FHWA Research and Technology Evaluation

SHRP2 Traffic Incident Management Responder Training Program

Final Report
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Foreword

The Federal Highway Administration (FHWA) Research and Technology (R&T) Program furthers the FHWA Office of Research, Development, and Technology's goal of ensuring transparency, accessibility, and responsiveness of R&T for all stakeholders.

This report examines how the National Traffic Incident Management (TIM) Responder Training Program, implemented by FHWA with assistance from the second Strategic Highway Research Program and the Every Day Counts Program, influenced the practices of emergency responders and contributed to improvements in key TIM performance metrics.

This report should be of interest to practitioners, researchers, and decisionmakers involved in road safety and emergency operations.

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Associate Administrator, Office of Research,
Development, and Technology

Notice

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16. Abstract This evaluation of the second Strategic Highway Research Program (SHRP2) Traffic Incident Management (TIM) Responder Training Program focuses on three areas: the dissemination of TIM trainings and concepts across the country, responder and agency adoption of SHRP2 TIM concepts, and improvements in key TIM performance metrics. From 2012 to 2015, SHRP2 TIM trainings reached over 150,000 emergency responders—representing a variety of responder disciplines—across the country. Responders and agency supervisors reported that SHRP2 TIM concepts improved on-scene safety and that these concepts were straightforward to apply. To identify improvements in TIM metrics that resulted from the trainings, the evaluation team focused on Metropolitan Phoenix and Eastern Tennessee as case studies. In Metropolitan Phoenix, the evaluators found that SHRP2 TIM trainings contributed to decreases in secondary crashes that involved emergency responders. In both Metropolitan Phoenix and Eastern Tennessee, TIM trainings contributed to reductions in roadway- and incident-clearance times.			
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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
	NOTE: volumes greater than 1000 L shall be shown in m^3			
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
^oC	Celsius	1.8C+32	Fahrenheit	^oF
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

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List of Abbreviations

Abbreviation	Definition
AASHTO	American Association of State Highway and Transportation Officials
DPS	Department of Public Safety (Arizona)
EDC	Every Day Counts
EDC-4	Every Day Counts Round 4
EMS	emergency medical services
FHWA	Federal Highway Administration
ICS	Incident Command System
ICT	incident-clearance time
R&T	research and technology
RCT	roadway-clearance time
SHRP2	second Strategic Highway Research Program
SI	occurrence of secondary incident
SME	subject-matter expert
TDOT	Tennessee Department of Transportation
TIM	traffic-incident management
TraCS	Traffic and Criminal Software
TtT	train-the-trainer
UAS	unmanned aircraft system

Executive Summary

Purpose of the Evaluation

The National Traffic Incident Management (TIM) Responder Training Program was deployed by the Federal Highway Administration (FHWA) with support from the second Strategic Highway Research Program (SHRP2) and the Every Day Counts (EDC) Program. The purpose of this evaluation is to assess the effectiveness of the SHRP2 TIM Responder Training Program in disseminating TIM concepts to a wide incident-responder community, enhancing agency practices, and positively impacting key TIM performance metrics.

Program Description

TIM is the "planned and coordinated multidisciplinary process to detect, respond to, and clear traffic incidents so that traffic flow may be restored as safely and quickly as possible."[2] Key goals of TIM include improving the safety of responders and reducing incident duration.[3,4] A strong interdisciplinary TIM program that standardizes the strategies responders of all disciplines use can decrease incident duration and reduce secondary-crash rates.[3]

Starting in 2012, FHWA delivered the National TIM Responder Training Program (SHRP2 TIM trainings) to a variety of State and local recipients with assistance from SHRP2 and, later, support from FHWA EDC. Resources offered through SHRP2 TIM trainings included a train-the-trainer curriculum, separate classroom trainings, Web-based components, a communications toolkit, and case study reports.

The SHRP2 TIM Responder Training Program is managed by the FHWA Office of Operations in cooperation with all 50 States and U.S. territories. This Office also provides national leadership and structure to regional and statewide TIM programs through technical assistance, guidance, training, identification of successful practices, and research on issues relevant to TIM. FHWA's goal is to work with States to train all responders in the country through SHRP2 TIM trainings, and efforts are underway to reach this goal. As of this report's writing, over 300,000 emergency responders across the United States have attended SHRP2 TIM trainings.[5]

Methodology

The evaluation examined three aspects of SHRP2 TIM trainings: dissemination, adoption, and performance. Within each of these areas, the evaluation team developed hypotheses and measures of effectiveness to assess whether SHRP2 TIM trainings achieved progress in these aspects. Such measures included training attendance, changes in responder and agency practices with respect to on-scene traffic-incident practices, as well as changes in quantitative performance indicators associated with incident clearance and responder safety.

As described in the main body of this report, the evaluation team incorporated a mixed-methods approach that drew from FHWA data, interviews with emergency responders, and traffic-incident data from two case studies: Metropolitan Phoenix and Tennessee Region 1.[1]

To assess the dissemination of SHRP2 TIM trainings, the evaluation team relied on data provided by FHWA on training sessions conducted across the country from 2012 to 2015. To gauge changes in agency practices and early impacts on performance measures that resulted from SHRP2 TIM trainings, the evaluation team interviewed emergency responders and analyzed crash data from Arizona and Tennessee.

Findings

SHRP2 TIM trainings contributed to a steady decline in secondary incidents that killed or injured emergency responders in Metropolitan Phoenix. SHRP2 TIM trainings also contributed to a decline in the proportion of secondary crashes in Tennessee Region 1. With respect to roadway-clearance times (RCTs) and incident-clearance times, the evaluation team found that SHRP2 TIM trainings furthered reductions in these metrics in both Metropolitan Phoenix and Tennessee Region 1 when considering all crash types together. For subsets of minor incidents, the evaluation team found that RCTs in Metropolitan Phoenix and Tennessee Region 1 met the 30- to 35-min targets that had been set by several States.(6) Such declines are notable given steady increases in the overall number of crashes and vehicle miles traveled for both sites during the study period.

With respect to the trainings themselves, the evaluation team found that, between 2012 and 2015, over 5,000 SHRP2 TIM–training sessions were held across the country, and more than 125,000 emergency responders attended these trainings.[2]

Regarding responder and agency practices, the evaluation team identified, through interviews described in the report, numerous positive changes in TIM practices. The SHRP2 TIM Responder Training Program was praised for bringing together emergency responders from a wide variety of disciplines. Interviewees reported that they and their agencies changed TIM practices as a result of SHRP2 TIM trainings and that responders could apply the concepts they learned immediately.

While encouraging results were found on secondary incidents involving responders, the evaluation team recommends that States continue to refine their TIM data–collection processes. The evaluation team remains concerned about missing data, erroneous data, and an inability to link TIM-trained responders to specific incidents. Improved data-collection methods could lead to better measurement of TIM outcomes and help target resources toward further improving responder and motorist safety. The evaluation team recognizes, however, that Arizona and Tennessee both made strong gains from 2012 to 2015 in their data collection. Further, the evaluation team lauds FHWA for including improvement of TIM data collection as part of its EDC Round 4 initiative.

[1]Tennessee Region 1 comprises the counties surrounding and including Knoxville.

[2]Since the 2012–2015 study period, over 300,000 emergency responders have received SHRP2 TIM training.

1. Introduction

1.1 Evaluation Purpose

The Federal Highway Administration (FHWA) has initiated an effort to evaluate programs related to research and technology (R&T). The leaders of governmental transportation R&T programs need to effectively communicate their findings and the impacts of their programs. The R&T Evaluation Program helps FHWA assess how effectively it is meeting its goals and objectives and providing useful data to inform future projects.

In its initial year, the R&T Evaluation Program worked with 9 FHWA offices to identify 16 projects for evaluation. The FHWA Office of Operations in conjunction with the second Strategic Highway Research Program (SHRP2) identified the National Traffic Incident Management (TIM) Responder Training Program (SHRP2 TIM trainings) as a project to evaluate.[1] The purpose of this evaluation is to assess the effectiveness of the SHRP2 TIM Responder Training Program in disseminating trainings to a wide audience, enhancing practices of emergency responders, and achieving improvements in traffic-incident performance metrics.

Starting in 2012, with backing from SHRP2 and, later, support from the FHWA Every Day Counts (EDC) Program, FHWA delivered the National TIM Responder Training Program to a variety of State recipients.(7) TIM-related SHRP2 "products" included the following:[2]

- **Product L12: Basic Training Curriculum**—This was a multidisciplinary training course for traffic-incident responders that included module-based training as well as tabletop and practical outdoor exercises. This curriculum comprised both a 10- and 4-hour course for emergency responders.

- **Product L32A: Train the Trainer (TtT) Course for Incident Responders and Managers**—This course aimed to train responders and managers to become familiar with SHRP2 TIM materials and thus to lead classroom sessions to train other incident responders.

- **Product L32B: E-Learning for Training Traffic Incident Responders and Managers**—This Web-based training offered an electronic version of the training curriculum.

- **Product L32C: Interdisciplinary TtT Post-Course Assessment and Report Tool**—This Tool was developed to assess student achievement of SHRP2 TIM–training objectives.[3]

[1] In this evaluation, the evaluation team will use the terms "National TIM Responder Training Program" and "SHRP2 TIM trainings" interchangeably.

[2] The evaluation team derived the listed information from an unpublished FHWA document on the implementation strategy for the National TIM Responder Training Program.

[3] The "L" in these product names stands for the SHRP2 Focus Area of Reliability.

FHWA conducted TtT courses in which first responders learned multidisciplinary TIM principles and how to lead TIM courses in their respective States. States and local agencies then took the lead to implement larger-scale trainings.[4]

The FHWA Office of Operations's TIM Program manages SHRP2 TIM trainings.(2) This Program provides national leadership and structure to State-led TIM efforts through technical assistance, guidance, training, identification of successful practices, and research on issues relevant to TIM. FHWA's goal is to train all responders in the country through SHRP2 TIM trainings, and for the last several years, efforts have been underway to reach this goal. While States and local emergency-responder agencies have implemented TIM training programs to various degrees, the National TIM Responder Training Program is the first nationally standardized TIM-training program to be deployed.(8)

The many agencies that potentially respond to traffic incidents may have their own agency priorities entirely separate from other agencies, even within the same jurisdiction.(9) These agencies, however, need to establish clear command, communication, and coordination at the scene of a traffic incident.(9) The evaluation team conducted interviews with agencies in two States to determine whether these agencies changed existing incident-management practices following SHRP2 TIM trainings and whether those practices ultimately improved outcomes in the field.

As practices improve and responders communicate and coordinate better at the scene of a traffic incident, it is expected that incidents will be cleared more quickly and that responder and motorist safety during incident response—a key concern of many agencies—will be improved.(4) Faster clearing of incidents should ultimately reduce congestion.(4)

Evaluating the SHRP2 TIM Responder Training Program's dissemination, adoption, and performance improvements can demonstrate the extent to which the Program meets the objectives of FHWA's *R&T Agenda*.(10) The SHRP2 TIM Responder Training Program aligns with the Office of Operations's objectives 1 and 2:

- Objective 1: Managing congestion by improving reliability and operating the system at peak performance.
- Objective 2: Building a strong foundation for proactive operations.

In addition to the *R&T Agenda*'s objectives, the SHRP2 TIM Responder Training Program also aligns with the overall goals of SHRP2:(11)

- Save lives.
- Save money.
- Save time.

Table 1 describes the three evaluation areas—dissemination, adoption, and performance—developed by the evaluation team.

[4]TIM subject-matter experts (SMEs), phone interview conducted by Joseph Luna (evaluation team), October 2017.

Table 1. Summary of evaluation framework.

Evaluation Area	Description
Dissemination	Extent to which SHRP2 TIM trainings reached a large, varied audience of first responders across all 50 States and U.S. territories.
Adoption	Changes in individual and agency practices and cross-agency coordination that resulted from SHRP2 TIM trainings.
Performance	Quantitative and qualitative impacts on key performance measures that were associated with SHRP2 TIM trainings.

