fill
- Identify additional specifications including details on repair and fill type, asphalt type
- Notify other departments if desired (great for project coordination)

There is a video tutorial describing the details on how to use this tool and the data and tool is open and available for anyone to use.

Figure 3. Report Auto Generator, Cost Estimate



PROJECT #:		PIN:		PROJECT NAME:		
Preservation Cost Estimate - Concept Level						
Prepared By:	Region 1	Date:	5/4/2015			
Proposed Project Scope:						

Approximate Route Reference Mile Post (BEGIN) =	0.000	(END) =	10.000
Project Length =	10.000	miles	52,800 ft
Current FY Year (July-June) =	2015		
Assumed Construction FY Year =	2016		
Construction Items Inflation Factor =	1.06	1	yrs for inflation
Assumed Yearly Inflation for Engineering Services (PE and CE) (%/yr) =	3.0%		
Assumed Yearly Inflation for Right of Way (%/yr) =	2.0%		
Items not Estimated (% of Construction) =	10.0%		
Preliminary Engineering (% of Construction + Incentives) =	4.0%		
Construction Engineering (% of Construction + Incentives) =	8.5%		

User Input

Send Report By Email

Construction Items			Quantity	Unit Cost	Total Cost	Remarks
Traffic Control				4%	$23,360	
Mobilization				7%	$40,880	
Roadway					$462,629	
Rumble Strips (ft)			0	$0.21	$0	
Rotomilling (yd²)					$0	
CHIP SEAL Type II			355394	$0.77	$273,653	
EMULSIFIED ASPHALT CS-1h (TACK)			225	$840.14	$188,975	
Soft Spot Repair				2%		
Traffic and Safety					$121,373	
Guardrail (ft)		5%	972	$27	$1,287	
Jersey Barrier (ft)		5%	623	$27	$826	
Sub Standard End Sections (ea)*			2	2665	$5,330	
Paint (gal)			2002	$27.00	$54,053	
Pavement Markings (ft)			7250	$8	$58,000	
Pavement Markings (ea)			0	$140	$0	
Signs (% of total exsisting ft²)		660	37545	5%	$1,877	
Structures			10		$0	
				Subtotal	$648,242	

* The unit cost is the percentage of the TOTAL ar

The orange cell is the percentage of total guardr

* The unit cost is the total number of endsections replacement cost of those end sections.

Concept Report | Safety Checklist | SURFACING | BARRIER | SIGN | PAVEMENT MARKING PAINT | Design Files

Ready

Source: https://drive.google.com/a/utah.gov/file/d/0B_k-MpCWnQUEZlc3bHV2Vzk2TEE/edit?pli=1

Crash Data Analysis Tool

Former UDOT engineers who helped build the Report Auto Generator are developing the Crash Data Analysis Tool. This tool uses crash and incident location data combined with asset inventory data related to safety and damage value/cost estimates to easily display where funding for safety improvements should happen. Currently the tool shows analysis on a user defined

segment of road and reports in spreadsheet format but it is still in development. There are plans to transition into an online dashboard that will be expanded to perform both user defined and network level analysis. The following screenshots show how the tool will allow a user to identify an area of interest (currently restricted to a segment of roadway) and return a report that analyzes treatment types, options, and benefits displayed as dollar amounts. Figure 4 is a summary of treatment options where the red indicates treatments that would result in the highest return on investment in safety data improvements. Figure 5 shows some of the detailed summaries of crash mitigation options. The major benefit of this tool is the speed and ease of performing analyses. Normally, a safety analyst or traffic engineer would have to manually collect data (often in the field) possibly taking weeks or longer to research and gather data for this type of analysis. The reports shown in the images below were generated using business intelligence tools and took less than five minutes to complete.