A successful SHRP2 TIM Responder Training Program will lower the number of emergency responders who are injured or killed while responding to a traffic incident. Also, the Program will reduce the time drivers spend in congestion caused by traffic incidents, which impose significant societal costs.(12)

1.2 TIM Background

Traffic incidents are costly and dangerous. For each minute that a freeway travel lane is blocked during peak use, an estimated 4–5 min of delay results after the incident is cleared, accounting for 4.2 billion hours of delay annually.(12) In 2005, congestion cost approximately $67.6 billion, while traffic crashes incurred costs of more than $164.2 billion.(12) Beyond these monetary costs, many emergency responders have lost their lives while responding to traffic incidents. In 2012, more than 250 public-safety professionals—police officers, firefighters, emergency medical responders, and tow operators—lost their lives, with approximately 13 percent of those fatalities occurring during incident response.(12,13) These numbers, however, do not necessarily capture the number of emergency responders who have been injured in secondary crashes, involved in property-damage-only crashes, or caught in "near-miss" incidents.(14)

A number of agencies and disciplines, including law enforcement, fire and rescue, emergency medical services (EMS), transportation agencies, tow operators, and hazardous-materials crews, may respond to traffic incidents. Responding to incidents is not the core function of any of these disciplines. Furthermore, each discipline has a different role and operational priority when responding to a traffic incident. A lack of coordination and common understanding among responders can lead to further delays and safety hazards for responders and crash victims at an incident scene.(9)

TIM is the "planned and coordinated multidisciplinary process to detect, respond to, and clear traffic incidents so that traffic flow may be restored as safely and quickly as possible."(2) Key goals of TIM include improving the safety of responders and reducing incident duration.(3,4) A strong interdisciplinary TIM program that standardizes the strategies responders of all disciplines use can significantly decrease incident duration and reduce secondary-crash rates.(3)

For the past 2 decades, FHWA has undertaken extensive efforts to develop national guidelines, good practices, operational processes, tools, and training to improve TIM programs.(15) Starting in the early 1990s, FHWA supported the National Incident Management Coalition, which facilitated conferences of various stakeholders and asserted the need for emergency responders to coordinate efforts.(12) In 2000, the Coalition released the *Traffic Incident Management Handbook* (updated in 2010), which introduced the term TIM.(16,12)

With various organizations supporting TIM, FHWA launched the TIM Performance Measures Focus States Initiative in 2005. This Initiative convened 11 States to develop basic measures that would permit evaluation of agency performance during traffic incidents. These measures—roadway-

clearance time (RCT), incident-clearance time (ICT), and secondary crashes—will be discussed further in chapter 2.[9]

In 2007, several national organizations representing the incident-response community ratified the National Unified Goal for TIM.[17] The National Unified Goal centers on three objectives: responder safety; safe, quick clearance; and prompt, reliable, interoperable communications.[18] Eighteen strategies fall under these three objectives, including several cross-cutting strategies:

- Cross-cutting strategies:
  - TIM partnerships and programs.
  - Multidisciplinary, national incident-management system and TIM training.
  - Goals for performance and progress.
  - TIM technology.
  - Effective TIM policies.
  - Awareness and education partnerships.

- Responder safety:
  - Recommended practices for responder safety.
  - Move-over/slow-down laws.
  - Driver training and awareness.

- Safe, quick clearance:
  - Multidisciplinary TIM procedures.
  - Response- and clearance-time goals.
  - 24/7 availability.

- Prompt, reliable incident communications:
  - Multidisciplinary communications practices and procedures.
  - Prompt, reliable responder notification.
  - Interoperable voice and data networks.
  - Broadband emergency communications systems.
  - Prompt, reliable traveler-information systems.
  - Partnerships with new media and information providers.

Also in 2007, FHWA partnered with the American Association of State Highway and Transportation Officials (AASHTO) and the Transportation Research Board to research and implement a TIM-training course under SHRP2.[15] This course was grounded in many of the concepts outlined in the National Unified Goal for TIM. The training course was launched across the country as a set of SHRP2 products in 2012. This evaluation focuses on that early period (2012–2015) of SHRP2 TIM trainings.[15]

The TIM Training Program evaluated in this report continues to evolve. FHWA's EDC Round 4 (EDC-4) tackles the issues of standardizing and improving data collection to assess key TIM performance metrics and informs future planning and operations.[19] Under EDC-4, FHWA will promote several low-cost technologies, such as computer-aided dispatch and electronic crash reporting, to enhance and expand the data that agencies collect.[19] To ensure ongoing awareness of TIM principles, the National Traffic Incident Response Awareness Week—held annually in November—brings together TIM stakeholders to draw public awareness toward the dangers faced by emergency responders at traffic incidents.[20] At 2017's National Traffic Incident Response Awareness Week, the U.S. Department of Transportation celebrated the milestone of national TIM trainings reaching 300,000 emergency responders.[21]

1.3 Report Structure

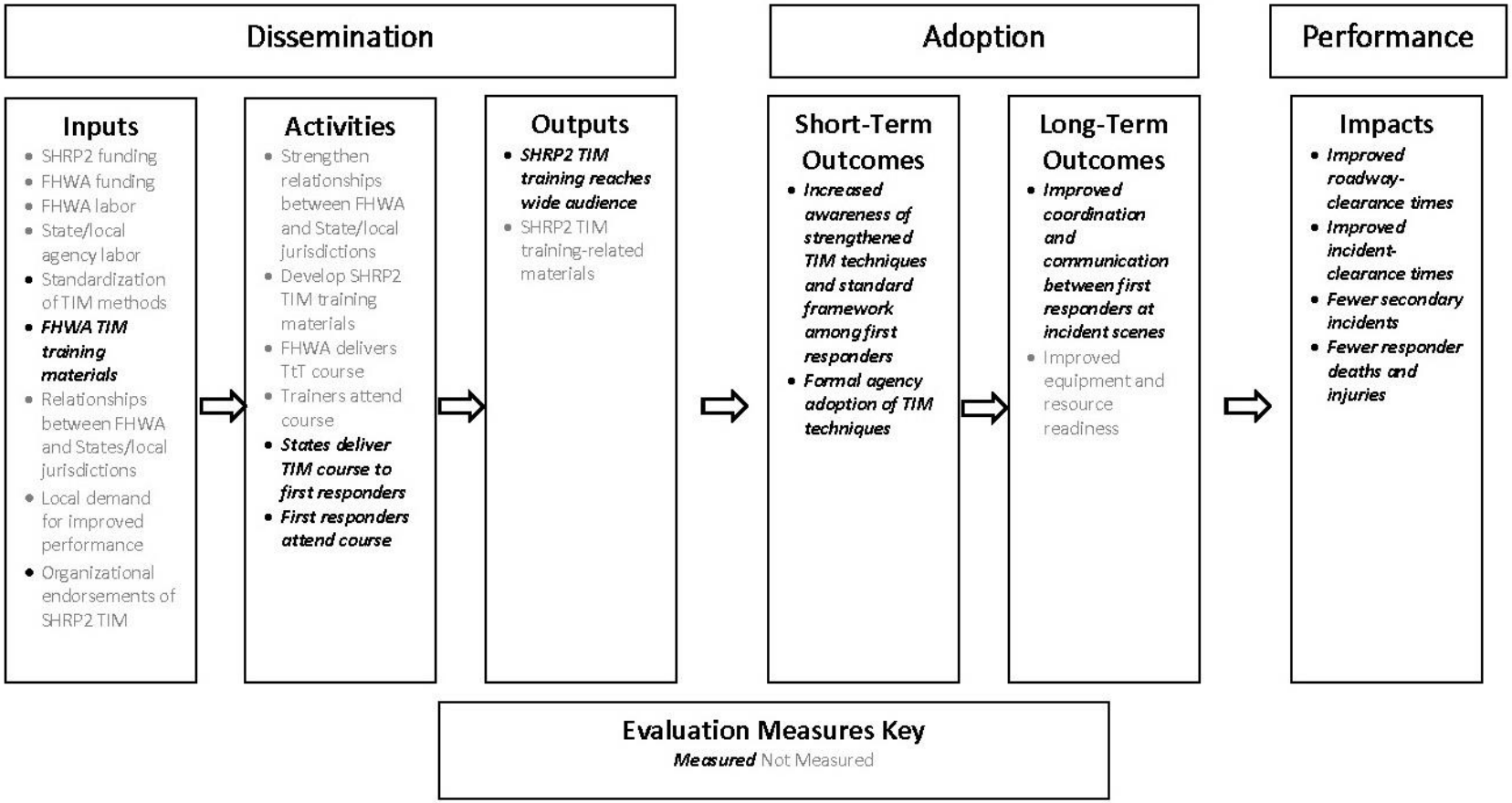
The next chapter, Evaluation Design, presents a logic model outlining the inputs, outputs, and expected outcomes of the SHRP2 TIM Responder Training Program and describes the key hypotheses, measures of effectiveness, and methodology of this evaluation. Chapter 3, Evaluation Findings, delineates the quantitative and qualitative findings by evaluation area (dissemination, adoption, and performance). The final chapter, Conclusion, summarizes this report.

2. Evaluation Design

2.1 Logic Model

A logic model is a series of statements that links program components (inputs, activities, outputs, outcomes, and impacts) in a chain of causality. It describes the relationship between program resources, planned activities, and expected results. It is not intended to be a comprehensive or linear description of all program processes and activities, but rather to clarify how stakeholders expect program activities to affect change. The logic model helps explain the theories of change that drive the design of a program and provides hypotheses that can be tested in an evaluation.

The SHRP2 TIM Responder Training Program logic model is displayed in figure 1.



Source: FHWA.

Figure 1. Illustration. SHRP2 TIM Responder Training Program logic model.

The SHRP2 TIM Responder Training Program logic model has six components. “Inputs” are resources and raw materials, such as program funding, dedicated personnel, and organizational endorsements. For SHRP2 TIM trainings, numerous organizations endorsed the Program, including the following:

- International Association of Chiefs of Police.
- International Association of Fire Chiefs.
- National Volunteer Fire Council.
- AASHTO.
- Towing and Recovery Association of America.
- State Association of Chiefs of Police.
- National Sheriffs Association.
- American Public Works Association.
- International Municipal Signal Association.
- Institute of Traffic Engineers.
- Intelligent Transportation Systems of America.
- National Association of County Engineers.
- Cumberland Valley Volunteer Firemen’s Association.
- National Association of State EMS Officials.
- International Association of Directors of Law Enforcement Standards and Training.[22]

“Activities” are actions that transform inputs into outputs. Research is a common activity in FHWA R&T logic models. “Outputs” are often media that deliver research findings, such as reports, guidebooks, trainings, and workshops. Together, these first three components cover the dissemination evaluation area. The new information embedded in outputs catalyzes short-term outcomes. “Short-term outcomes” are changes in awareness or knowledge that are considered necessary to achieve long-term outcomes. “Long-term outcomes” are changes in behavior and decisionmaking that are considered necessary to achieve impacts. Together, short- and long-term outcomes cover the adoption evaluation area. Finally, programs are usually designed to “move the needle” on specific metrics to be considered successful. “Impacts” are changes in these metrics that can be attributed to the Program. Impacts cover the performance evaluation area. In many FHWA R&T evaluations, short-term outcomes are expected to manifest within 3 yr, long-term outcomes within 7 yr, and impacts within 10 yr.

Each component of the logic model in figure 1 contains multiple items in bold that are measured in this evaluation. For example, “Short-Term Outcomes” include both “Increased awareness of strengthened TIM techniques and standard framework among first responders” and “Formal agency adoption of TIM techniques.” Items that are measured in this evaluation will be approached with both qualitative (e.g., interviews) and quantitative (e.g., statistics) methods. Several other items are included in the logic model for the sake of completeness but lie outside the scope of this evaluation.

2.2 Evaluation Hypotheses

Overview

Table 2 expands on the evaluation areas depicted in table 1. Each evaluation area can generate multiple hypotheses, and the evaluation team identified several measures of effectiveness by which to test these hypotheses.

Table 2. Hypotheses and measures of effectiveness.

Evaluation Area	Hypothesis	Measures of Effectiveness
Dissemination	At a national level, SHRP2 TIM trainings successfully reached a large number of responders across a diverse range of disciplines.	Number of disciplines attending trainings. Number of attendees. Proportion of trainings hosting multiple disciplines.
Dissemination	SHRP2 TIM trainings imparted new or additional TIM knowledge to attendees.	Attendee self-assessed value of training.
Adoption	SHRP2 TIM–training attendees changed their TIM practices in accordance with the trainings.	Percent or number of training attendees who changed personal TIM practices.[1]
Adoption	Departments or agencies sending responders to SHRP2 TIM trainings have formally adopted traffic-incident practices aligned with training recommendations.	Organizations' assessment of the adoption of SHRP2 TIM–training recommendations.
Performance	SHRP2 TIM trainings contributed to improved RCTs.	Time elapsed between the reporting of an incident and the clearance of the roadway. Trainees' assessments of how training impacted practices.
Performance	SHRP2 TIM trainings contributed to improved ICTs.	Time elapsed between the reporting of an incident and departure of final responder. Trainees' assessments of how training impacted practices.
Performance	SHRP2 TIM trainings contributed to a reduction in secondary incidents.	Number of secondary incidents that occurred while a primary incident was in progress. Trainees' assessments of how training impacted practices.

Table 2 shows that the evaluation approach consists of three evaluation areas: dissemination, adoption, and performance. The key hypotheses and their performance measures align with each of these areas, examining the spread of SHRP2 TIM–training knowledge and the impact of this training knowledge on agency practices and TIM performance outcomes.

Dissemination is measured by analyzing attendance records along with additional information from two case studies. Adoption of SHRP2 TIM–training methods will be assessed directly from emergency responders and responders' answers to postcourse assessments. Performance will be measured via a combination of quantitative analysis of incident data and qualitative information provided by responders and their agencies. Section 2.3 describes the evaluation methodology further.

[1]The evaluation team recognizes that this measure of effectiveness may be particularly difficult to measure precisely given multiple sources of TIM information—as well as extensive information sharing—available to responders.

2.3 Evaluation Methodology

Several data sources informed the evaluation of the SHRP2 TIM Responder Training Program. To assess the adoption and performance evaluation areas, the evaluation team focused on SHRP2 TIM trainings in Arizona and Tennessee. These States are considered strong cases that actively participated in SHRP2 TIM trainings and collected data on crashes. The evaluation team interviewed emergency responders, TIM trainers, and agency managers in both States and analyzed crash data. While choosing stronger cases may limit the ability of this evaluation to inform policies in States that are less advanced in TIM trainings, the evaluation team found that the analysis conducted for each case yielded insights that should be relevant to various jurisdictions.

Quantitative Data Analysis

FHWA, the Arizona Department of Public Safety (DPS), and the Tennessee Department of Transportation (TDOT) provided quantitative crash data to assist this evaluation. FHWA shared data on SHRP2 TIM–training locations, trainers, and attendees for all States and territories from 2012 to early 2016.

TDOT shared data on over 6,400 traffic crashes that occurred in Tennessee Region 1 (Eastern Tennessee, centered around Knoxville) from 2012 to 2015. Table 3 details total single- and multivehicle crashes that occurred on Tennessee Region 1 highways between 2012 and 2015. As shown in table 3, the number of multivehicle crashes increased over time.

Table 3. Single- and multivehicle crashes: Tennessee Region 1 (2012–2015).

Vehicles Involved	2012	2013	2014	2015
Single	441	529	381	438
Multiple	1,024	1,124	1,209	1,314

Arizona DPS provided data on approximately 88,000 highway crashes that occurred in Metropolitan Phoenix from 2012 to 2015. Data from Arizona DPS provided detail on the nature of vehicle crashes beyond the number of vehicles. As table 4 demonstrates, in Arizona, it is possible to determine whether a crash was injury, fatal, or property-damage-only. The distinctions between those types of crashes can affect TIM practices at a given scene and, if not properly accounted for, can distort comparison of performance indicators.[2] Fatal crashes, for instance, take significantly longer to clear as some jurisdictions require a homicide investigation unit and a medical examiner.[3] From 2012 to 2015, two-vehicle property-damage-only crashes were the most common type of crash in Metropolitan Phoenix. In comparison, there were far fewer fatal crashes.

Table 4. Total crashes by vehicle count and type: Metropolitan Phoenix (2012–2015).

Vehicles Involved	Property-Damage-Only	Injury	Fatality
One	11,556	5,088	142
Two	43,511	14,477	131
Over two	6,768	6,374	142

The following summarizes a selection of key crash variables in the Metropolitan Phoenix and Tennessee Region 1 data sets:

- Incident record number.
- Single- or multivehicle crash.

[2]TIM SMEs, phone interview conducted by Joseph Luna (evaluation team), February 2017.
[3]TIM SMEs, phone interview conducted by Joseph Luna (evaluation team), February 2017.

- Number of vehicles involved in crash (Arizona only).
- Time of incident.
- Time agency notified of incident.
- Incident location.
- Number of vehicles involved.
- Injuries associated with incident (Arizona only).
- Fatalities associated with incident (Arizona only).
- RCT.
- ICT.
- Occurrence of secondary incident (SI).
- SI that involves responders (Arizona only).

RCT is defined as the interval between the first recordable awareness of an incident and when the roadway travel lanes are clear for travel.[4] ICT refers to the interval between the first recordable awareness of an incident and when the last responder leaves the incident scene. SI refers to the number of additional crashes beginning with the time of detection of the primary incident in which a collision occurs within either the incident scene or its queue, including the opposite direction, resulting from the original incident.(23)

The evaluation team applied descriptive statistical analysis to FHWA TIM training data to assess the dissemination of SHRP2 TIM trainings across States and responder disciplines. With respect to the crash data, the evaluation team employed descriptive statistics and explored inferential methods (e.g., regression analysis) to assess the relationship between SHRP2 TIM trainings and key TIM performance metrics.[5] Given the differences in incidents that cause only property damage versus incidents that involve injuries or fatalities, the evaluation team subsetted statistical analysis under the advice of subject-matter experts (SMEs). Subsets consisted of whether incidents generated injuries or fatalities and whether incidents involved one or multiple vehicles.[6]

Interviews

To assess responders' perception of SHRP2 TIM trainings, illustrate agency changes in TIM practices, and clarify the impact of SHRP2 TIM trainings on key performance measures, the evaluation team relied on interviews with emergency responders and agency managers from Arizona and Tennessee. In addition, the evaluation team held conference calls with TIM SMEs to clarify traffic-incident scenarios and data questions.

Table 5 presents a list of persons interviewed and their agencies. While these interviewees were primarily drawn from State transportation departments and law enforcement, several interviewees also had experience as firefighters. The evaluation team recognizes, however, that the interview sample size is small and that these limited observations from Arizona and Tennessee may not apply to other States. The interview guide can be found in the appendix.

[4]However, traffic in these lanes does not necessarily have to be moving at normal speeds.

[5]Due to data errors, missing data, and difficulties linking trained responders to incidents, the inferential analysis will not be presented in this report.

[6]TIM SMEs, phone interview conducted by Joseph Luna (evaluation team), February 2017.

Table 5. List of interviewees.

Interviewee	Date of Interview	Organization
TIM SMEs	February 2017	FHWA, outside consultant
Road trooper and TIM trainer	April 2017	Arizona DPS
Road trooper and TIM trainer	April 2017	Arizona DPS
Former emergency manager	April 2017	Arizona Department of Transportation
Traffic operations manager	May 2017	TDOT
Road trooper and TIM trainer	May 2017	Tennessee Highway Patrol
Road trooper and TIM trainer	May 2017	Tennessee Highway Patrol
Road trooper	May 2017	Tennessee Highway Patrol
TIM SMEs	October 2017	FHWA

3. Evaluation Findings

3.1 Dissemination

Overview of Findings

Two hypotheses related to the dissemination of SHRP2 TIM trainings were studied. The first hypothesis pertained to whether SHRP2 TIM trainings reached responders from a variety of agencies. The second hypothesis pertained to whether attendees found that the trainings imparted useful knowledge.

Hypothesis: At a national level, SHRP2 TIM trainings successfully reached a large number of responders across a diverse range of disciplines.

FHWA provided data on SHRP2 TIM–training attendance from 2012 to 2015. These data detailed the location and date of each SHRP2 TIM training, the trainer leading each session, and attendance broken down by responder discipline. The disciplines included police, fire, EMS, State transportation department personnel, tow operators, and other responders.

Finding: From 2012 to 2015, the SHRP2 TIM Responder Training Program trained over 125,000 emergency responders across the country.[1]

Between 2012 and 2015, over 5,000 SHRP2 TIM–training sessions were held around the country. Training sessions were conducted at multiple sites in all 50 States, the District of Columbia, and Puerto Rico. During this time period, a total of 126,145 emergency responders received SHRP2 TIM trainings. When broken down by responder discipline, 41,700 police officers, 45,943 firefighters, 6,535 EMS personnel, 11,503 tow operators, 15,733 State transportation department personnel, and 4,731 other responders were trained.

Figure 2 depicts the number of responders who received SHRP2 TIM trainings by year and discipline.[2] In the first 2 yr of SHRP2 TIM trainings, police officers comprised the plurality of trainees. Ultimately, more firefighters were trained as were an increasing number of other emergency responders.[3] Over the course of the study period, 3,764 emergency responders attended SHRP2 TIM trainings in Arizona. To date, approximately 23 percent of Arizona emergency responders are trained in TIM.(24) In Tennessee, 7,462 emergency responders attended SHRP2 TIM trainings from 2012 to 2015. In many cases, TIM trainings were offered to cadets at police and fire academies, ensuring that new emergency responders would already be well versed in TIM concepts.[4]

[1]To date, over 300,000 emergency responders have attended SHRP2 TIM trainings.

[2]For visual simplicity, the evaluation team is only including the police, fire, towing, and State transportation departments in these figures.

[3]It should be noted that, at a typical incident scene, there are usually twice as many firefighters as law-enforcement officers. (TIM SMEs, conference call led by Joseph Luna (evaluation team), October 2017.)

[4]TIM SMEs, conference call led by Joseph Luna (evaluation team), October 2017.

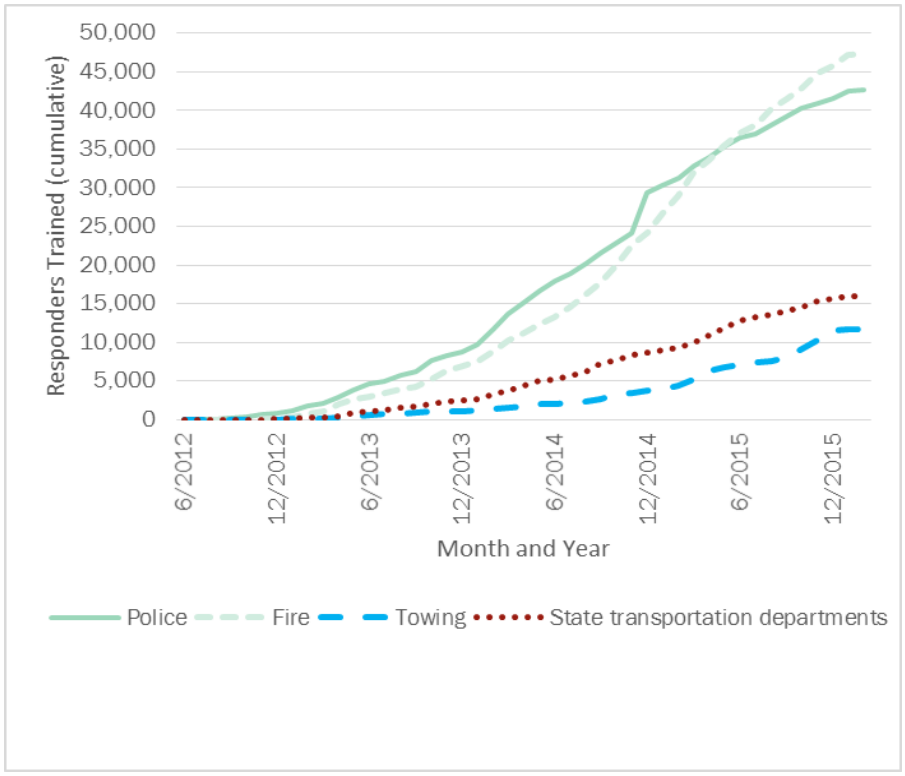
Source: FHWA.

Figure 2. Bar chart. SHRP2 TIM–trained responders by year and discipline.

Finding: The rate at which members of different disciplines attended SHRP2 TIM trainings varied by State.