Figure 4. Example Treatment Options Report for the New Crash Data Analysis Tool

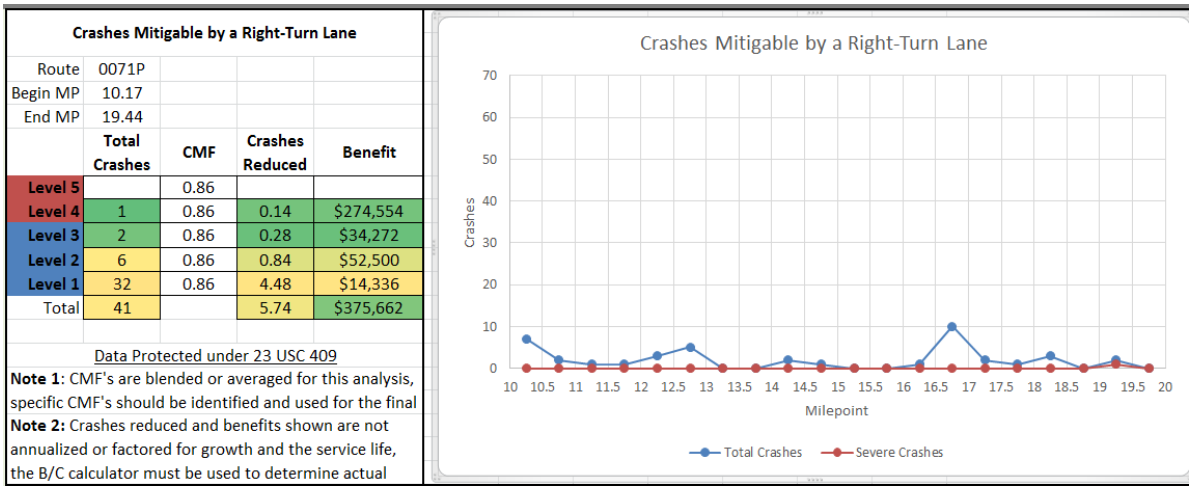
Route 0071P MP 10-20 Treatment Options

	Treatment Type	Total Crashes by Severity						Crash Modification Factor					Crashes Reduced						Benefit
		5	4	3	2	1	Total	5	4	3	2	1	5	4	3	2	1	Total	Total
Intersection Related	Right-Turn Lane		1	2	6	32	41	0.86	0.86	0.86	0.86	0.86		0.14	0.28	0.84	4.48	5.74	$375,662
	Left-Turn Lane		5	44	59	102	210	0.74	0.74	0.74	0.74	0.74		1.30	11.44	15.34	26.52	54.6	$4,993,300
	Intersection Lighting		1	5	3	11	20	0.8	0.8	0.8	0.8	1		0.20	1.00	0.60	0.00	1.8	$552,120
	e Detection & Warning Flashers	1	11	51	108	216	387	0.9	0.9	0.9	0.9	0.9	0.10	1.10	5.10	10.80	21.60	38.7	$3,721,680
	Left-Turn Phasing Changes		5	46	61	120	232	0.81	0.81	0.81	0.81	0.81		0.97	8.92	11.83	23.28	45	$3,808,686
	ll Traffic Signal or 4-Way Stop	1	5	9	16	28	59	0.56	0.56	0.56	0.56	0.56	0.44	2.20	3.96	7.04	12.32	26	$6,141,432
Roadway Departure	tructure/Column Crash Cushion	2		9	2	12	25	0.31	0.31	0.31	0.31	0.54	1.38		6.21	1.38	5.52	14.5	$3,570,336
	Centerline Rumblestrips	2	5	12	6	25	50	0.86	0.86	0.86	0.86	0.86	0.28	0.70	1.68	0.84	3.50	7	$2,191,210
	Shoulder Rumblestrips	1	2	4	3	16	26	0.84	0.84	0.84	0.84	0.84	0.16	0.32	0.64	0.48	2.56	4.16	$1,057,856
	Pave or Widen Shoulder							0.85	0.85	0.85	0.85	0.85							
	Clear Zone Improvements	2	2	7	3	17	31	0.94	0.94	0.94	0.94	0.94	0.12	0.12	0.42	0.18	1.02	1.86	$536,586
	Roadway Delineation	3	2	9	4	21	39	0.85	0.85	0.85	0.85	0.85	0.45	0.30	1.35	0.60	3.15	5.85	$1,683,645
	Shoulder Barrier	2	2	7	3	14	28	0.56	0.53	0.53	0.93	0.93	0.88	0.94	3.29	0.21	0.98	6.3	$3,988,159
	Median Barrier	2		5		4	11	0.57	0.71	0.71	0.71	1.24	0.86		1.45		-0.96	1.35	$1,860,954
Other Treatment Types	Raised Median	2		17	11	65	95	0.85	0.85	0.85	0.85	0.85	0.30		2.55	1.65	9.75	14.3	$1,034,775
	Two-Way Left-Turn Lane			4	2	19	25	0.8	0.8	0.8	0.8	0.8			0.80	0.40	3.80	5	$135,080
	Curve/Grade Signing			1		3	4	0.82	0.82	0.82	0.82	0.82			0.18		0.54	0.72	$23,760
	Wildlife Signing				1	6	7	0.75	0.75	0.75	0.75	0.75				0.25	1.50	1.75	$20,425
	Bicycle Warning Signs	1	10	21	12	2	46	0.75	0.75	0.75	0.75	0.75	0.25	2.50	5.25	3.00	0.50	11.5	$6,224,725
	Pedestrian Activated Flasher	2	4	15	8	3	32	0.71	0.71	0.71	0.71	0.71	0.58	1.16	4.35	2.32	0.87	9.28	$4,092,538
	Runaway Truck Ramp							0.75	0.75	0.75	0.75	0.75							
	Adding/Extending Passing Lane							0.75	0.75	0.75	0.75	0.75							
	Drainage Improvements	1	2	6	3	28	40	0.6	0.6	0.6	0.6	0.6	0.40	0.80	2.40	1.20	11.20	16	$2,757,320
	Pavement Resurfacing		1			2	3	0.95	0.95	0.95	1.01	1.01		0.05			-0.02	0.03	$37,391