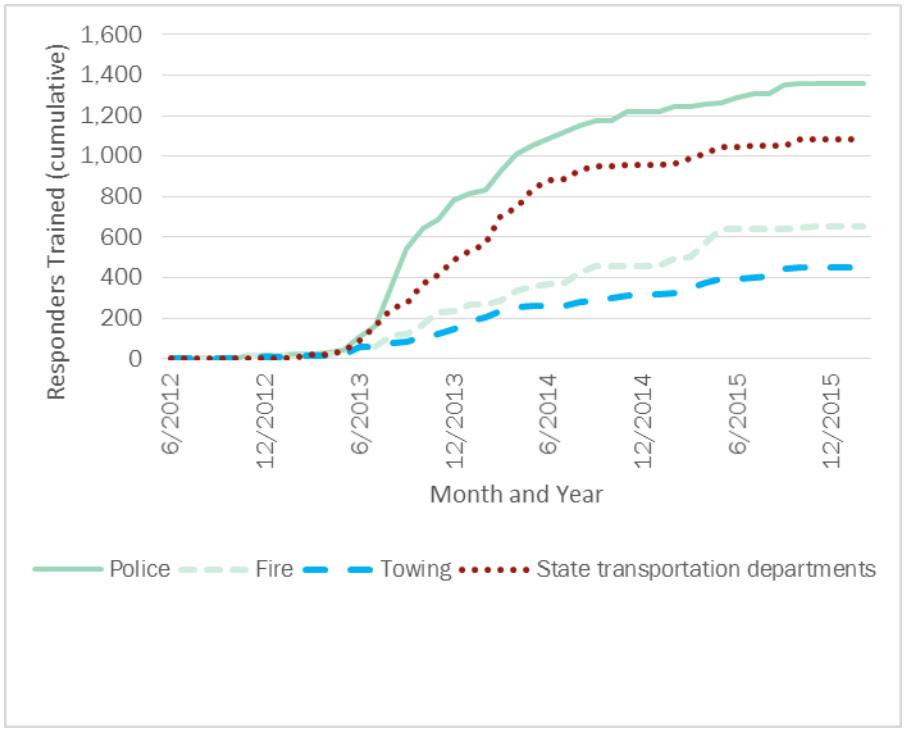
Figure 3, figure 4, and figure 5 illustrate that, while the number of individuals trained plateaued in Arizona and Tennessee at the end of 2015, the rate at which members of different disciplines received the training varied by State.[5] It is clear that police officers were the earliest recipients of TIM training though the relative breakdown by discipline of responders trained differed by State. The number of responders from each discipline who were exposed to TIM training increased steadily in Arizona and the country as a whole since the Program's inception. In Tennessee, the number of responders who had attended a training session did not increase as steadily. Such differences in the rate of training may be explained by the prevalence of trainings offered to large cadet classes at police and fire academies.

[5]It is possible, however, that these trends may have changed since the 2012–2015 study period.



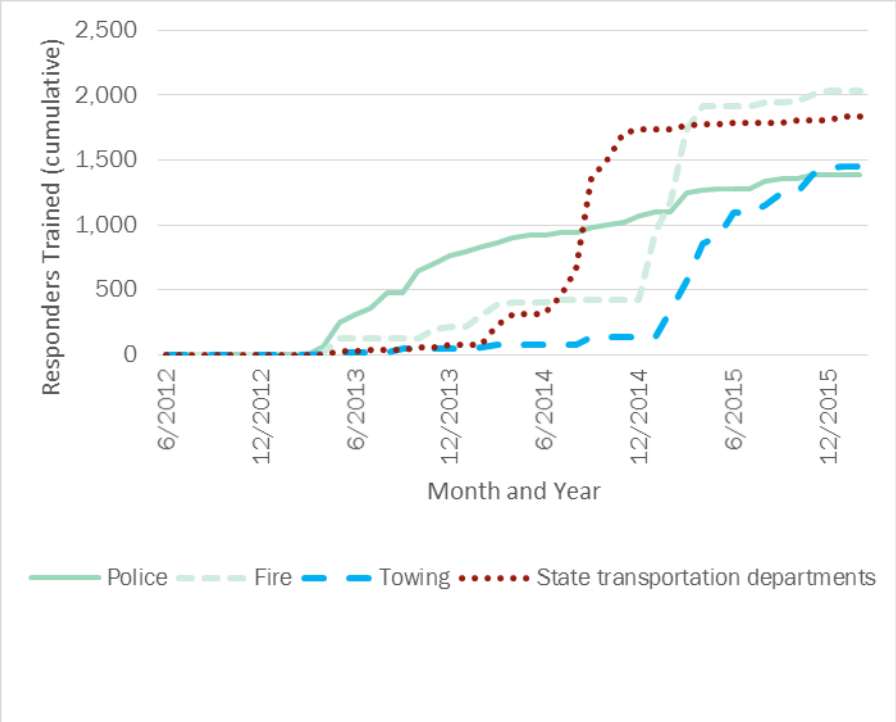
Source: FHWA.

Figure 3. Line graph. Cumulative number of responders trained over time by discipline: U.S. total.



Source: FHWA.

Figure 4. Line graph. Cumulative number of responders trained over time by discipline: Arizona.

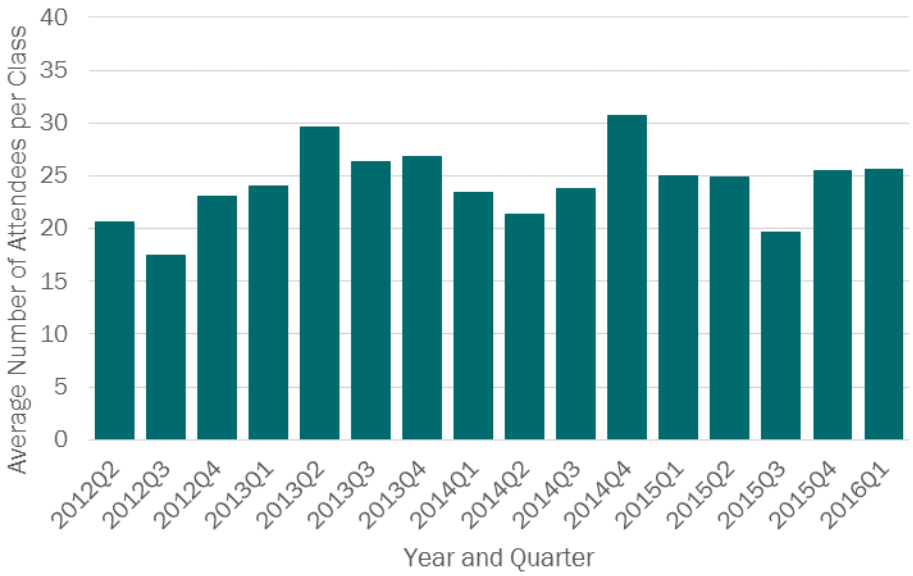


Source: FHWA.

Figure 5. Line graph. Cumulative number of responders trained over time by discipline: Tennessee.

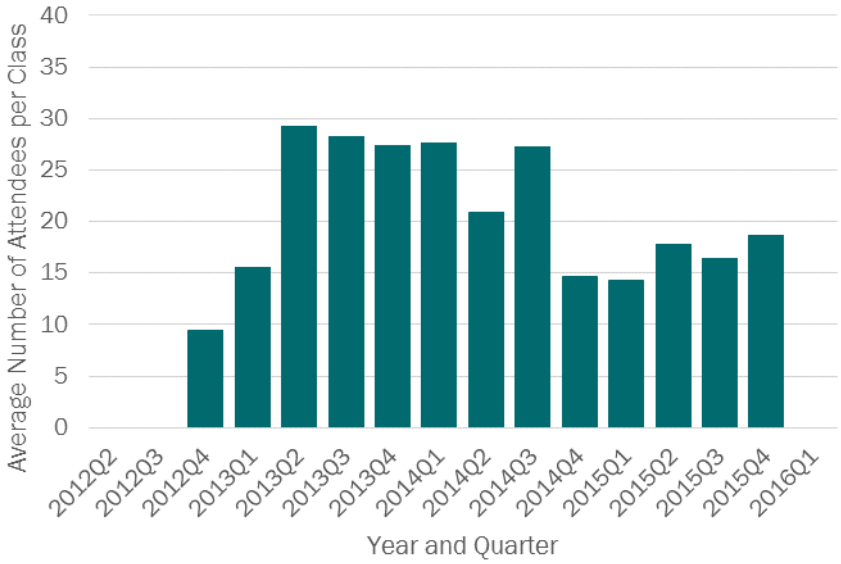
Finding: Across the country, the average size of training sessions remained relatively steady.

The value of TIM-training sessions may have been impacted by the size and composition of the classes. As figure 6, figure 7, and figure 8 show, the average size of training sessions across the country has remained relatively steady over the Program's lifetime. Moreover, there appears to have been little systematic difference in class size by geography; training sessions involved about 25 individuals on average nationwide, 23 individuals on average in Arizona, and 27 individuals on average in Tennessee.



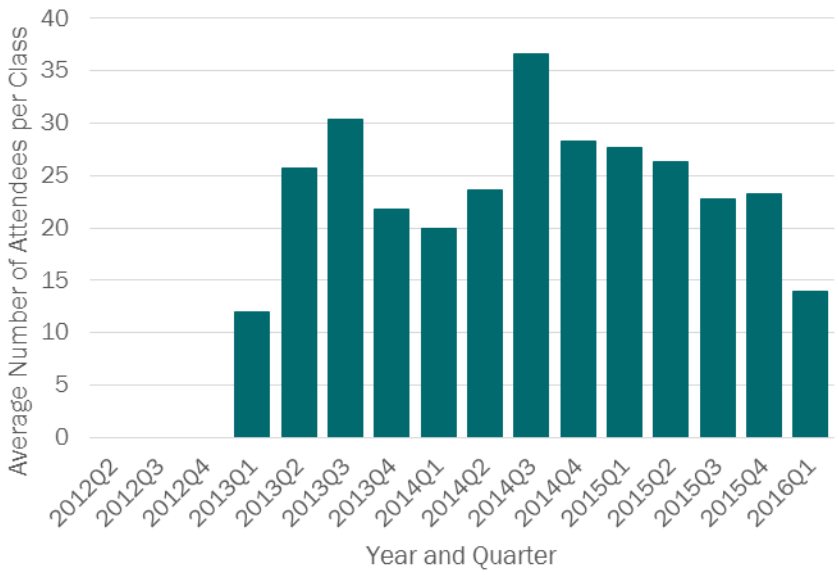
Source: FHWA.

Figure 6. Bar chart. Quarter-annual, average class size: U.S. total.



Source: FHWA.

Figure 7. Bar chart. Quarter-annual, average class size: Arizona.



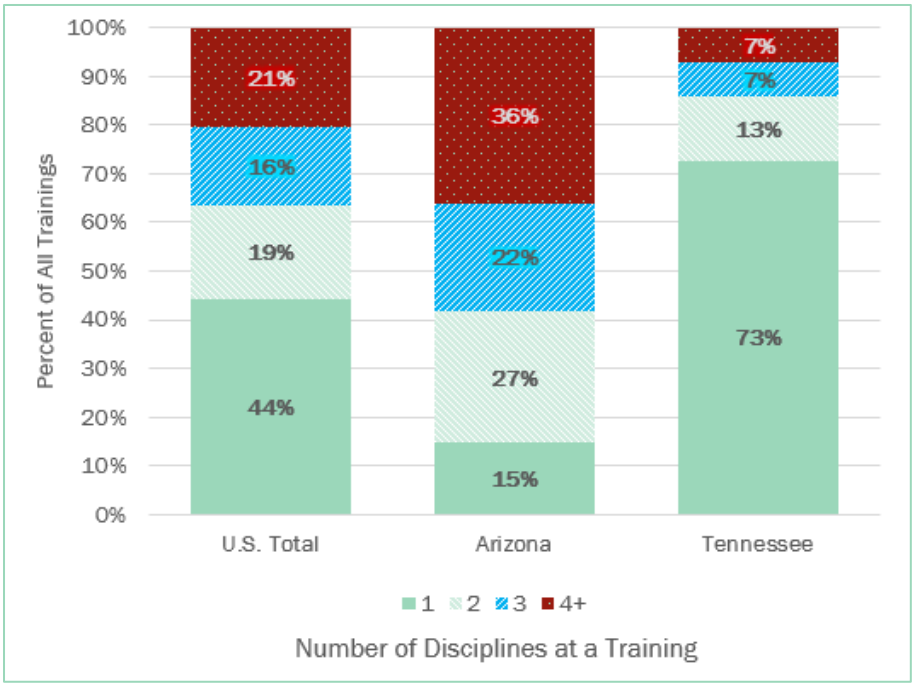
Source: FHWA.

Figure 8. Bar chart. Quarter-annual, average class size: Tennessee.

Finding: The average number of emergency-response disciplines represented at each training varied by State.

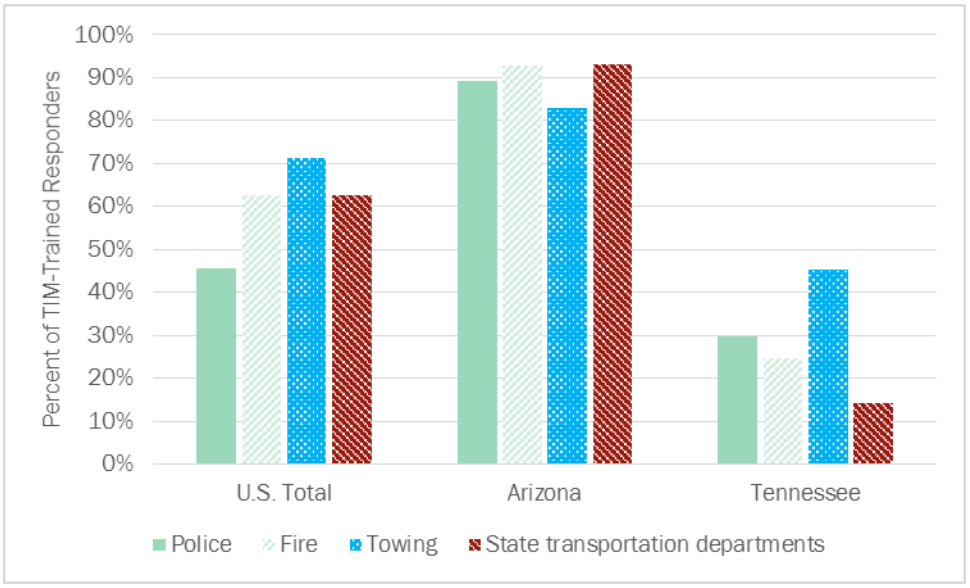
According to several interviewees, considerable benefits are gained from having a diverse set of disciplines in attendance at training sessions. Figure 9 breaks down the share of all classes in which attendees represented one, two, three, or four or more distinct disciplines. Nationwide, TIM-training sessions in Arizona were among the most consistently diverse of any State, whereas those in Tennessee were less diverse in terms of responder discipline. There were at least two different disciplines in attendance at 27 percent of the 281 total training sessions held in Tennessee, at 85 percent of the 163 total training sessions held in Arizona, and at 56 percent of the 5,204 total training sessions held across the country.

Figure 10 delves further into this trend, illustrating the likelihood that a responder who attended a TIM training went to a class composed of multiple disciplines. Some differences exist among disciplines—nationwide, for instance, police officers were most likely to attend classes composed only of other police. However, it is not clear that such differences would exist in each State.



Source: FHWA.

Figure 9. Bar chart. Breakdown of the number of disciplines in attendance at all trainings: United States, Arizona, and Tennessee.



Source: FHWA.

Figure 10. Bar chart. Share of all TIM-trained responders who attended classes with multiple disciplines.

Hypothesis: SHRP2 TIM trainings imparted new or additional knowledge to attendees.

Beyond assessing the attendance of SHRP2 TIM trainings, it is critical to assess how TIM trainings changed emergency responders' understandings and practices of TIM. Changes in understandings and practices could be achieved through the learning of new concepts or by seeing familiar material from a different perspective.

Finding: Bringing multiple disciplines together allowed attendees to better understand responders outside their discipline.

In designing the SHRP2 TIM Responder Training Program, FHWA recognized the value of bringing together various responder disciplines so that responders could understand the perspectives and challenges facing their counterparts.(15) Interviewees praised the multidisciplinary settings of SHRP2 TIM trainings as follows:

> *"Unique from other trainings in the past because, before the TIM trainings, everyone just talked about working with the other disciplines. The SHRP2 [TIM] process says to put them all together and train them together."*[6]

> *"To me, one of the greatest things about that Program was to get those from one discipline to understand what those from other disciplines go through."*[7]

> *"Understanding the various disciplines and the struggles that they have on the same scenes. Understanding fire even when they're dealing with things. Understanding the tow companies, the medical companies."*[8]

> *"The students themselves enjoyed the training tremendously. It was the first time that I've seen everyone as a first responder get together to talk about it. Especially the towing industry. I appreciated hearing what they do so that I can adjust my actions at an incident accordingly."*[9]

One aspect appreciated by interviewees was an increased understanding of the difficulties faced by tow drivers and how best to facilitate communications between police and tow drivers. Similarly, some police interviewees reported that SHRP2 TIM trainings helped bridge gaps in understanding between police and fire agencies.

[6]Road trooper, Arizona DPS, phone interview conducted by Nathan Einstein and Joseph Luna (evaluation team), April 2017.

[7]Former emergency coordinator, Arizona Department of Transportation, phone interview conducted by Nathan Einstein and Joseph Luna (evaluation team), April 2017.

[8]Road trooper, Arizona DPS, phone interview conducted by Nathan Einstein and Joseph Luna (evaluation team), May 2017.

[9]Road trooper, Arizona DPS, phone interview conducted by Nathan Einstein and Joseph Luna (evaluation team), April 2017.

3.2 Adoption

Overview of Findings

Interviewees indicated that SHRP2 TIM trainees in Arizona and Tennessee changed their TIM practices as a result of these trainings. While interviewees stated that their agencies improved their official practices as a result of SHRP2 TIM trainings, it was difficult to clarify whether such changes were due specifically to SHRP2 TIM trainings or other policy changes. While such difficulty in isolating specific "treatment effects" of SHRP2 TIM trainings is not ideal for rigorous evaluation, there is still significant public value to multiple TIM-related improvements occurring in parallel.

Hypothesis: SHRP2 TIM–training attendees changed their TIM practices in accordance with the trainings.

The SHRP2 TIM Responder Training Program is designed to promote a shared understanding of how to achieve safe, quick clearance at an incident and establish prompt and reliable communications. Through the Program's multidisciplinary perspective, responders learn TIM best practices and recommendations that will help prevent additional injuries or delays.(7)

Finding: Interviewees reported that SHRP2 TIM trainings improved emergency responders' practices.

Interviewees reported a better understanding of the logistics and operational flow of a traffic-incident scene. Such improved understanding allowed responders to better manage which resources they would require over the course of incident response.

> *"Absolutely. I am also an incident command instructor, and one thing I always discussed was knowing all the resources out there. I now emphasize knowing the limits of the resources—for instance, calling a medical investigator [too late] will slow the response because it will take a while for them to get out. Or, you don't order a tow truck when the vehicle needs to be moved, rather you order the tow truck in anticipation of when the vehicle needs to be removed."*[10]

For some responders, SHRP2 TIM trainings changed perceptions of how to treat the effects of a traffic incident, namely, the queue that backs up (in both directions) once an incident occurs.

> *"Used to be that nobody knew what a queue was, so you used to work a crash and say, 'oh well, they'll [other drivers in queue] just have to wait.' Now, we'll have others out there—sometimes Tennessee Department of Transportation—it's a unified effort by different agencies to get the crash dealt with."*[11]

Such a realization—that an incident is actively causing congestion in both directions—can certainly facilitate faster incident clearance and lower the likelihood of a secondary crash.

[10]Road trooper, Arizona DPS, phone interview conducted by Nathan Einstein and Joseph Luna (evaluation team), April 2017.

[11]Road trooper, Tennessee Highway Patrol, phone interview conducted by Nathan Einstein and Joseph Luna (evaluation team), May 2017.

Beyond these interview findings, responders reviewed the SHRP2 TIM Responder Training Program through the TIM Training Post-Course Assessment Tool. This Tool, sponsored by the FHWA Office of Operations, aimed to assess student learning and measure the impact TIM trainings had on operations through surveys completed by responders and agency supervisors who attended a TIM training. One set of these surveys focused on behavior—specifically, whether or not students implemented TIM procedures and strategies provided in the training. Table 6 presents the average results of survey questions pertaining to responders' awareness and safety at traffic incidents. Of the 434 individuals who responded to this survey, 59 were agency supervisors.[12]

Table 6. TIM postcourse assessment of awareness and safety at incidents.

Question	Responder	Supervisor
Since receiving the training, how would you describe your/your staff's awareness and efforts to minimize secondary crashes at traffic-incident scenes?	85.3% more aware	72.6% more aware
Since receiving the training, how would you describe your/your staff's overall level of safety when working at traffic-incident scenes?	78.0% more safe	77.0% more safe
Since receiving the training, how would you describe your/your staff's awareness and behavior when working around moving traffic and the "zero buffer"?	73.8% more aware	51.1% more aware
Since receiving the training, how would you describe your/your staff's safety practices when exiting your responder vehicle at traffic incidents?	71.1% more safe	55.4% more safe
Since receiving the training, how would you describe your safety awareness when working around vehicle fires?	61.2% more aware	45.2% more aware

Finding: Attendees were able to apply the concepts they learned immediately in their daily work.

Beyond simply improving their TIM practices, some interviewees noted no delay between learning SHRP2 TIM materials and being able to put them into practice.

> *"Overall yes, [one is] immediately able to use SHRP2 training. I think you can leave the training and go to a scene and have that sense of urgency. What TIM does, it instills in you that reminder, that sense of urgency to get the highways open. In the big scheme of things, when that doesn't happen, [you get] people being stuck, and millions of dollars [worth of people's time in traffic]. You have other issues like secondary crashes. I think the whole thing instills that sense of urgency to get the roadways open."*[13]

[12]The evaluation team derived the TIM postcourse assessment data from one unpublished FHWA document and one draft FHWA document on the TIM postcourse surveys.

[13]Road trooper, Tennessee Highway Patrol, phone interview conducted by Chris Calley and Joseph Luna (evaluation team), May 2017.

Hypothesis: The departments or agencies sending responders to SHRP2 TIM trainings have formally adopted traffic-incident practices aligned with training recommendations.

While individual responders who have received SHRP2 TIM trainings may have improved their TIM practices and communications with other responder disciplines, it has been helpful for agencies to change their standard TIM procedures in line with SHRP2 TIM recommendations. Such changes in policy could allow responders who have not received SHRP2 TIM trainings or newly hired responders to immediately apply SHRP2 TIM concepts.

Finding: Interviewees stated that their departments or agencies changed practices as a result of the SHRP2 TIM Responder Training Program and State-led initiatives.

Interviewees noted that their States had mandated "Move Over" laws (where motorists involved in minor collisions are required to move their vehicles off the roadway) and reflective-vest regulations. Law-enforcement interviewees also stated that their agencies had updated regulations to ensure that tow-truck companies attended SHRP2 TIM trainings before being eligible for agency contracts. However, some interviewees were unsure if such changes were due to SHRP2 TIM trainings or State-led initiatives.[14]

One interviewee noted that SHRP2 TIM trainings spurred the creation of new guidelines for State transportation department help-truck operators and traffic management center staff.

> *"We've issued new [guidelines for] help-truck operators and the traffic management center has new operations manuals that they work from. Both changed very recently—they were reauthorized last year."*[15]

Another emergency responder noted that his agency emphasized protecting the traffic queue that results from an incident.

> *"I believe so, yes. For instance, [now we] protect the queue, where you might have secondary crashes a mile or two behind the main crash. Seems to be better communication with other agencies and TDOT."*[16]

Recently, the Arizona Department of Transportation in conjunction with DPS and the Arizona Professional Towing & Recovery Association launched a dedicated TIM website.(24) In addition to providing public resources and information about the National TIM Responder Training Program, the site lists upcoming TIM trainings across Arizona and allows participants to directly register for these trainings. Several other States have also launched dedicated TIM websites with information on TIM concepts and trainings. Such States include California, Indiana, New York, Vermont, and Washington.(25–29) Across the country, States and agencies have adopted TIM trainings into academy curricula for emergency responders.[17]

[14]However, one Arizona-based TIM SME did state that, after 2012, all of Arizona's TIM-related activities were SHRP2 activities. (TIM SME, conference call led by Joseph Luna (evaluation team), October 2017.)