Data Protected under 23 USC 409

Source: Michael Butler, Contract Administrator, UDOT

Figure 5. View of Detailed Analysis in the Crash Data Analysis Tool



Crashes Mitigable by a Right-Turn Lane

Route	0071P			
Begin MP	10.17			
End MP	19.44			
	Total Crashes	**CMF**	**Crashes Reduced**	**Benefit**
Level 5		0.86		
Level 4	1	0.86	0.14	$274,554
Level 3	2	0.86	0.28	$34,272
Level 2	6	0.86	0.84	$52,500
Level 1	32	0.86	4.48	$14,336
Total	41		5.74	$375,662

Data Protected under 23 USC 409

Note 1: CMF's are blended or averaged for this analysis, specific CMF's should be identified and used for the final

Note 2: Crashes reduced and benefits shown are not annualized or factored for growth and the service life, the B/C calculator must be used to determine actual

Source: Michael Butler, Contract Administrator, UDOT

Other Safety Analysis Tools

UDOT has a few other options for safety data analysis and planning as shown in Table 2. The table describes the methods and quantifies the data and effort to use it.

Table 2. Utah's Safety Analysis Options

Analysis Methods	Description	Data and Effort
FHWA Systemic Safety Tool	Uses crash data to identify appropriate target crash types and risk factors and then uses those risk factors to prioritize potential sites for implementation of target countermeasures	Low
United States Road Assessment Program (usRAP) Tools	Software tools that use predictive models and limited crash data to characterize crash risk. The primary product includes a program of highway infrastructure improvements prioritized on a benefit-cost basis. A limited selection of roadway variables is required in order to identify potential hazardous conditions.	Medium
Utah Crash Prediction Model	Uses a predictive Bayesian crash model to screen, diagnose, select, appraise, prioritize, and evaluate statewide highway safety projects. Results are integrated within a GIS framework to better visualize the model results	High

Source: Systemic Safety Analysis - Utah's Approach, PowerPoint by Scott Jones, Utah DOT for 2014 Systemic Safety Implementation Peer Exchange

The FHWA Systemic Safety Tool uses an initial screening measure to determine which crash types represent the bulk of crashes to help UDOT focus further analysis in areas that need more attention. UDOT does not use this tool to analyze specific crashes or to determine countermeasures at specific locations. Figure 6 demonstrates an example of results from running the tool. As shown, the tool produced a prioritized list of areas needing attention based on the data.

Figure 6. FHWA Systemic Safety Tool

Source: W. Scott Jones, Safety Programs Engineer, UDOT

UDOT uses the United States Road Assessment Program data model to create a risk-based assessment of the entire state roadway system. United States Road Assessment Program analyzes roadway characteristics such as barriers, rumble strips, lane widths, access points, speeds, AADT, and more on a given road to identify risks. UDOT calibrates the model using existing crash data and the tool produces outputs in the form of "star ratings" showing the relative safety of each of the state roads. This tool also helps produce a "safer roads investment plan" which is a list of recommended projects UDOT could pursue to reduce the risk of serious injuries and fatalities. The most innovative aspect of this tool is the incorporation of Google Street View to allow more options for data collection on roadways that might not be covered in UDOT's data collection coverage (on state roads only). The benefit is that data collection options are available to agencies so they can run safety analysis models on non-state roads when needed. There are plans to expand the model to the Federal aid system following initial deployment and testing on the state system.

The Utah Crash Prediction Model is a powerful and flexible model (currently only pertaining to the state road system) that can run any combination of variables together and output a list of road segments accordingly. The Bayesian model runs a comparison of actual crash history versus the expected crashes, which enables UDOT to not only see where crashes are occurring most frequently, but also to see where infrastructure changes are likely to make a difference to reduce fatal and serious injury crashes. Locations with the largest difference between actual and expected crashes should represent best opportunities for affecting positive change.

UDOT's tools and technology are innovative, inspire other DOTs, and keep their managers excited about investing in data collection and technology. To keep the technology and data collection momentum going and better manage future efforts, UDOT recognizes that structure for data management needs to be in place.