[15]Transportation management center staff, TDOT, phone interview conducted by Nathan Einstein and Joseph Luna (evaluation team), May 2017.

[16]Road trooper, Tennessee Highway Patrol, phone interview by Nathan Einstein and Joseph Luna (evaluation team), May 2017.

[17]TIM SMEs, conference call led by Joseph Luna (evaluation team), October 2017.

3.3 Performance

Overview of Findings

The evaluation team found that SHRP2 TIM trainings were associated with a decrease in secondary incidents that killed or injured emergency responders in Metropolitan Phoenix. The evaluation team also found that RCTs and ICTs for several types of minor incidents were near or below 30 min for both Metropolitan Phoenix and Tennessee Region 1.

Hypothesis: SHRP2 TIM trainings contributed to a reduction in secondary crashes.

Secondary crashes that occur as a result of an initial crash, in either the same or opposite direction as the initial crash, form a key TIM performance metric. Secondary crashes present risks to emergency responders, who may be injured or killed by drivers who are distracted and do not notice the initial crash scene. However, secondary crashes can be difficult to measure and there is ongoing debate about the definition of a secondary crash.[9] In addition, many jurisdictions have only recently started collecting data on secondary crashes.[19]

Finding: Crash data from Metropolitan Phoenix demonstrated a reduction in secondary crashes that affect responders.

A key goal of SHRP2 TIM trainings is to ensure the safety of emergency responders attending to the scene of a traffic incident.[12] SHRP2 TIM concepts, such as clearing blocked lanes quickly, positioning vehicles correctly, and improving communications between responder disciplines, have reduced the number of secondary crashes that injured or killed responders.

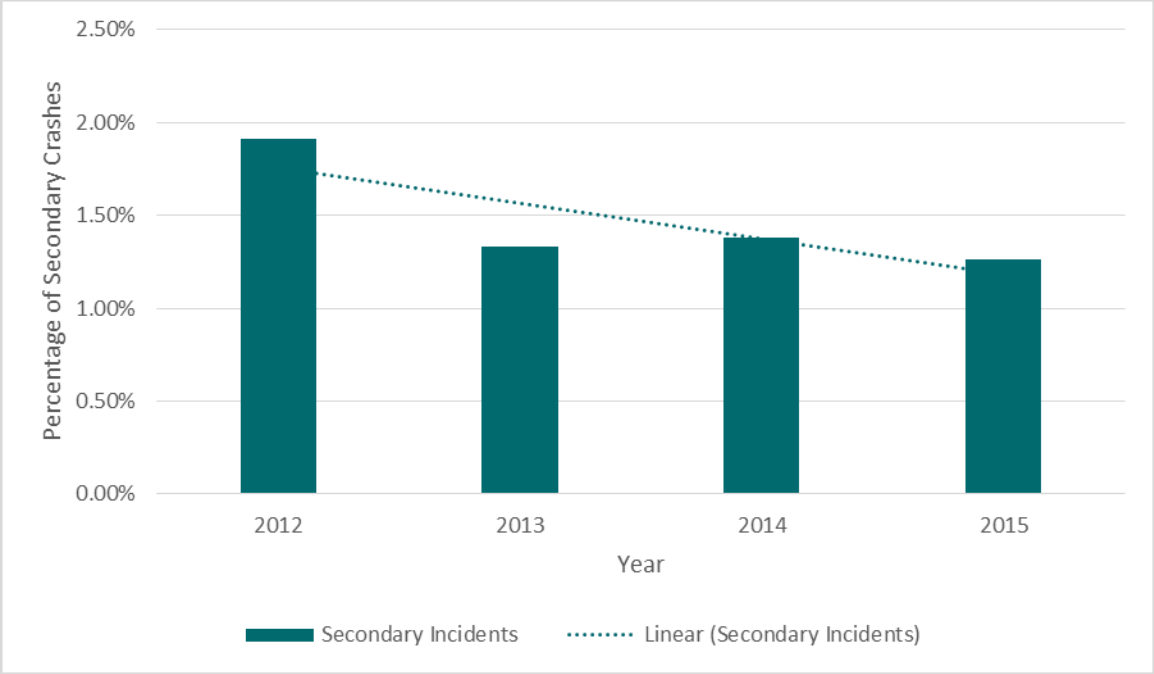
Figure 11 presents the percentage of secondary crashes in Metropolitan Phoenix that involved emergency responders. From 2012 to 2015, there was a negative trend in the percentage of secondary crashes that involved emergency responders. It is interesting to note that the overall number of crashes in Metropolitan Phoenix increased from 2012 to 2015.

Source: FHWA.

Figure 11. Bar chart. Percentage of secondary crashes involving responders: Metropolitan Phoenix.

Finding: Crash data from Tennessee Region 1 demonstrated a reduction in secondary crashes.

Figure 12 presents a negative trend in the percentage of secondary crashes that occurred in Tennessee Region 1 from 2012 to 2015. Similarly to Metropolitan Phoenix, the overall number of crashes in Tennessee Region 1 increased from 2012 to 2015.



Source: FHWA.

Figure 12. Bar chart. Percentage of secondary crashes: Tennessee Region 1.

Hypothesis: SHRP2 TIM trainings contributed to improved RCTs and ICTs.

RCT—that is, the interval it takes to remove a traffic incident from blocking an active roadway—is a key TIM performance metric. ICT—the interval between the first reportable awareness of an incident and the departure of the last emergency responder—is also a key TIM performance metric.[23]

Finding: SHRP2 TIM trainings furthered reductions in RCTs and ICTs in both Metropolitan Phoenix and Tennessee Region 1.

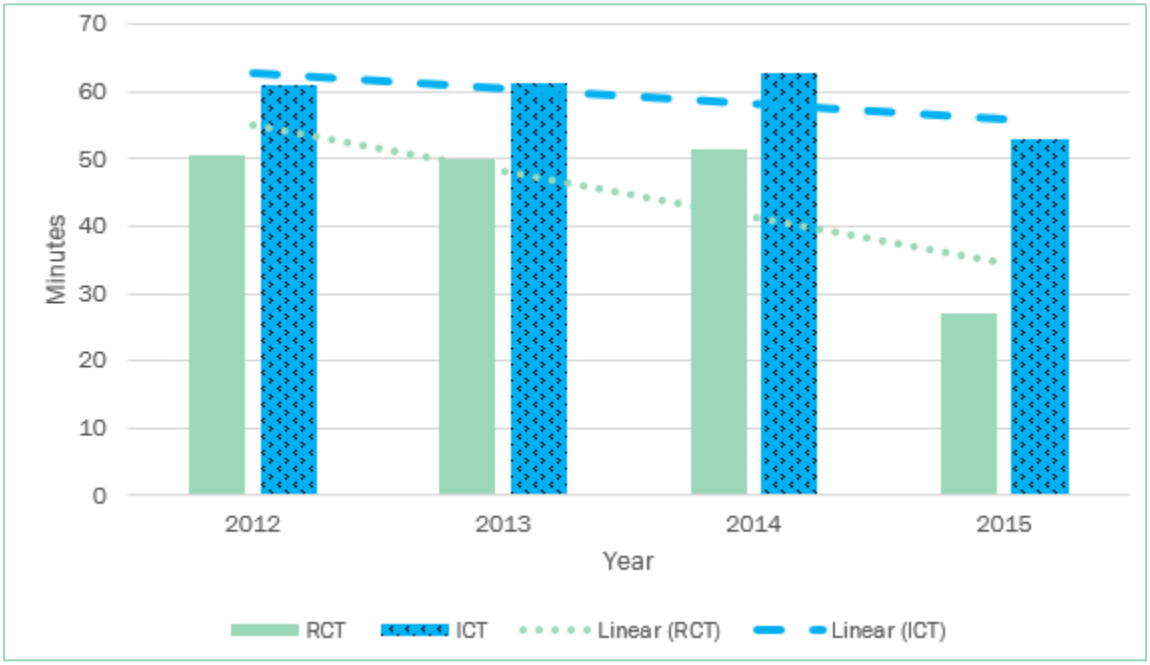
Interviewees agreed that SHRP2 TIM trainings changed behavior among emergency responders in a manner that reduced RCTs and ICTs. A common response was that clearing a blocked roadway became a much higher priority after responders participated in SHRP2 TIM trainings, resulting in shorter RCTs and fewer secondary crashes. For some interviewees, prioritizing roadway clearance lowered the risk of emergency responders being injured or killed by a secondary crash at the incident scene.

> *"Yes. Before, we wouldn't take crashes off the highway—you would just investigate it where it happened to occur. We definitely had a shift in those procedures, in taking crashes off the highway sooner than we did before."*[18]

Some interviewees noted that SHRP2 TIM trainings allowed them to understand incident response from the perspective of other agencies and become aware of nuances that could help expedite incident response. For instance, some emergency resources—such as tow trucks—can take longer to arrive on scene, so they should be contacted immediately. Being able to anticipate when resources will be needed can save minutes in incident clearance.

> *"Yes, absolutely. We're clearing the incident faster because we are focusing not just on one task at a time—we're multitasking and anticipating when things will be needed."*[19]

Since the early 2000s, Arizona and Tennessee have been among a leading group of States with respect to improving TIM.[30,16] Along with each State's prior TIM efforts, SHRP2 TIM trainings strengthened responder and agency practices, resulting in further reductions to overall RCTs and ICTs in both Metropolitan Phoenix and Tennessee Region 1. Figure 13 and figure 14 depict average RCTs and ICTs (in minutes) for each site, combining all crash types. These figures demonstrate that RCT and ICT decreased in both Metropolitan Phoenix and Tennessee Region 1 over the course of the study period.

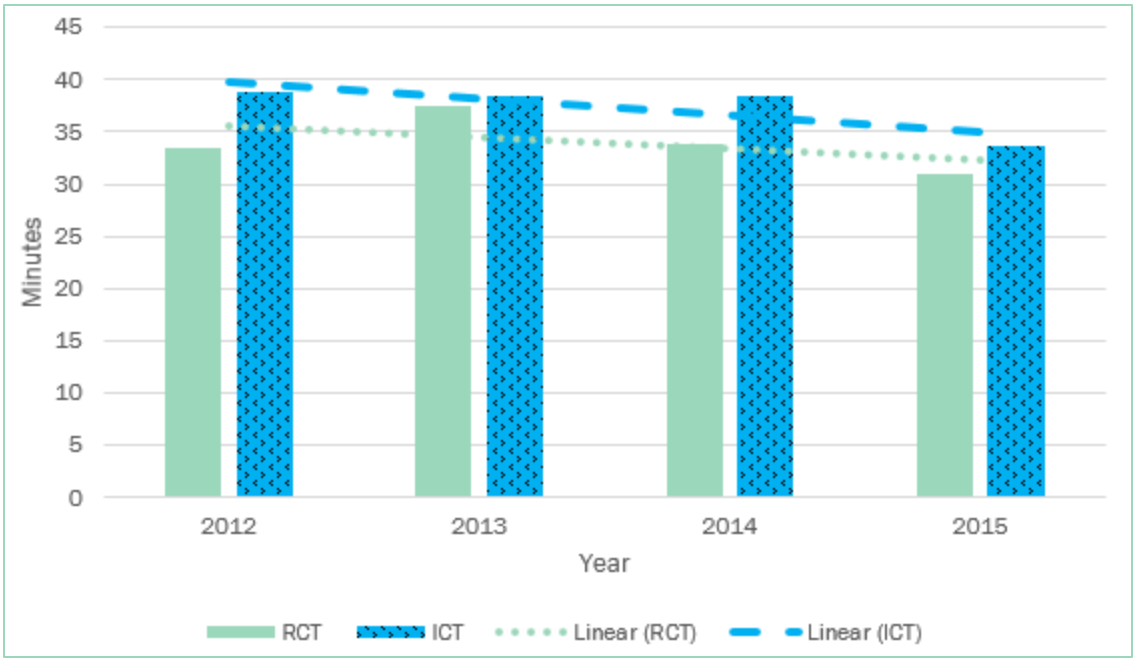


Source: FHWA.

Figure 13. Bar chart. RCTs and ICTs for all crash types: Metropolitan Phoenix.

[18]Road trooper, Arizona DPS, phone interview conducted by Nathan Einstein and Joseph Luna (evaluation team), April 2017.

[19]Road trooper, Arizona DPS, phone interview conducted by Nathan Einstein and Joseph Luna (evaluation team), April 2017.



Source: FHWA.

Figure 14. Bar chart. RCTs and ICTs for all crash types: Tennessee Region 1.

Within these aggregate results, there are many subsets of crash types that can be analyzed. One method of subsetting crashes is by the number of vehicles involved in the crash: one, two, or more vehicles. As demonstrated in table 4, two-vehicle crashes account for most crashes in Metropolitan Phoenix. Beyond the number of vehicles involved, crashes can be subdivided according to the nature or outcome of the crash. Crashes in which only the vehicles or surrounding physical assets are damaged (i.e., no injuries or fatalities) are termed property-damage-only crashes. Injury and fatal crashes are crashes that result in an injury or fatality.[20] It is important to subset crashes when analyzing TIM data in depth because the nature of incident response differs by crash subset. For example, property-damage-only crashes may not require EMS to be called. Fatal crashes often require longer RCTs and ICTs because many jurisdictions require on-scene investigations from homicide units and medical examiners.[21]

While there are a variety of crash subsets that can be analyzed, not all subsets will demonstrate the negative declines exhibited by the combined data set.[22] There may be omitted or difficult-to-measure variables that affect specific crash types—either raising or lowering their clearance times—that do not affect other crash types. For instance, it is possible that SHRP2 TIM trainings can reduce RCTs and ICTs for minor injury crashes that require various types of emergency responders but not reduce clearance times for property-damage-only crashes that require few responders. This difference may be magnified if minor property-damage-only crashes already have low clearance times or if those clearance times are low but vary randomly.

[20]Depending on jurisdiction, an injury or fatality that is reported within 30 d of the crash and connected to the crash would result in that crash being labeled as an injury or fatal crash. (TIM SMEs, phone interview conducted by Joseph Luna (evaluation team), February 2017.)

[21]TIM SMEs, phone interview conducted by Joseph Luna (evaluation team), February 2017.

[22]Such a phenomenon is known as the ecological-inference problem as well as Simpson's paradox. It is possible for all logical subsets to exhibit negative trends while the combined data set exhibits a positive trend.

From 2012 to 2015, RCTs and ICTs for minor crashes in Metropolitan Phoenix and Tennessee Region 1 maintained low levels, often below 30 min. The averaged results suggest that SHRP2 TIM trainings sustained and advanced gains made by Arizona and Tennessee in reducing RCTs and ICTs for this subset of crashes. In analyzing RCTs and ICTs, the evaluation team removed crashes from the data set that exceeded 12 hours in RCT or ICT, which represented less than 3 percent of crashes in each data set. Such excessive RCT or ICT lengths often result from data-entry errors. For instance, crashes that occurr before midnight and are cleared after midnight are sometimes entered incorrectly. Table 7 presents data for Tennessee Region 1, subdivided by whether a crash involved one or multiple vehicles. RCTs averaged around 30 min, and ICTs averaged approximately 37 min over the course of the study period (2012–2015).

Table 7. RCTs and ICTs (minutes) by crash type: Tennessee Region 1.

Measure	Single-Vehicle Crash	Multivehicle Crash
RCT	30.4	31.2
ICT	36.8	35.4

Phoenix data allowed for further subdivision of crashes by whether these crashes involved no injuries or fatalities (only property damage) or only injuries. Table 8 provides RCTs and ICTs for property-damage-only crashes in Metropolitan Phoenix grouped into one-, two-, and over two–vehicle crashes. The RCTs for two- and over two–vehicle property-damage-only crashes are especially low.[23] The data represent averages over the course of the study period (2012–2015).

Table 8. RCTs and ICTs (minutes) for property-damage-only crashes: Metropolitan Phoenix.

Measure	1-Vehicle Crash	2-Vehicle Crash	Over 2–Vehicle Crash
RCT	25.3	9.3	14.3
ICT	56.3	32.5	48.9

Table 9 presents RCTs and ICTs for injury crashes in Metropolitan Phoenix grouped by the number of vehicles involved. Despite the presence of injuries, two-vehicle crashes are cleared from the roadway in approximately 23 min. The data represent averages over the course of the study period (2012–2015).

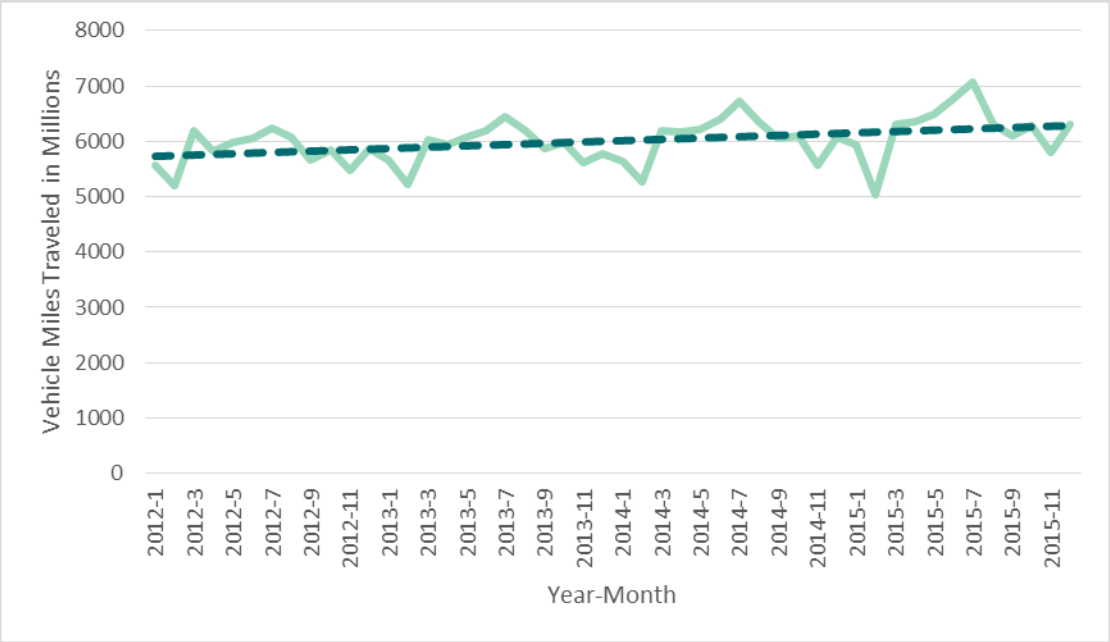
Table 9. RCTs and ICTs (minutes) for injury crashes: Metropolitan Phoenix.

Measure	1-Vehicle Crash	2-Vehicle Crash	Over 2–Vehicle Crash
RCT	43.0	23.3	33.2
ICT	74.4	50.4	66.8

Finding: These improvements in TIM performance metrics occurred during a general increase in vehicle miles traveled.

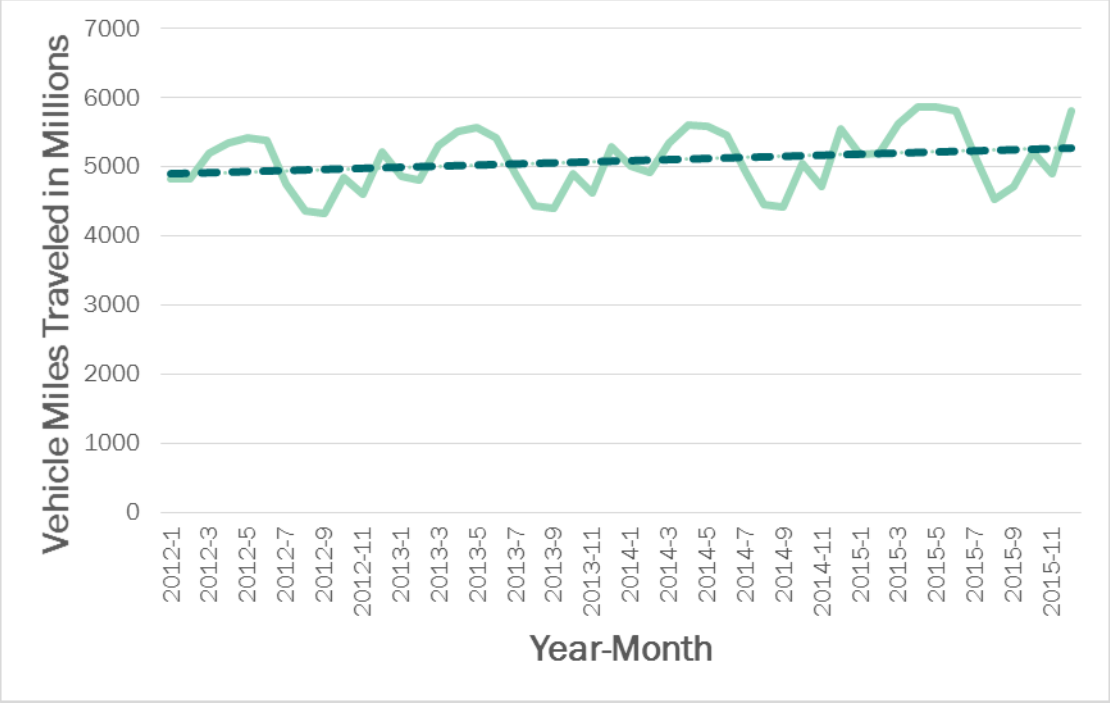
While the results regarding RCT, ICT, and secondary crashes are encouraging, they are even more impressive given that, over the 2012 to 2015 period, road demand, as measured by vehicle miles traveled, increased.(31) Figure 15 and figure 16 present vehicle miles traveled in both Tennessee and Arizona. With cars traveling more miles in these States, one would expect TIM performance metrics to suffer, but interviewees and quantitative analysis—while limited—suggested that those TIM metrics improved.

[23]In Metropolitan Phoenix, one-vehicle crashes are often rollover crashes, which can result in longer RCTs and ICTs. (TIM SMEs, conference call led by Joseph Luna (evaluation team), October 2017.)



Source: FHWA.

Figure 15. Line graph. Vehicle miles traveled: Tennessee.



Source: FHWA.

Figure 16. Line graph. Vehicles miles traveled: Arizona.

Finding: Crash data from Arizona and Tennessee contained a high proportion of missing data and erroneous data, which should be addressed before attempting more sophisticated quantitative analysis.

Missing or erroneous entries for several data variables affect the quality of the quantitative analysis that can be performed with TIM data. In both the Arizona and Tennessee data sets, the evaluation team encountered missing values for variables such as first recordable awareness of incident, RCT, and ICT. It is possible that, for many crashes, a missing RCT indicates an RCT of 0 min instead of that data is actually missing, but it is not possible to determine without further information. A common data error was a recorded RCT or ICT that occurred before the recorded time of incident, which provides invalid results. Another data error, which was corrected by the evaluation team with the assistance of TIM SMEs, was the miscalculation of RCTs and ICTs for crashes that occurred before midnight but were cleared after midnight. These errors often yielded artificially inflated RCTs and ICTs, but it can be impossible to determine whether certain incidents were incorrectly entered or actually had extremely long clearance times.

As demonstrated in table 10, around 30 percent of incident-clearance data is missing for Tennessee Region 1 for the years 2012 to 2015. In table 11, approximately 10 percent of roadway-clearance data is missing for Metropolitan Phoenix for the years 2012 to 2014, with improved data completeness in 2015.

Table 10. Percentage of missing data for RCT and ICT: Tennessee Region 1.

Performance Metric	2012	2013	2014	2015
RCT	0.34%	0.06%	0.00%	0.00%
ICT	27.71%	35.81%	33.52%	28.03%

Table 11. Percentage of missing data for RCT and ICT: Metropolitan Phoenix.