APPLICABILITY TO OTHER STATES

UDOT is innovative, creative, and proactive when it comes to implementing new strategies. This is part of their organization's culture and accompanies UDOT's strategy of coordinating with business areas and IT and incorporating user needs and ideas into the development of data and information systems. UDOT's ideas, strategies, and lessons learned from the development of UGate, the data collection project, and from the development and deployment of tools for analysis, planning, and performance measures can be greatly beneficial to other states. A few lessons learned from UDOT related to safety data management and technology follow:

- Costs for data collection and management need to relate to the hidden cost of not having linked data or not being able to make data driven decisions. UDOT feels strongly that there must be a way to show a return on the investment in data.
- Even though it is sometimes hard to develop and implement new ways of managing and reporting data, the change in culture at UDOT has been a good thing; people are working together more effectively now than in the past.
- Always think about ways to collect data once for use by many groups.
- Make an effort to consolidate tools, reports, and data in centralized locations while making sure they meet the needs of as many business areas as possible.
- Ability to display all of this information in UPlan was very beneficial for consolidating efforts and to show the value of sharing data in a centralized portal.
- Keep working on ideas and strategies to utilize Business Intelligence (BI) tools. They help with data analysis, reporting and with justification of the investment in data management improvements.
- Involve all the parties that use the data (safety, asset, etc.) and consider all areas of UDOT. This helps secure buy-in and support across the board.
- Having the right people in the room helps with decision-making.
- Make sure to inform managers and executives on cost savings and other benefits achieved through more efficient processes.
- It takes people with passion. UDOT was committed to getting the job done so they proceeded with ideas and strategies and handled any problems as they arose.

Other states can benefit from following UDOT's example of open and collaborative development of data and information systems.

FUNDING RESOURCES

UDOT utilizes funding from multiple sources. To raise business area interest in sharing resources for data management, one strategy is to talk to entities that have a need or use for data and analysis tools and show them what is possible. Another method is to show upper management how investment in data system improvements (UGate 2.0) would help manage data and information, by speeding up access to and analysis of data.

Most of UDOT's IT budget is through State funds in a transportation bill, which are earmarked funds for IT expenditures. In some cases, using State funds for the maintenance program is justified. For example, UDOT used state funds for about a third of the LiDAR in the data collection project because it creates efficiencies for the maintenance program such as time and cost savings by not having to survey in the field.

UDOT uses Federal funds for eligible programs; these may include Highway Safety Improvement Program (HSIP), State Planning and Research (SP&R), or occasionally the Surface Transportation Program (STP).

REFERENCES

Collection and Use of Roadway Asset Data in Utah, Roadway Safety Data and Analysis, Case Study, FHWA-SA-14-078, Prepared for FHWA Office of Safety, Roadway Safety Data Program, http://safety.fhwa.dot.gov/rsdp/

Final UDOT CDIP Report, FHWA Office of Safety, by Data Nexus, Inc., November 28, 2011

Interview with UDOT for FHWA Safety Data Systems and Processes for Literature Review and Synthesis Report, February 2015

Phone, interviews, and email conversations with:

- Michael Butler, Contract Administrator Consultant Services, UDOT
- W. Scott Jones, Safety Programs Engineer, UDOT
- Stan Burns, Director for Asset Management, UDOT
- Chris Meredith, Cartography and GIS, UDOT
- Steve Quinn, Engineering Technology Services (ETS) Manager, UDOT
- Becky Hjelm, GIS Manager, UDOT
- Robert Hull, Former Safety Program Engineer, UDOT

Systemic Safety Analysis – Utah's Approach, 2014 Systemic Safety Implementation Peer Exchange, Scott Jones, Utah DOT ("UDOT"), PowerPoint

UDOT Data Portal: data.udot.utah.gov

UDOT Data Portal News, September, 2013, Google UDOT Routes with Linear Bench Explorer, Frank Pisani, Becky Hjelm

UDOT Efficiencies and Accomplishments, http://www.udot.utah.gov/main/

UDOT 2015 Strategic Direction, www.udot.utah.gov/go/strategicdirection

UGate: UDOT's LRS-based Data Warehouse, UGateCase Study, Gistic Research

AASHTO Innovation Initiative – UPlan: http://aii.transportation.org/Pages/UPlan.aspx

FHWA Office of Safety Roadway Safety Data Program Toolbox: Noteworthy Practices Database link, http://safety.fhwa.dot.gov/rsdp/

Anita Vandervalk, Dena Snyder, Kim Hajek, Talena Adams, and Lisa Smith from Cambridge Systematics, Inc. performed this project.

FHWA, Office of Safety

Stuart Thompson. P.E.

Federal Highway Administration

202-366-8090

Stuart.Thompson@dot.gov