Performance Metric	2012	2013	2014	2015
RCT	11.1%	10.7%	10.6%	3.6%
ICT	4.7%	4.7%	4.3%	3.0%

High data missingness impedes the use of more sophisticated techniques, such as Weibull regression for duration data and nonparametric matching for causal inference. The evaluation team initially attempted to apply regression analysis (including linear, Weibull, and other methods) and matching methods but ultimately determined that the data from Arizona and Tennessee were not reliable and complete enough to yield accurate regression findings. The evaluation team recognizes that FHWA is continuing to work with State partners to improve TIM data collection through the EDC-4 initiative. The evaluation team particularly recommends that States, as funding permits, develop systems to detect incompletely or erroneously entered data and to train staff in data collection, maintenance, and analysis.

Beyond crash subsetting, a variety of other factors can influence the quantitative trends of TIM performance data. It is possible that data gathering by Arizona and Tennessee improved over the course of the study period and that agency staff were able to correct data errors in later years. Consequently, negative results or trends might be more pronounced in later years of the study period (due to remaining data errors biasing results in earlier years), skewing overall results in RCT and ICT.

This evaluation's data analysis is also limited in that it is impossible to determine, within the data available to the evaluation team, whether responders at a given crash had actually attended SHRP2 TIM trainings. However, even for crashes without formally TIM-trained responders, there were likely spillover effects of SHRP2 TIM trainings. Specifically, as more responders received training, SHRP2 TIM concepts were more likely to spread by example or word of mouth; such spillover effects would increase in likelihood as more responders receive the trainings over time.

Finding: FHWA and States are actively working to improve TIM processes and data accuracy through better tools, technology, and the EDC-4 initiative.

Though Arizona and Tennessee present two excellent cases of TIM, they also demonstrate the difficulty in ensuring accurate data reporting from emergency responders who are facing fast-paced potentially life-or-death situations. Since the end of this report's study period (2012–2015), many States have improved their collection of data related to TIM performance measures. Arizona, in particular, has recognized the importance of providing tools for clearer, more accurate data entry. Arizona has modified a version of Traffic and Criminal Software (TraCS) that allows emergency responders to more easily collect data for RCT, ICT, and secondary crashes.(32) Tennessee also uses a locally modified, electronic crash-reporting system to collect TIM data. At present, 16 States use TraCS or a similar system for TIM.(19) Such tools and technologies can help to automate the process of recording traffic-incident data, reducing the paperwork burden for emergency responders and their agencies.

Beyond Arizona and Tennessee, many other States are improving their TIM practices. For example, South Carolina recently evaluated its existing Incident Command System (ICS) and TIM practices to identify areas for improvement. Developed in the 1970s, the ICS outlines procedures for coordinating multiple responder agencies at an emergency scene. Today, ICS protocol is widespread and used by numerous agencies at all levels of government.(33) In 2017, South Carolina identified improvements to TIM procedures related to towing, hazardous materials, coroners, and crash investigation, drawing from best practices seen in other States. Changing towing incentives to expedite crash clearance could save South Carolina an average of 234 min for a single fatal incident.(33)

Other States are looking to incorporate emerging technologies to streamline crash investigations and facilitate traffic flows, not just on the affected roadways but also nearby roadways. Texas researchers have recently investigated the use of unmanned aircraft systems (UASs) to assist with TIM. The researchers confirmed that UASs could provide real-time confirmation and monitoring of a traffic incident as well as monitoring of alternate routes and secondary crashes.(34) UASs could also communicate video, photography, and sensor data to a central command center. However, more research must be done to assess remaining issues with the use of UAS for TIM, particularly potential legal issues.(34)

Through its EDC-4 initiative, FHWA has recognized the importance of providing better tools to improve TIM data collection for emergency responders and their agencies. FHWA is promoting low-cost, off-the-shelf technologies, such as integrated computer-aided dispatch, electronic crash reporting, Traffic Management Center software, and smart devices, to facilitate data collection. These tools can reduce paperwork burdens and assist agencies in expanding the data that they collect on traffic incidents. Ultimately, these measures could strengthen the overall quality of traffic-incident data.(19)

Improved data quality has numerous benefits. In addition to demonstrating TIM performance outcomes and impacts more accurately, complete data can also help evaluate the benefits of other technological and procedural innovations. For instance, if agencies acquire a new set of smart devices, those devices could reduce paperwork burdens on responders; complete data on incidents could then determine whether responders with those devices performed better in the field. Such evaluations can also identify any necessary process improvements. For the many agencies that face budget constraints, higher data quality gives agency leadership the opportunity to make stronger business cases to political leadership, helping to both save money and improve agency effectiveness.

Ultimately, the enhanced TIM technologies and procedures supported by States, FHWA, and EDC-4 can improve agencies' practices and enhance traffic safety. Traffic incidents exact high costs on the public and emergency responders, particularly with respect to secondary incidents that involve responders. Establishing procedures and technologies to facilitate data gathering and strengthen data quality can lead to long-term improvements in agency practices and public-safety outcomes. Reliable, accurate measurement of TIM metrics will incentivize front-line responders to meet and exceed TIM performance standards, ultimately improving safety for the traveling public.

4. Conclusion

From 2012 to 2015, the SHRP2 TIM Responder Training Program, in partnership with States and local agencies, oversaw more than 5,000 trainings, reaching over 125,000 emergency responders across the country. Responders valued the multidisciplinary nature of SHRP2 TIM trainings, which allowed them to understand traffic incidents from the perspectives of other emergency responders.

In terms of adopting TIM practices, interviewees noted that SHRP2 TIM concepts could be applied immediately after receiving the training. Interviewees reported that SHRP2 TIM trainings helped enhance several of their practices, such as calling for additional resources earlier in incident response. SHRP2 TIM trainings crystallized a mentality of removing incidents from roadways as quickly as possible to restore the flow of traffic, reduce the occurrence of secondary crashes, and minimize the likelihood of responder injuries and fatalities.

Examining the 2012 to 2015 period, the evaluation team found that SHRP2 TIM trainings contributed to reductions in secondary crashes in Tennessee Region 1 and reductions in secondary crashes involving responders in Metropolitan Phoenix. With respect to RCT and ICT, SHRP2 TIM trainings lowered durations when considering all crash types together. For specific crash types, the evaluation team found that SHRP2 TIM trainings contributed to low RCT and ICT for single- and multivehicle crashes in Tennessee Region 1 and for multivehicle property-damage-only and injury crashes in Metropolitan Phoenix. The evaluation team recommends, however, that States address issues of missing data in their TIM databases. Such missing data can limit the methods available for analyzing TIM performance metrics.

The evaluation team recognizes that FHWA is continuing to execute its data-driven approach to TIM. The evaluation team believes that the current EDC-4 initiative to address TIM data gaps and future data measurement is a strong step toward building State and local TIM capacity and in ensuring the safety of responders and the traveling public.[19]

Appendix. Interview Guide

Script: Thank you for agreeing to speak with us today. As mentioned in our emails, we represent the U.S. Department of Transportation, and we are currently evaluating the Federal Highway Administration's National Traffic Incident Management Responder Training Program, which was deployed under SHRP2, the second Strategic Highway Research Program.

As you know, the National TIM Responder Training Program was deployed in Arizona, and as part of our evaluation we would like to learn from your experiences in the program.

This is one of many interviews we plan to conduct for our evaluation, and in the next several months we will write our final report. This interview will not be recorded, but my colleague here will be typing notes. We may use quotes that you provide during this interview in our evaluation report; however, we will not cite you by name, but will instead use a generic description of your position and agency (e.g., Highway Trooper, State Highway Patrol). Would it be alright if we incorporated your quotes into our final report? (wait for response)

Thank you. We know that you have a busy schedule, so let's go ahead and get started.

1. Would you please describe your role in your agency?
2. Around which date(s) did you attend SHRP2 TIM training(s)?
3. Are you also a SHRP2 TIM trainer?
    a. *Probe:* Around which date(s) did you lead SHRP2 TIM trainings?
    b. *Probe:* Would you please describe your role as SHRP2 TIM trainer?
4. How would you describe the SHRP2 TIM trainings that you attended?
    a. *Probe:* About how many responders attended?
    b. *Probe:* How many disciplines and agencies were represented?
5. How were responders selected to receive SHRP2 TIM trainings?
    a. *Probe:* From 2012 to 2015, approximately how many personnel at your agency attended SHRP2 TIM trainings?
    b. *Probe:* Approximately how many personnel at your agency would have been eligible to attend SHRP2 TIM trainings?
    c. *Probe:* Approximately how many personnel at your agency have received TIM training that was not associated with SHRP2?
6. Many states have deployed TIM training programs and activities, both through SHRP2 and through their own state and local initiatives. Would you say that the SHRP2 TIM trainings imparted knowledge that was different from other TIM activities, or was that not the case?
    a. *Probe (if yes):* Could you specify what new knowledge was imparted by the SHRP2 TIM trainings?

7. Could you please describe any other TIM activities or policy changes that occurred before or during the SHRP2 TIM training period?
    a. *Probe:* Did these activities or policies result in any changes in TIM performance outcomes before or during the SHRP2 TIM training period?
8. Would you say that your personal TIM practices changed as a result of the SHRP2 TIM trainings, or was that not the case?
    a. *Probe:* And how did these practices change?
    b. *Probe:* Would you say that the SHRP2 TIM trainings improved communication between agencies at the incident scene, or was that not the case?
9. In your experience, would you say that you were able to immediately apply the SHRP2 TIM training concepts in your daily work, or would you say that it took more time for the concepts to take hold?
10. Have you discussed the practices taught at your SHRP2 TIM training with other responders who did not receive the SHRP2 TIM training?
    a. *Probe:* Do you think those responders will change their TIM practices as a result of this discussion, or do you think that would not be the case?
11. At a traffic incident, there may be responders who have received SHRP2 TIM training and responders who have not received that training. To what extent do you think your SHRP2 TIM training practices impact the behavior of those responders who have not received the training?
    a. *Probe:* Would you say that their TIM practices improved, or is that not the case?
12. Did your agency change formal TIM policies as a result of the SHRP2 TIM trainings, or was that not the case?
    a. *Probe:* Were formal TIM policies changed for any other reason?
    b. *Probe:* How did these changes in formal TIM policies affect your own practice of TIM?
13. Would you say that the SHRP2 TIM trainings contributed to a decrease in roadway-clearance times, or was that not the case?
    a. *Probe (if yes):* How did that happen?
    b. *Probe (if yes):* Can you think of any specific incidents where SHRP2 TIM concepts improved roadway clearance?
14. Would you say that the SHRP2 TIM trainings contributed to a decrease in incident-clearance times, or was that not the case?
    a. *Probe (if yes):* How did that happen?
    b. *Probe (if yes):* Can you think of any specific incidents where SHRP2 TIM concepts improved incident clearance?

15. Would you say that the SHRP2 TIM trainings contributed to a decrease in secondary crashes, or was that not the case?
    a. *Probe (if yes):* How did that happen?
    b. *Probe (if yes):* Can you think of any specific incidents where SHRP2 TIM concepts reduced secondary crashes?
16. Would you say that the SHRP2 TIM trainings contributed to a decrease in secondary crashes involving responders, or was that not the case?
    a. *Probe (if yes):* How did that happen?
    b. *Probe (if yes):* Can you think of any specific incidents where SHRP2 TIM concepts reduced secondary crashes involving responders?
17. What did you find most useful about the SHRP2 TIM trainings?
    a. *Probe:* Did you think it was easy to apply the concepts learned in the SHRP2 TIM trainings, or was that not the case?
18. Are there any particular types of incidents or scenarios for which you feel the TIM training was especially beneficial?
19. Do you think that there has been enough time to see the overall effects of the SHRP2 TIM trainings, or is more time needed?
20. Are there any changes that you would recommend to improve the SHRP2 TIM trainings?
21. Are there any changes that you would recommend to improving the rollout of the SHRP2 TIM trainings?
22. Is there anything else you would like to add?

Script: This brings our interview to a close. If you have any additional comments, please feel free to send them to us. If we have any additional questions, would it be alright if we reached out to you again?

As part of our evaluation, we want to ensure that we interview a comprehensive set of people involved in the SHRP2 TIM trainings in Arizona. Are there other first responders, SHRP2 TIM trainers, and agency managers that you think we should speak with? (get names and contacts, or have interviewee send via email)

The information you have provided has been valuable, and will greatly assist in this evaluation. Thank you again for your time today, and we wish you the very best in your work.

Acknowledgments

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